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JCTAX 66 (839) 1-134 (1994)

DECEMBER 1994



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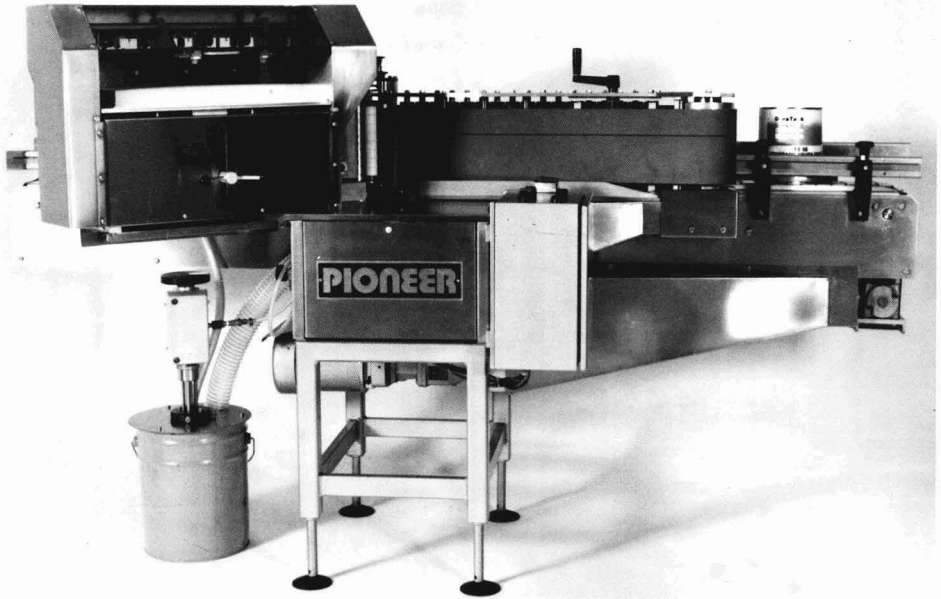
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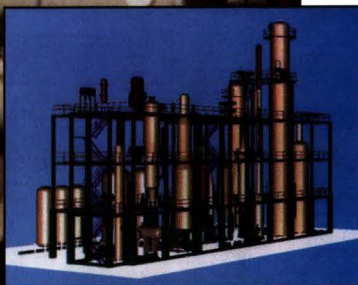
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- Technical Articles**
- 59 The Effect of Polyurethane Curing Conditions on the Delamination of Pressure Sensitive Films — B.W. Ludwig and M.W. Urban
- 69 High Performance Polyurethane Coating Systems Utilizing Oxazolidine-Based Reactive Diluents — G.N. Robinson, T.L. Johnson, and M.D. Hoffman
- 75 Melamine Phosphates and Pyrophosphates in Flame-Retardant Coatings: Old Products with New Potential — E. Weil and B. McSwigan
- 83 Evaluation of Corrosion Behavior of Metal-Filled Polymeric Coatings — N. Kouloumbi, G.M. Tsangaris, and S.T. Kyvelidis
- 89 Polymers for Water-Based Coatings — A Systematic Overview — J.C. Padget
- Federation News**
- 19 1994 FSCT Annual Meeting and Paint Industries' Show Wrap-Up
- 39 Fall 1994 Board of Directors Report

Departments

Comment	7	Future Society Meetings	122
Abstracts	8	People	123
Government & Industry	12	Meetings/Education	125
Regulatory UPDATE	35	Literature	129
1994 JCT Annual Index	107	Coming Events	132
Society Meetings	114	Humbug from Hillman	134
Elections	120		

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

Second class postage paid at Blue Bell, PA and at additional mailing offices. POSTMASTER: Send address changes to JOURNAL OF COATINGS TECHNOLOGY, 492 Norristown Rd., Blue Bell, PA 19422.

Subscriptions: U.S. and Canada — 1 year, \$30; 2 years, \$57; 3 years, \$82. Europe (Air Mail) — 1 year, \$60; 2 years, \$117; 3 years \$172. Other Countries — 1 year, \$45; 2 years, \$87; 3 years, \$127.



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The JOURNAL OF COATINGS TECHNOLOGY is published monthly by the Federation of Societies for Coatings Technology at 492 Norristown Rd., Blue Bell, PA 19422-2350. Phone: (610) 940-0777. FAX: (610) 940-0292.

Annual dues for Active and Associate Members of the Federation of Societies for Coatings Technology is \$20.00. Of this amount, \$13.50 is allocated to a membership subscription to this publication. Membership in the Federation is obtained through prior affiliation with, and payment of dues to, one of its 26 Constituent Societies. Non-member subscription rates are:

	U.S. and Canada	Europe (Air Mail)	Other Countries
1 Year	\$30.00	\$60.00	\$45.00
2 Years	\$57.00	\$117.00	\$87.00
3 Years	\$82.00	\$172.00	\$127.00

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

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

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Comment

Out with the Old, In With the New

While change can sometimes be unpredictable, one of the few things in this world which is predictable is that change *will* happen. Whether we like it or not time moves forward and, if we're lucky, so do we! That is why as the curtain comes down on 1994, we are very excited about the many differences our members and readers will see in the coming 12 months.

For starters, this "Comment" is being prepared on the Federation's new state of the art computer system. Although it served our needs well in the '80s, the old system did not allow the FSCT to utilize the new and better methods now available to gather and disseminate information. Although the transition to new methods of staff operation takes time, the changes in information technology will bring increased service to our members for years to come.

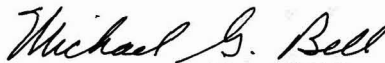
In the past year, the FSCT made inroads on the technology highway with the inception of the MSDS/CD-ROM project, PANORAMA™. This system provides users with up-to-date information on thousands of raw material MSDSs at the touch of a button. Imagine storing vast amounts of knowledge on a four-inch disk, information retrievable in an instant. Added to this will be a completely updated and revised edition of the Raw Material Index, previously published by NPCA, as well as NAFTA-related certificates of origin and harmonized number information.

The new year will have the Federation exploring new lands, with Spring Week events in Mexico. The session, scheduled for May 17-22, 1995, in Cancun, will feature the technical program, "Coatings in the Americas: Regulatory and Technological Issues."

Another change about to take place is the revised format for the JOURNAL OF COATINGS TECHNOLOGY. Featuring more information, particularly useful in the day-to-day work of the coatings chemist, the new JCT will be easier to read and easier to use. Look for the change beginning with the January 1995 issue.

Meanwhile, in looking ahead, let's not overlook the past. Featured this month is a review of the recent and very successful Annual Meeting and Paint Industries' Show held in New Orleans. The big city at the Mississippi's Delta may never be the same!

Look ahead, also, for the 60th Paint Show, which will be held October 9-11, 1995, in St. Louis. We promise you that the changes (for the better) haven't stopped!



Michael G. Bell
Director of Educational Services

Abstracts of Papers in This Issue

(Translation provided by: Cesar Fuentes Carrasco, of Instituto Mexicano de Tecnicos en Pinturas y Tintas.)

The Effect of Polyurethane Curing Conditions on the Delamination of Pressure Sensitive Films—B.W. Ludwig and M.W. Urban

JCT, 66, No. 839, 59 (Dec. 1994)

The application of vinyl films as graphics materials to the surface of urethane coatings used in OEM and vehicle refinishes is a common practice. However, if urethane coatings are not properly cured, the vinyl films may delaminate due to the evolution of gases within the coatings. In this study, the influence of curing temperature and time on the extent of delamination observed for several vinyl films having various degrees of permeability was examined. Using a newly developed "photoacoustic umbrella" Fourier transform infrared spectroscopy (PA FTIR) technique, CO₂ has been identified as the gas responsible for the delamination of the graphics films. The mechanism of CO₂ production and its relationship to the curing conditions are also discussed.

High Performance Polyurethane Coating Systems Utilizing Oxazolidine-Based Reactive Diluents—G.N. Robinson, T.L. Johnson, and M.D. Hoffman

JCT, 66, No. 839, 67 (Dec. 1994)

Recent changes in environmental regulations have required that volatile emissions from coatings be reduced. Currently, many approaches are being offered to help reduce volatile organic compounds (VOC) in industrial coatings. The use of reactive diluent chemistries has proven to be a viable concept in meeting current VOC compliance mandates. As newer regulations limit VOC more severely, more effective reactive diluents will be essential to meet the lower VOC requirements. A new class of ultra-low viscosity oxazolidine-based reactive diluents has been found which demonstrates excellent reactivity while also improving coating performance. As a result of this development, current solvent-borne industrial urethane coating technology can be made to meet the new VOC regulations as well as offering an effective solution toward compliance of any future mandated VOC levels.

Melamine Phosphates and Pyrophosphates in Flame-Retardant Coatings: Old Products with New Potential—E. Weil and B. McSwigan

JCT, 66, No. 839, 75 (Dec. 1994)

The use of melamine salts of phosphoric and pyrophosphoric acid in flame-retardant coatings, particularly intumescent coatings, is reviewed. Recent insights into mode of action suggest that several vapor phase and solid phase actions occur, involving both the melamine and the phosphoric acid portions of the salt molecule. Melamine phosphates cover a wide range of stabilities and vary in water solubility. Melamine pyrophosphate is the most thermally stable and the least water soluble of the available melamine phosphates. Fire-retardant coating applications are known for the melamine phosphates in coatings based on tung oil, chlorinated rubber, various vinyl latices, epoxy and amino resins.

Efecto De Las Condiciones De Curado De Poliuretano En La Delaminacion De Peliculas Sensibles A La Presion—B.W. Ludwig y M.W. Urban

JCT, 66, No. 839, 59 (Dec. 1994)

La aplicación de películas vinílicas como materiales gráficos para la superficie de recubrimientos uretánicos usados en OEM y repintado automotriz es una práctica común, sin embargo si el recubrimiento de uretano no es curado adecuadamente las películas de vinilo pueden delaminarse debido a la evolución de gases en los recubrimientos. En este estudio, se ha examinado la influencia de la temperatura y el tiempo de curado para la observación de la delaminación en varias películas de vinilo teniendo varios grados de permeabilidad. Se ha identificado mediante el uso de un nuevo desarrollo en la técnica de espectroscopia infrarroja de transformada de Fourier con "paraguas fotoestático" (PA-FT-IR) que el CO₂ es un gas responsable de la delaminación de películas gráficas. Se discute el mecanismo de producción del CO₂ y su relación con las condiciones de curado.

Alto Desarrollo En Sistemas De Recubrimiento De Poliuretano Utilizando Diluyentes Reactivos Basados en Oxazolidina—G.N. Robinson, T.L. Johnson, y M.D. Hoffman

JCT, 66, No. 839, 67 (Dec. 1994)

Los recientes cambios en las regulaciones ambientales han requerido que las emisiones de volátiles en recubrimientos sean reducidas. Comúnmente, se ofrecen muchas formas para ayudar a la reducción de compuestos orgánicos volátiles (VOC) en recubrimientos industriales. El uso de diluyentes reactivos más efectivos será esencial para cumplir con los requerimientos para la disminución de VOCs. Se ha encontrado una nueva clase de diluyentes reactivos de ultra-baja viscosidad a base de oxazolidina demostrando excelente reactividad al mismo tiempo también mejora el desarrollo del recubrimiento. Como un resultado de este desarrollo, la tecnología de recubrimientos uretánicos industriales base solvente pueden ser hechos para cumplir con las nuevas regulaciones de VOC al igual que ofrecer una solución efectiva para complacer cualquier mandato futuro en los niveles de VOC.

Fosfatos de Melamina y Pirofosfatos en Recubrimientos Retardantes a La Flama: Productos Viejos Con Nuevos Potenciales—E.D. Weil y B. McSwigan

JCT, 66, No. 839, 75 (Dec. 1994)

Se hace una revisión del uso de sales de melamina de ácido fosfórico y pirofosfórico en recubrimientos retardantes a la flama, particularmente en recubrimientos intumescentes (recubrimiento retardante el cual cuando se quema se vuelve plástico y produce gases no inflamables como CO₂ y NH₃). Recientes observaciones en su forma de actuar hace suponer que el proceso ocurre en la fase vapor y sólida involucrando a las moléculas de sal del ácido fosfórico y melamina. Los fosfatos de melamina caen en un amplio rango de estabilidad y varían en cuanto a la solubilidad en agua. El pirofosfato de melamina es mas estable termicamente y es menos soluble en agua que los fosfatos de melamina disponibles. Las aplicaciones de los recubrimientos retardantes a la flama para los fosfatos de melamina

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Evaluation of Corrosion Behavior of Metal-Filled Polymeric Coatings—N. Kouloumbi, G.M. Tsangaris and S.T. Kyvelidis

JCT, 66, No. 839, 83 (Dec. 1994)

Pretreated steel samples have been coated with a layer (~250µm) of a metal-filled (Ni, Cu, Fe) epoxy resin (Dow 324) deposited by a spinning process. The corrosion behavior of these specimens in 3.5% NaCl has been investigated by electrochemical impedance spectroscopy, Tafel measurements, and dielectric measurements undertaken in the frequency range of 20-10⁷ Hz. Correlation between the different approaches shows that coatings of epoxy resin composites filled with iron powder possessing higher ac resistance and lower capacitance are more protective than the pure epoxy resin coatings. On the contrary, copper or nickel powder addition leads to coatings which, though still protective, exhibit lower protection than the pure epoxy.

Polymers for Water-Based Coatings— A Systematic Overview—J.C. Padgett

JCT, 66, No. 839, 89 (Dec. 1994)

The various types of polymers used in waterborne coatings are reviewed systematically from the point of view of the methods of synthesis and their principal physical characteristics. The polymer types range from the two extremes of dispersions of highly insoluble polymers in water to highly water-soluble polymers, and cover a whole range of intermediate types, such as hydrophobically modified water-soluble polymers, swollen microgels, alkali soluble emulsions, alkali swellable emulsions, and water-reducible polymers. The key properties of each type are discussed with reference to the ways they are utilized in aqueous coatings and their film forming behavior.

Particular emphasis is placed on key developments over the years, and on more recent developments, such as associative thickeners, aqueous dispersions of step-growth polymers (notably aqueous polyurethanes), hybrid systems in which more than one polymer type is combined in the same system, aqueous radiation curing, voided polymer particles, and sequential polymerization techniques to give control over the morphology of emulsion polymer particles. The paper ends with a discussion of some of the deficiencies of waterborne coatings which will need to be addressed in the future.

en recubrimientos basados en aceite de tung, hule clorado, resinas epoxicas y aminicas son estudiadas.

Evaluacion Del Comportamiento De La Corrosion De Un Metal Cubierto Con Recubrimientos Polimericos—N. Kouloumbi, G.M. Tsangaris y S.T. Kyvelidis

JCT, 66, No. 839, 83 (Dec. 1994)

Muestras de acero pre-tratado han sido recubiertas con una capa (~250 µm) de un metal (Ni, Cu, Fe) con una resina epoxica depositada (Dow 324) por un proceso de hilado. El comportamiento en la corrosión de estos especimenes en 3.5% de NaCl se ha investigado por espectroscopía electroquímica y por mediciones Tafel y por mediciones dieléctricas en el rango de frecuencia de 20-10⁷ Hz. La correlación entre las diferentes aproximaciones muestra que los recubrimientos compuestos con resinas epóxicas y cubiertos con polvo de hierro con alta resistencia C.A. y baja capacitancia son más protectores que los recubrimientos con pura resina epóxica, por el contrario, la adición de polvos de cobre o níquel conducen a recubrimientos que son protectores pero exhiben menor protección que las puramente epoxicas.

Polimeros Para Recubrimientos Base Agua—Una Revision Sistemática—J.C. Padgett

JCT, 66, No. 839, 89 (Dec. 1994)

Varios tipos de polímeros usados en recubrimientos base agua son revisados sistemáticamente desde un punto de vista de los métodos de síntesis y sus principales características físicas. El rango de los tipos de polímeros en dispersiones cubren los dos extremos, desde los polímeros altamente insolubles en agua a los polímeros altamente solubles en agua y tienen un amplio rango de polímeros intermediarios, como los polímeros solubles en agua hidrofólicamente modificados, microgeles dilatados, emulsiones solubles a alcalis, emulsiones hinchables en alcalis y polímeros reducibles en agua. Se discuten aquí las propiedades principales de estos en relación a las formas en que son utilizados en recubrimientos acuosos y su comportamiento en la formación de películas.

Se pone un particular énfasis en su desarrollo através de los años y en los más recientes desarrollos como los espesantes asociativos, dispersiones acuosas que hacen crecer a los polímeros (notablemente los poliuretanos acuosos), sistemas híbridos en el cual mas de un tipo de polímero es combinado en el mismo sistema, el curado por radiación que evita particulas de polímeros y las técnicas de polimerización secuencial que dan un control sobre la morfología de la particulas de la emulsión del polímero.



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NPCA Presents Peter Flood with Heckel Award; Other Companies and Local Associations Honored

Recognized for making the membership recruitment and retention activities of the National Paint and Coatings Association (NPCA) a "personal priority," Peter E. Flood, President of the Flood Company, received the 1994 George Baugh Heckel Award. The award was presented at the association's 107th Annual Meeting in New Orleans, LA, on October 10-12, 1994.

Currently a member of NPCA's Board of Directors, Mr. Flood also serves on the association's Architectural Coatings Committee and is Chairman of the newly formed Membership Committee.

The Heckel Award, presented to Mr. Flood by 1994 recipient Robert J. Koch, is given in recognition of outstanding achievement and the contribution of significant time and energy toward the furtherance of a specific association goal.

In other news, NPCA announced the following companies as recipients of the Fourth Annual Pollution Prevention Awards: Benjamin Moore & Co., Milford, MA; Fuller O'Brien Paints, South San Francisco, CA; The Glidden Co., Huron, OH; and Passonno Paints, Watervliet, NY. The awards were presented during the honors luncheon in recognition of innovative efforts to minimize waste during the process of manufacturing paints and coatings.

The Benjamin Moore facility was honored for its commitment to waste minimization by involving all personnel in identifying opportunities to reduce and eliminate waste at the source and establishing corporate goals to achieve these reductions. After identifying several initial opportunities to reduce waste generation, the plant attained a corporate goal of reusing 100% of its wash water and reducing waste generation to under three percent by concentrating on source reduction and enhanced wash segregation.

Fuller O'Brien Paints emphasized source reduction by reformulating many solvent-based products with less hazardous substances and reusing spent solvents in new batches of product, which has contributed to achieving a zero discharge of wastes and reduced disposal costs and worker exposure considerations.

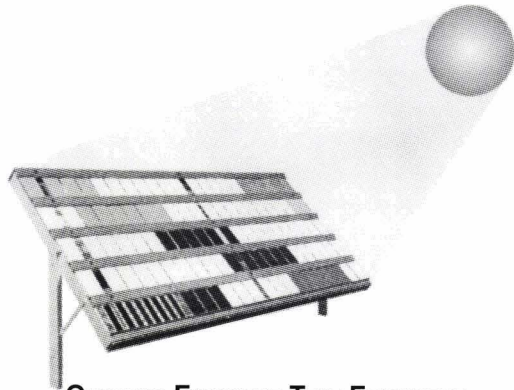
The Glidden Co. was acknowledged for their patented latex paint recovery process. This technique converts paint process wash water into a paint concentrate and a low-solids water. The paint concentrate is readily converted into a marketable consumer paint

and the water is reused into new batches of paint. This new process allows the Glidden Co. to reduce the discharge of treated wash water by over 350,000 gallons annually and

has reduced the number of filter cakes sent to landfills by 70%.

(Continued on next page.)

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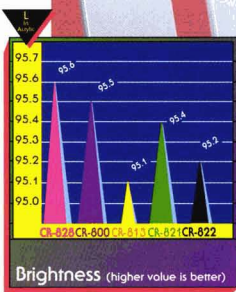
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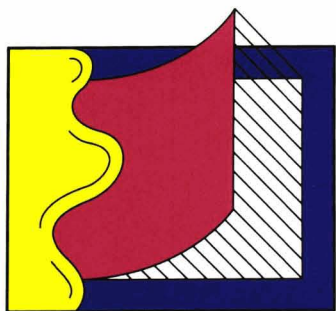
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Peter Flood NPCA's Heckel Award Winner

(Continued from previous page.)

For its longtime tradition of protecting the environment through waste minimization and toxics reduction technologies and practices, Passonno Paints received a Pollution Prevention Award. While solvents and wash water are currently reused to make new coating products, the company is experimenting with other uses for paint manufacturing wastes.

The 1994 Allen W. Clark Award was also presented to four local associations in recognition of outstanding community service efforts undertaken as part of NPCA's Picture It Painted (PIP) service program.

The Baltimore Coatings Association (BCA) sponsored two community improvement activities. BCA organized the painting of the new offices of a homeless advocate. Members donated paint, supplies, and manpower to brighten the interior of an older building. Their second project is part of an ongoing commitment to the local Habitat

for Humanity organization. This year, BCA teamed up with Habitat to provide exterior makeovers for low-income homes in the city's Sandtown area, by supplying paint, materials, and volunteer painters.

Another recipient of the Clark Award was the Cleveland Paint and Coatings Association for their four projects: (1) an anti-graffiti campaign; (2) painting of a newly-constructed S.W.A.T. training center; (3) the renovation of the Our Lady of Peace Transitional Housing facility; and (4) a mural project to help combat graffiti.

In Louisville, the paint association teamed up with the local Paint and Decorating Contractors of America and Local #118 of the International Brotherhood of Painters and Allied Trades to bring a complete makeover to the campus of Bellewood Presbyterian Home for Children.

The Dallas PIP team took third place honors for its partnership with the city of Fort Worth in sponsoring the Mayor's Anti-Graffiti Inner-City Cleanup program. With paint and instructions from DPCA, graffiti offenders replaced gang messages with creative mural drawings.

Also, NPCA honored three local paint and coatings associations with Gold Star Awards.

The New England Coatings Association, the Wisconsin Paint and Coatings Association, and the Cleveland Paint and Coatings Association were recognized for excelling in the areas of membership recruitment, community improvement, legislative/regulatory involvement, national association involvement, meetings, and publications. Entrants were categorized according to size and were awarded for meeting the criteria in each area of performance.

Hoechst Celanese Forms New Resins Business Unit

Hoechst Celanese Specialty Chemicals Group, Charlotte, NC, has formed a new resins business unit with technical-laboratory support to satisfy resin needs of performance and compliance formulators.

Under the direction of Hugh Fowler, the Business Director of the Performance and Compliance Resins business unit, this unit will begin marketing new resin products. The new resin products to be sold in North America include: Alftalat™, Beckopox™, Daotan™, Macrynal™, Phenodur™, Resydrol™, and Synthacryl™.

Singapore Site of Zeneca's Plant and Technical Center

A new Asia/Pacific venture for Zeneca Resins, Waalwijk, The Netherlands, has begun with the opening of a regional plant and technical center in Singapore. Built to support the company's regional sales, marketing, and customer service activities, the total capital investment is approximately \$20 million (Singapore dollars).

The Singapore plant will manufacture acrylic emulsions, advanced urethane dis-

persions, and novel acrylic-urethane products with a combined annual capacity of approximately 10,000 metric tons and is capable of developing new and customized products more suited to the needs of the Asia-Pacific region.

White Hydrate Facility to Be Built by Alcoa in Bauxite, AR

The North American Industrial Chemicals Division of Alcoa, Pittsburgh, PA, has targeted late 1994 as the time re-engineering and modernization of the hydrate chemicals production facility will begin. Located in Bauxite, AR, the existing hydrate chemicals process will continue to operate without interruption throughout the construction phase. Startup is scheduled for early 1996.

Hüls Announces Dedication of New IPDI Plant in Theodore, AL

A new \$40 million isocyanate plant was recently dedicated by Hüls America Inc., Piscataway, NJ. Located in Theodore, AL, the 22-million pound manufacturing unit is expected to be on stream in early 1996.

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Wood Furniture Reg-Neg Appears to Reach Consensus

A consensus on a draft standard for limiting hazardous air pollutants (HAPs) emissions from wood furniture manufacturing operations has been reached. Therefore, the U.S. Environmental Protection Agency (EPA) plans to issue a rule embodying the reg-neg agreement last month, according to a report published by the National Paint and Coatings Association, Washington, D.C.

The proposed rule, a National Emission Standard for Hazardous Air Pollutants (NESHAP), should be issued by EPA by mid-December to meet a court-ordered deadline for promulgation. The draft NESHAP contains emissions control levels and work practice strategies which constitute maximum achievable control technology (MACT). A draft model volatile organic compound (VOC) rule for the wood furniture industries has been agreed to earlier

this year by the reg-neg participants, and is already available to states for their use in planning and revising ozone control approaches.

The wood furniture reg-neg committee's last formal negotiating session was in December 1993; however, protracted and difficult negotiations since then appear to have resolved remaining issues of disagreement. These issues, which now appear to have been settled, include a new requirement for a formulation assessment plan, a requirement which will mandate additional tracking of certain HAPs and which will permit additional regulatory scrutiny of their overall use in coatings, as well as a requirement that industry produce a trends report that

will track HAPs and VOC usage levels and review technological trends in the industry.

Participating parties, which include furniture and kitchen cabinet manufacturers, the coatings industry and its suppliers, environmentalists, state agencies, health organizations, and EPA, now plan to formally agree to a proposal which will reflect the actual draft rule. The tentative consensus which the committee has achieved allows this rule to go forward in the rulemaking process as a consensus rule, which generally enhances the agreement's prospects of emerging essentially unchanged in EPA's final rule. However, industry will continue to examine the rule closely to uncover and resolve or clarify any remaining technical concerns.

Air Products Acquires Emulsions Manufacturer

Air Products and Chemicals Inc., Allentown, PA, has joined with a group of Mexican private investors to acquire the polymer emulsion producing assets of Dale Quimica, S.A. de C.V. The new company was renamed Air Products Resinas, S.A. de C.V. Although headquartered in Mexico City, the emulsions will be produced in San Juan del Rio, Queretaro. Terms of the acquisition were not disclosed.

CPMA Issues Background Document on OSHA Cadmium Standard as It Pertains to Cadmium Pigments

The Color Pigments Manufacturers Association (CPMA), Alexandria, VA, has issued a legal memorandum prepared by association counsel bringing manufacturers and users of cadmium pigments up-to-date on developments with respect to the Occupational Safety and Health Administration (OSHA) Cadmium Standard as it pertains to cadmium pigments.

The Federal Eleventh Circuit Court of Appeals, on March 22, 1994, exempted dry color formulators from the Cadmium Standard published in September 1992. The court's opinion was in response to a petition

submitted by the CPMA Cadmium Pigments Committee for review of the OSHA final rule for cadmium exposure in the workplace. The decision, in favor of the CPMA, in effect voids certain provisions that relate to the use of cadmium pigments in the workplace as promulgated in that standard.

Subsequent to that decision, OSHA filed several motions to limit the scope of the court's ruling. The court denied all of these motions, and, as a result of the court action, the decision of the court to reverse and remand the Cadmium Standard as it applies to dry color formulators stands.

CPMA has had brought to its attention the fact that several dry color formulator facilities which use cadmium pigments have been inspected by OSHA field enforcement personnel, and, in some instances, the OSHA field personnel were not aware of the current status of the standard. As such, the facility inspections are carried forward by OSHA representatives and unapplicable provisions of the Cadmium Standard could be the subject of enforcement action.

As a result, the CPMA legal memorandum was prepared to provide a brief description of the previous activities of the CPMA Cadmium Pigments Committee with respect to the standard and a review of its current status.

As outlined in that memorandum, the "court indicated that OSHA has not shown that the standard is technologically or economically feasible for dry color formulators. Unless, and until, the standard is shown to be feasible for this group of manufacturers in a new regulatory action, the standard remains unapplicable to dry color formulators. Therefore, dry color formulators should be regulated by the rules which were applicable prior to the promulgation of the standard: a PEL of 200 $\mu\text{g}/\text{m}^3$ as cadmium."

Degussa Dedicates Specialty Carbon Black Plant

Degussa Corp., Ridgefield Park, NJ, recently dedicated their new specialty carbon black production plant in Belpre, OH. This facility includes a new manufacturing unit capable of producing a diverse line of pigment-grade carbon blacks for printing inks, plastics, and coatings. With an initial capacity of 22 million pounds per year, the specialty unit will be part of Degussa's existing production complex in Belpre where carbon blacks and organosilanes are manufactured for the rubber industry.

The carbon black facility features new emission control equipment, which will allow the plant to reduce uncombusted (tailgas) emissions by 50%.

Previously, specialty carbon black had been imported by Degussa on an overall basis to North America from its parent company Degussa AG. Select grades will continue to be imported.

In January 1995, a new Applied Technology Center will be on stream to further support the carbon black customers. Located in Bath, OH, this 20,000 square foot

facility will house the technical support operations of Degussa's Carbon Black and Silica Divisions and is equipped with analytical and polymer/rubber processing equipment and special equipment for inks and coatings.

Kemira Changes Name; S.P. Morell to Distribute TiO₂

In an attempt to increase recognition of Kemira's pigments, Kemira, Inc., Savannah, GA, has changed its name to Kemira Pigments, Inc. All of the titanium dioxide manufacturing and marketing companies of Kemira Pigments Oy, Helsinki, Finland, will now share the Kemira Pigments name. This change is in name only and will have no impact upon operations or organizational structures.

In other news, the S.P. Morell Co., Tarrytown, NY, will distribute Kemira titanium dioxide.

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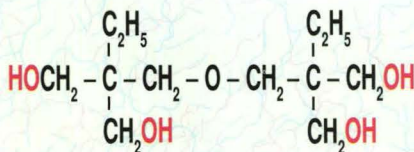
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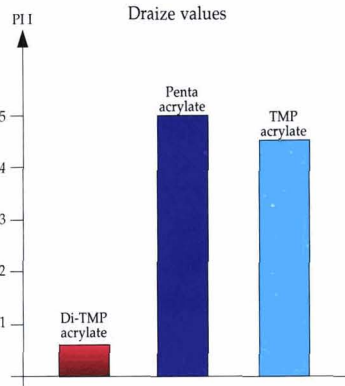
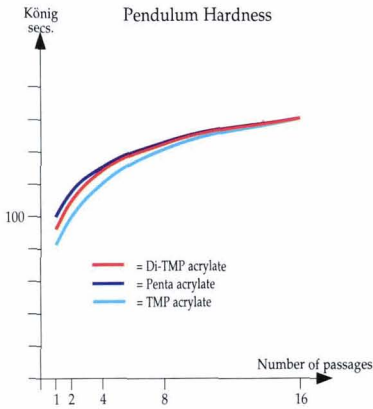
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Federation of Societies for Coatings Technology



New Orleans Convention Center
New Orleans, LA
October 12-13-14, 1994

1994 Annual Meeting & Paint Industries' Show Wrap-Up

FSCT Annual Meeting & Paint Show Wrap-Up

New Orleans—a city of magic and mystique—offers visitors a bewitching array of supernatural delights. Haunted mansions, cemetery tours, and vampire hunts provide tourists with a fascinating glimpse of days (real or imagined) gone by. Yet, none of the voodoo or witchcraft shops consulted possess a crystal ball powerful enough to see what the future holds for the coatings industry.

That vision was offered in a much more pragmatic setting—at the Ernest N. Morial Convention Center on October 12-14, 1994. There, the members of the coatings industry met to experience the 72nd Annual Meeting & 59th Paint Industries' Show of the Federation of Societies for Coatings Technology. And what a future it promises! Innova-

tive products, critical solutions to pressing problems, exciting uses of new technologies—all were available to the nearly 8,000 participants who set out to discover what is new and important in the world of coatings.

The Opening Session set the tone for the Annual Meeting program, with its emphasis on "Excellence Through Innovation." A highlight of the session was the presentation of the prestigious George Baugh Heckel Award to a man noted for his outstanding contributions to the Federation—Saul Spindel, of D/L Laboratories. The theme of innovation was also the focus of the Keynote Address by science and technology forecaster, Daniel Burrus. In his energetic presentation, Mr. Burrus introduced the

audience to the world of "Futureview." While he lightly remarked that, "The future isn't what it used to be," he noted that, to be successful, technical innovation and an understanding of technological trends are essential.

The spirit of excellence and innovation was evident with the Annual Meeting technical programming. The Program Committee, chaired by Ronda Miles, of Union Carbide, provided a program which offered a variety of topics and formats.



FSCT President John A. Lanning and his wife, Pat, join with Show Manager Robert Ziegler to officially open the 59th Paint Industries' Show of the Federation.



Hundreds gathered at the Ernest N. Morial Convention Center to participate in the Opening Session of the Annual Meeting.

Particularly successful were the Early Bird Sessions, "hands-on" equipment presentations, and discussions on areas of critical interest to attendees. The technical program culminated with the Mattiello Memorial Lecture, presented by Dr. Richard Eley, of The Glidden Company.

Innovation was also key to the exhibits featured at the Paint Industries' Show. The record-setting number of exhibitors present—309—filled nearly 91,000 square feet of exhibit space with the latest raw materials, equipment, and services the industry has to offer. The number of first-time exhibitors also broke existing records as over 40 companies chose the Paint Show to introduce their products.

No special charms were needed to discover that the future of the Federation is well insured. At the FSCT Business Meeting, Joseph P. Walton, of Jamestown Paint Co., assumed the office of President of the organization for 1994-95 and pledged that the Federation will continue to grow and prosper as a strong organization.

Of course, the success of the Annual Meeting & Paint Show can be credited to the efforts of the exhibiting companies, the attendees, and all of the Annual Meeting & Paint Show Committee members who worked so diligently to insure the highest qual-

ity event. Special recognition is due to the Southern Society Host Committee, under the direction of Chairman Gerry A. Mattson, of



Science and technology forecaster, Daniel Burrus, of Burrus Research Associates, Inc., invigorated the audience with his presentation of the Keynote Address, entitled "Futureview."

University of Southern Mississippi.

With this information gained at the FSCT event, attendees came away better equipped to successfully compete in the future. And that ain't witchcraft!

Meet Us in St. Louis!

The FSCT invites you to attend the 73rd Annual Meeting & 60th Paint Industries' Show, October 9-11, 1995 at the Cervantes Convention Center, in St. Louis, MO.

The Annual Meeting Program Committee, led by Chairman Louis F. Holzknrecht, of Devco Coatings Co., Louisville, KY, will present a varied program focused on the theme, "Creativity + Adaptability = Gateway to Success." Members of the St. Louis Society, under the direction of Chairman Dennis Cahill, of Archway Sales, Inc., will serve on the Host Committee.

For exhibit or attendance information, contact FSCT Headquarters, 492 Norristown Rd., Blue Bell, PA, (610) 940-0777, FAX: (610) 940-0292.

Saul Spindel Receives 1994 George Baugh Heckel Award At Federation's Annual Meeting in New Orleans, LA

The Federation of Societies for Coatings Technology is pleased to announce that Saul Spindel, President of D/L Laboratories, New York, NY, is the recipient of the organization's George Baugh Heckel Award for 1994.

Mr. Spindel, a 37-year member of the New York Society for Coatings Technology and the FSCT, received the award at the Opening Session of the Federation's Annual Meeting and Paint Industries' Show, in New Orleans, LA, on October 12.

The Heckel Award, FSCT's highest honor, recognizes the outstanding contributions that Mr. Spindel has made to the Federation's interest and prestige. Established in 1951, the Award is dedicated to the memory of George Baugh Heckel—author, poet, editor, and historian—who served as temporary Chairman when the Federation was organized in 1922 and as Secretary for many years thereafter.

A member of the Federation since 1957, Mr. Spindel served on the FSCT Board of Directors from 1981 to 1990. He was Chairman of the Technical Advisory Committee and the Corrosion Committee from 1979 to 1986. Mr. Spindel is the immediate past Chairman of the Planning Committee.

He was instrumental in the development and production of the New York Society video "Good Tests—Bad Testing." Mr. Spindel has been active on numerous committees of the New York Society during his years of membership. Elected to the Society Board of Directors in 1967, he was named President in 1979. Mr. Spindel served as Society Representative to the FSCT Board of Directors for three terms, from 1981 to 1990. He is Chairman of the Society Awards Committee. The New York Society honored him with their prestigious PaVaC Award for "outstand-

ing devotion to the Society and technical and educational efforts which contributed to the advancement of the protective coatings industry."

Mr. Spindel's years of experience have been in the development, formulation, evaluation, production, and application of various types of architectural, maintenance, marine, and industrial product finishes, as well as the raw materials used therein.

He started his career in the coatings industry in 1947. He spent the first 12 years working for producing organizations, such as E.M. Wanderman & Co. and Clover Leaf Paint and Varnish Co. In 1959, he joined D/L Laboratories, an independent consulting and testing laboratory. Currently, Mr. Spindel is President of D/L Laboratories.

Mr. Spindel has been a member of the American Society for

Testing and Materials (ASTM) since 1973. He served as a member of ASTM C-24, Building Seals and Sealants, and chaired numerous task groups and committees during this tenure of involvement. Mr. Spindel has contributed to ASTM D-1, Paint and Related Coatings; ASTM D-14, Adhesives; and ASTM E-6, Performance of Buildings. He was the 1986 recipient of the ASTM Award of Merit.

A member of the Metropolitan New York Paint & Coatings Association, Mr. Spindel has also been active with the National Paint & Coatings Association, the National Association of Corrosion Engineers, the Washington Paint Technical Group, and is a member of the Society of Gallows Birds.

He is listed in *Who's Who in Technology Today* and *Who's Who in the East*.



Saul Spindel (center) receives the 1994 George Baugh Heckel Award from friend and colleague, John Oates. During his acceptance speech, Mr. Spindel thanked Mr. Oates for introducing him to the Federation and its many activities. Saul also thanked Sid Levinson, his "mentor and former boss, as well as the leaders and members of the New York Society" for their inspiration. In addition, Mr. Spindel acknowledged the support of his wife of 44 years, Esther.



The Roon Awards, established and sponsored in 1957 by the late Leo Roon, are for the best technical papers entered in the Roon Awards Competition and submitted for presentation at the FSCT Annual Meeting. This year's recipients are congratulated by George Pilcher (left), of Akzo Nobel Coatings Inc. First place winner is G.P. Craun (right), of The Glidden Co., and taking second place is D.R. Bassett (center), of Union Carbide Corp.



The Distinguished Service Award is presented to John A. Lanning (left), by Joseph P. Walton, in grateful recognition of John's valuable contribution to the progress of the FSCT while serving as President of the Federation in 1993-94.

Annual Meeting Awards Winners

GEORGE BAUGH HECKEL AWARD—

Saul Spindel, of D/L Laboratories

DISTINGUISHED SERVICE AWARD—

John A. Lanning, of Courtaulds Coatings, Inc., Porter Paints Div.

ROON FOUNDATION AWARDS—

First Place—"Epoxy Nucleophile Catalyzed Transesterification," by G.P. Craun, The Glidden Company.

Second Place—"A Study on the Chemistry of Polyguanidine as Precursors for Polycarbodiimide Crosslinkers in Powder Coatings," by J.W. Taylor, M.J. Collins, and D.R. Bassett, of Union Carbide Corporation.

ALFRED L. HENDRY AWARD—

"Synthesis of High Performance Clearcoat Systems Involving Tetrachlorohydroquinone," by Jason A. Giles and William L. Dechent, of University of Missouri-Rolla.

SOCIETY SECRETARIES AWARDS—

First Place—Robert J. Skarvan (Los Angeles Society), of McWhorter Inc.

Second Place—John C. Avery (CDIC Society), of Cintech Industrial Coatings.

A.F. VOSS/AMERICAN PAINT & COATINGS JOURNAL AWARDS—

First Place—Los Angeles Society—"VOC Testing Comparison: EPA 24 Versus the Cal Poly Method."

Second Place—Cleveland Society—"Correlation of Accelerated Exposure Testing and Exterior Exposure Sites."

Third Place—Northwestern and Montreal Societies—"A Study of the Effect of Acid Rain on Alkyd, Polyester, and Silicone Modified High-Solids Coating."

SOCIETY SPEAKERS AWARDS—

First Place—Max T. Wills (Los Angeles Society), of Cal Poly-San Luis Obispo.

Second Place—Latoska Price (Detroit Society), of Akzo Nobel Coatings.

ANNUAL MEETING POSTER SESSION—

First Place—"Maleinized and Chlorinated Maleinized Poly-cis-isoprene as a Powder Curing Additive"—Payton W. Poole, of the University of Southern Mississippi.

Second Place—"In-Situ Sensor Monitoring of Cure, Latex Coalescence and Buildup in End Use Properties"—David Kranbuehl, of William and Mary.

Third Place—"Chlorinated Polyolefin Adhesion Promoters for Exterior Application"—William L. Dechent, of University of Missouri-Rolla.

GOLDEN IMPELLER AWARD—

H. Horton Russel, of Devco & Reynolds.

UNION CARBIDE COATINGS TECHNOLOGY AWARD—

Chicago Society for Coatings Technology Technical Committee.

Roon Awards

The A.L. Hendry Award, established by the Southern Society in memory of an honored Past-President of the Society, Alfred L. Hendry, is for the best undergraduate student-authored paper submitted for presentation. The winner for 1994 was the paper, "Synthesis of High Performance Clearcoat Systems Involving Tetrachlorohydroquinone," by Jason A. Giles (second from right) and William L. Dechent (far left), both from the University of Missouri-Rolla. Also pictured are Educational Committee Chairman Donald E. Boyd (far right) and Prof. James Stoffer, of UMR (second from left).



Membership Certificates



Society Representatives Wayne Kraus (Philadelphia) and R. Scott McKenzie, Jr. (Southern) are presented with certificates in recognition of their Societies' membership increases for the year 1993-94.

Society Speaker Awards



The object of these awards is to recognize the Society speakers who present papers in the best form and manner at the Annual Meeting. Pictured above are (from left): Philip C. Brumenstahl and Jan Van Zelm (Los Angeles) accepting for Max T. Wills; Van Evener (Detroit) accepting for Latoska Price; and Committee Chairman G.C. Simmons.

A.F. Voss/APJ Awards



The A.F. Voss/APJ Awards are given to the most constructive papers presented by Constituent Societies in connection with research, development, manufacture, or application of the industry's products. The above are (left to right): Lowell Wood and Larry Brandenberger (Northwestern); Ben Carozzo (Cleveland); Joe Maty, APJ; Jan Van Zelm and Philip C. Brumenstahl (Los Angeles).

Society Secretaries Awards



Those Secretaries of FSCT Societies who furnish to the JCT the most interesting reports of Society monthly meetings qualify for this award. Committee Chairman Carolyn L. Tully (left) presents this year's winners (from left) Second place—John C. Avery (CDIC); First place—accepting for Robert J. Skarvan (Los Angeles) Philip C. Brumenstahl and Jan Van Zelm.

Technical Focus Speaker



Technical Focus Speaker Mark Holt (right), of Ciba-Geigy Corp., was presented with a Certificate from FSCCT Educational Coordinating Chairman Donald E. Boyd for his presentation, "Additives for Coatings: Meeting the Needs a Changing Industry."

Union Carbide Award



The Union Carbide Coatings Technology Award was presented to the Chicago Society's Technical Committee for their contributions in the development of the Federation's Panorama™ Coatings MSDS CD Retrieval System. Accepting the award from Brian McDonald, on behalf of the Society is member Committee Chairman Darlene Brezinski.

Poster Session Awards

The Annual Meeting Poster Session is designed to provide a noncommercial arena for new ideas and techniques, preliminary results, work that is significant but not ready for publication,



results or ideas that do not fit normal publication criteria, etc. This year winners are (from left): Third place—William L. Dechent and Jason A. Giles, University of Missouri-Rolla; and Second place—David Kranbuehl, William and Mary. Annual Meeting Program Committee Chairman Rhonda Miles congratulates the winners. (First place winner, Payton W. Poole, University of Southern Mississippi, is missing from photo.)



Mattiello Memorial Lecture

President John Lanning congratulates Dr. Richard Eley, of The Glidden Co., for presenting the 1994 Joseph J. Mattiello Memorial Lecture. Dr. Eley was chosen as Lecturer in recognition of his outstanding contributions to the advancement of science. The title of his talk was, "Characterization and Analysis of Coatings Rheology and Coatings Flows."



Federation Officers Past and Present



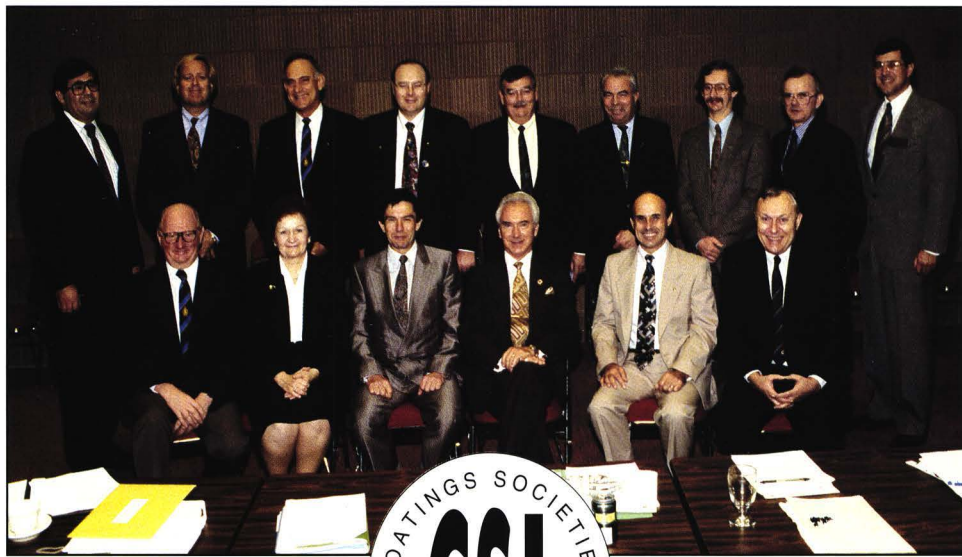
John Lanning (right) passes on the Presidential Gavel to incoming FSCT President Joseph P. Walton. Mr. Walton pledged to do his best to "uphold the traditions" set by his predecessors. His primary goal is to "work for the betterment of the industry."



Elected to serve on the Federation's Executive Committee for the year 1994-95 are: Seated (from left)—John A. Lanning, Darlene R. Brezinski, and Jay Austin. Standing—Joseph P. Walton, Forest Fleming, Larry Brandenburger, and Gerry J. Gough.

FSCT Past-Presidents in attendance included: Seated (from left)—John Oates (1977-78); Carlos E. Dorris (1986-87); Milton A. Glaser (1956-57); Carroll M. Scholle (1965-66); and Colin D. Penny (1993-94). Standing—James A. McCormick (1978-79); William F. Holmes (1991-92); Kurt F. Weitz (1990-91); and John C. Ballard (1989-90).





International Bonds Furthered By CSI in New Orleans

While it is well-known that the FSCT Annual Meeting brings together industry members from around the world in informal gatherings, it may not be known by all that there is a formal organization devoted to the discussion of international topics. The Coatings Societies International (CSI) is composed of the leaders of technically-oriented coatings organizations from many countries and regions. Members include the FSCT; FATIPEC (Federation of Technicians of the Paint, Varnish, Lacquer, and Printing Ink Associations of Continental Europe); JSCM (Japan Society of Colour Materials); OCCA (Oil & Colour Chemists' Association); SLF (Scandinavian Paintmakers Association); SCAA (Surface Coatings Association Australia); and SCANZ (Surface Coatings Association New Zealand).

Several topics of importance were discussed at the meeting, including the establishment of award to recognize the most significant technical presentation at selected conferences; the recognition of professional grade certification by CSI organizations; and public relation and promotional efforts.

Of concern to the organizations is the proliferation of privately-sponsored international conferences

and exhibitions, which detract from CSI-member technical association-sponsored events. Agreement was reached to develop closer ties with each organization with the goal of better promotion and enlightenment of the industry of the activities of the associations and the use of resources from sponsored conferences and exhibitions to further the work of the groups.

Pictured above are those representatives who met in New Orleans: Seated (from left to right) Ray McConnell (SCAA); Darlene Brezinski (FSCT); Phil Taylor (SCANZ); Colin Penny (FSCT); John Lanning (FSCT); Mike Symes (SLF). Standing (left to right) Kurt Weitz (FSCT); John Ballard (FSCT); William Holmes (FSCT); Jay Austin (FSCT); Joseph P. Walton (FSCT); Francis Borel (FATIPEC); Gerry Gough (FSCT); Christopher Pacey-Day (OCCA); and Robert Ziegler (FSCT).

The CSI will next meet during the OCCA SURCON on September 27-28, 1995 at Heathrow Airport, in London.

For further information on CSI and its activities, contact FSCT Headquarters.

Annual Meeting Program Sessions "Excellence Through Innovation"



New Orleans Convention Center
New Orleans, LA
October 12-13-14, 1994



Members of the Social Guest Committee



1994 Women in Coatings Awards

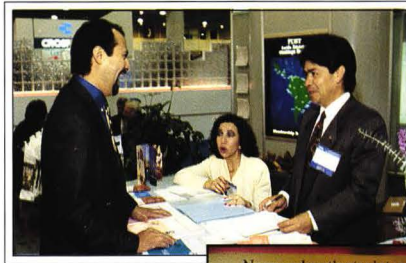
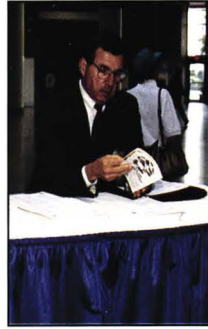
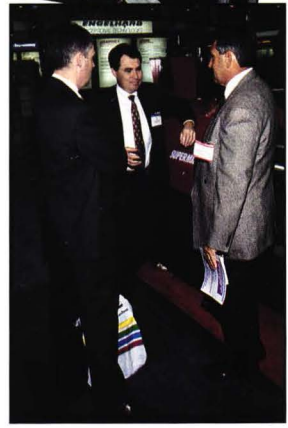


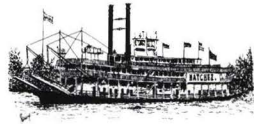
Pictured above are the 1994 winners of the WIC Awards. They include (seated from left): Leadership—Barbara Mayginnnes, Performance Coatings Inc.; Purchasing—Jennifer Rumberg, Mahoning Paint Corp.; and FSCT President John Lanning. Standing: Industry Support—Melissa Matheson, PiCon Chemicals, Inc.; Sales & Marketing—accepting for Joy Knapp, United Coatings Inc. is her father Jules Knapp; and Awards Chairman Eve De La Vega-Irvine.

**Special Thanks
to the Official
Paint Show
Sponsors for Their
Support and
Contributions!!**

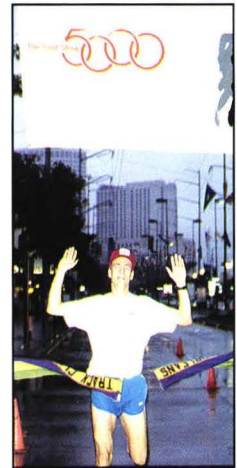
Air Products & Chemicals, Inc.
Amoco Chemical
Eastman Chemical Co.
The C.P. Hall Co.
McWhorter Technologies
Occidental Chemical Corp.
Zeneca Resins

What a Paint Show!!





Troy Run—"Paint Show 5000"



Having a baby in April did nothing to slow down Kay Sanborn, of Rohm and Haas Co. The first female across the finish line was congratulated for her 19.42 time.



Neither rain nor "incoming cars" slowed Jim Schak, of Kady International from his destination—the winner of the Paint Show 5000 with a time of 18.19.

Winning Booths at Paint Show

72nd Annual Meeting & 59th Paint Industries Show
**FSCIT
1994**
 New Orleans Convention Center
 New Orleans, LA
 October 12-13-14, 1994



Representatives of the 1994 Paint Show Awards Winners are pictured above. They include (front row from left): Lesley Crewsdon, of South Florida Test Service, Inc.; Mike Lento, of Microfluidics International; Janis Grant, of Exxon Chemical Co.; Steve Raper, of Dry Branch Kaolin Co.; and Shelley Toenniges, of Ebonex Corp. Back row: Paint Show Committee Chairman Richard Max; Bruce Krumholz, of CB Mills, Inc.; Eli Aschner, of EM Industries, Inc.; Bud Equi, of SC Johnson Polymer; and Hal Good, of HunterLab.



An exhibitor for 13 years, SC Johnson Polymers, of Racine, WI, won in the category of Raw Materials—10+ Booths.



Exxon Chemical Co., Houston, TX, took the prize for Raw Materials—6-9 Booths. They have been exhibiting in the Paint Show for 11 years.



A 13-year exhibitor, EM Industries, Inc., of Hawthorne, NJ, was the recipient of the Raw Materials—3-5 Booths award.

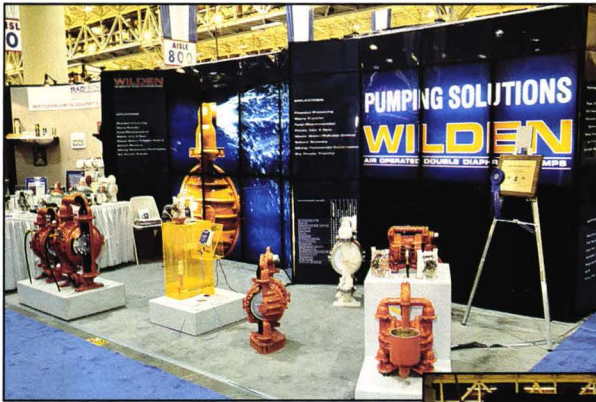
Dry Branch Kaolin Co., Dry Branch, GA, took the prize for Raw Materials—Double Booth. They have been an exhibitor in the Paint Show for 32 years.



An exhibitor for 20 years, Ebonex Corp., of Melvindale, WI, won in the category of Raw Materials—Single Booth.

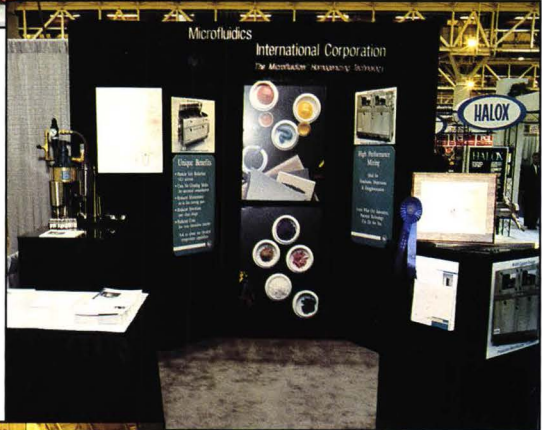


A 35-year exhibitor, CB Mills, Div. of Chicago Boiler Co., Buffalo Grove, IL, took the Production Equipment—3+ Booths award.



An exhibitor for 23 years, Wilden Pump & Engineering Corp., of Colton, CA, won in the category of Production Equipment—Double Booth.

Microfluidics International Corp., Newton, MA, took the prize for Production Equipment—Single Booth. They have been exhibiting in the Paint Show for four years.



A 33-year exhibitor, HunterLab, of Reston, VA, was the recipient of the Service Industries Award.

An exhibitor for 52 years, South Florida Test Service, Inc., Miami, FL, won the Lab and Testing Equipment Award.



Regulatory UPDATE

DECEMBER 1994

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.

Department of Housing and Urban Development Environmental Protection Agency November 2, 1994—59 FR 54984

Lead; Proposed Requirements for Disclosure of Information Concerning Lead-Based Paint in Housing

Action: Proposed rule

The U.S. Department of Housing and Urban Development (HUD) and the U.S. Environmental Protection Agency (EPA) are proposing to issue regulations requiring disclosure of certain information by persons selling or leasing housing that may contain lead-based paint or lead-based paint hazards.

Sellers and lessors, or any agency acting on their behalf, of most residential housing built before 1978 would be required to provide purchasers and lessees with all information known to the seller, lessor, or agent on the presence of lead-based paint and lead-based paint hazards, as well as an EPA pamphlet on lead-based paint hazards. Additionally, sellers would be required to grant purchasers 10 calendar days to conduct an inspection or risk assessment for lead-based paint hazards before being obligated under any contract to purchase that housing. The regulation would also require that a standard warning, disclosure, and acknowledgment form be attached to all leases and sales contracts involving target housing. The completion of these disclosure activities would be mandatory before the purchaser or lessee had become obligated under any contract to purchase or lease the target housing.

Written comments in response to the proposed rule will be accepted until January 3, 1995. If requests are received for oral comments, EPA and HUD will consider a public hearing in Washington, DC. Requests for oral comments must be received by December 2, 1994. A decision on a public hearing will be made by December 19. Written comments should be submitted in triplicate to TSCA Document Receipts (7407), Rm. E-G99, Office of Pollution Prevention and Toxics, Environmental Protection Agency, 401 M St., S.W., Washington, D.C. 20460. All comments should be identified by the docket number OPPTS-62130A.

For further information, contact Susan B. Hazen, Director, Environmental Assistance Division, Office of Pollution Prevention and Toxics, U.S. EPA, Washington, D.C., (202) 554-1404. NPCA members may contact Steve Sides, Director, Health, Safety and Environmental Affairs at (202) 462-6272.

Environmental Protection Agency

October 31, 1994—59 FR 54420

Lead; Requirements for Lead-Based Paint Activities; Extension of Comment Period

On September 2, 1994, EPA published a proposed rule governing lead-based paint activities to ensure that individuals engaged in such activities are properly trained, that training programs are accredited, and that contractors engaged in such activities are certified. The proposed rule would also establish standards for performing lead-based paint activities and require that lead-based paint activities be performed by certified individuals. Additionally, EPA has developed a proposed model state program. When promulgated, this program may be adopted by any state that seeks to administer and enforce a state program under Title IV of the Toxic Substance Control Act (TSCA).

The purpose of this notice is to inform the public that the comment period on this proposed rule has been extended to December 15, 1994.

Written comments should be sent in triplicate to TSCA Public Docket Office (7407), Office of Pollution Prevention and Toxics, EPA, 401 M St., S.W., Washington, D.C. 20460. Comments must include the docket control number OPPTS-62128. For further information, contact Susan B. Hazen, Director, Environmental Assistance Division, Office of Pollution Prevention and Toxics, U.S. EPA, (202) 554-1404. For technical questions, contact Diane Sheridan, (202) 260-0961. NPCA members may contact Steve Sides, (202) 462-6272.

Department of Transportation Federal Highway Administration October 12, 1994—59 FR 51824

Transportation of Hazardous Materials; Highway Routing

Action: Final rule

Effective November 14, 1994, the Federal Highway Administration (FHWA) is adopting regulations implementing parts of the Hazardous Materials Transportation Act of 1975 (HMTA), which was amended by the Hazardous Materials Transportation Uniform Safety Act of 1990 (HMTUSA).

The regulations include federal standards and procedures which states must follow if they establish, maintain, or enforce routing designations that (1) specify highway routes over which placarded non-radioactive hazardous materials (NRHM) may and may not be transported within their juris-

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.

dictions and/or (2) impose limitations or requirements with respect to highway routing of such hazardous materials. Included are amendments to the procedures relating to federal preemption and waivers of preemption, and new procedures for the resolution of disputes involving state NRHM routing designations. States are also required to furnish updated NRHM rout information for publication by the FHWA. The existing motor carrier regulations with NRHM routing requirements have been incorporated into this regulation, also with the new requirements which mandate that motor carriers comply with the NRHM routing designations of states.

The intent of the requirements is to ensure that NRHM are moved safely and that commerce is not burdened by restrictive, uncoordinated, or conflicting requirements of various jurisdictions.

For further information, contact Pamela K. Deadrick, Hazardous Materials Routing and Special Studies Branch, Office of Highway Safety (202) 366-8788; or Mr. Raymond W. Cuprill, Office of Chief Counsel, (202) 366-0834. NPCA members may contact Kevin Sall, (202) 462-6272.

UPS "Four-Pack" Resolution—A mutually acceptable resolution has been reached between the National Paint and Coatings Association (NPCA) and the United Parcel Service (UPS) in the UPS hazardous materials shipping cost increase matter. The paint industry had been experiencing substantial shipping cost increases for shipments of hazardous materials in the UPS system, resulting from changes to UPS's shipping guide. In the *1993 Guide for Shipping Ground and Air Hazardous Materials*, p. 143, UPS states that "paint shipments utilizing one gallon containers have a restriction of 2 one-gallon containers per carton." In short, the shipping package, 4 one-gallon containers per carton ("four-pack") used by the paint industry and others in shipping hazardous materials, was excluded from use by the paint industry. As a result, 2 one-gallon containers per carton would have to be used in place of the "four-pack." Yet, the hazardous material shipment fee remained a per package fee. This, combined with a recent UPS tariff increase from \$6 to \$7 for all hazardous material shipments, has made the situation extremely burdensome for the industry.

NPCA explored the possibility of negotiating with UPS to reach a reasonable accommodation. Through negotiations, NPCA relayed to UPS the results of an industry-wide survey showing negatives for both parties (in particular) that UPS stood to lose paint revenue from defections to other carriers, while the paint industry stood to lose a great deal of shipping costs and the affordable use of a dependable carrier. In response, UPS offered a "four-pack" specification that would meet UPS approval. NPCA's Transportation and Distribution Committee built the "four-pack" to UPS specifications, having to make slight changes due to can sizes and use of over caps, and conducted a cost analysis. The analysis revealed that the "four-pack" was cost efficient. Industry savings could be nearly \$4 million over the next year and approximately \$4,000 per year per shipper.

One September 20, UPS agreed to NPCA's proposal for the use of new "four-pack" specifications. In UPS's September 20 letter, Ronald R. Hinkle, UPS's national hazardous materials systems manager, states that UPS is currently revising its Guide for Shipping Ground and Air Hazardous Materials to reflect a new 4 one-gallon package specification. For further information, contact NPCA's Kevin Sall.

Land Disposal Restrictions Phase II. Universal Treatment Standards Set for Hazardous Wastes—As part of the Land Disposal Restrictions (LDR) Program, the

Environmental Protection Agency (EPA) published in the *Federal Register* (59 FR 47982, September 19, 1994) a final rule which will require hazardous waste generators and facility operators to meet new and more extensive treatment standards for a greater number of hazardous wastes prior to land disposal than current regulations demand. At the same time, provisions of the new rule are expected to reduce costs and simplify existing land disposal restrictions. The Resource Conservation and Recovery Act (RCRA) LDR Phase II Program establishes new treatment standards for 42 newly listed hazardous wastes and consolidates the existing LDR compliance procedures by setting universal treatment standards for over 200 constituents. The required treatment standards for these wastes must be met before they are land disposed.

The LDR Phase II rule prohibits the disposal of ignitable characteristic wastes with a high total organic carbon (TOC) content greater than 10% TOC and toxic characteristic pesticide wastes into deep-well injection via Class I Underground Injection Control (UIC) wells, unless the wastes are injected into a well that is subject to a no-migration determination or is treated by the new designated LDR treatment method prior to disposal, as described in the final rule.

The EPA also established a single set of requirements, referred to as universal treatment standards (UTS), that apply to organic, metal, and cyanide constituents—one set for wastewaters and another for nonwastewaters—which replaced current treatment standards for most hazardous wastes.

EPA also published clarifying guidance regarding treatability variances. Finally, EPA modified the hazardous waste recycling regulations, which will streamline regulatory decisions of certain types of recycling activities.

The LDR Phase II final rule is significant for the paint and coatings industry and other members of the regulated community because it revises and simplifies the existing treatment standards and creates standards for hazardous wastes that are not presently subject to LDR provisions. The final rule also replaces previous treatment standards with a universal set of standards and modifies the hazardous waste recycling provisions under RCRA Subtitle C.

The final rule is effective December 19, 1994. Section 266.100 and 40 CFR 261 Appendix VIII were effective September 19, 1994. Although the effective date of the final rule is December 19, 1994, facilities will be in compliance if they meet the universal treatment standards (UTS) before the 90-day period ends.

For technical information about toxicity characteristic wastes, contact Mary Cunningham of EPA at (703) 308-8453. For more information, contact Richard Kinch, EPA Office of Solid Waste at (703) 308-8414. NPCA members may contact Soonie McDavid or Stacie at (202) 462-6272.

Increased OSHA Inspection Activity in Coatings Manufacturing Facilities—The Occupational Safety and Health Administration (OSHA) is targeting the paint and allied coatings industry, standard industrial classification (SIC) 2851, for increased inspection activity. This year,

industry representatives across the country have noted a five- to ten fold increase in the number of coatings manufacturing facilities receiving inspections. OSHA recently confirmed that SIC 2851 is a priority industry for "programmed" inspections, and paint manufacturers across the nation are more likely to receive an OSHA inspection now than in the past.

On average, only about half of all OSHA inspections are "programmed," meaning conducted at sites chosen by OSHA (the rest are conducted in response to employee complaints and serious accidents). Therefore, the agency tries to concen-

trate its programmed inspection efforts on industries where there have historically been a larger number of problems.

To prioritize programmed inspection activity, OSHA calculates the five-year historical average number of serious health violations found per inspection within each industry, tabulated by the SIC code, and chooses the worst offenders. Reportedly, SIC 2851 is among these.

Company names (including addresses and phone numbers) from within these SIC codes are used to produce a confidential, random list of priority businesses to target when OSHA conducts programmed inspections. While not every paint manufacturer will receive a visit from OSHA this year, many will.

Companies can improve their ratings by learning more about OSHA and inspections, reviewing company occupational safety and health policy and programs, and making an effort to resolve potential problems before OSHA finds violations. In the short term, good preparation can help minimize the number and seriousness of citations issued to a company. This will reduce the associated fines and penalties, which can be substantial.

In the long term, a lower rate of citations at individual company facilities will also help remove the industry from OSHA's priority list. Companies can reduce their own long term risk of being inspected by encouraging and assisting other SOC 2851 businesses to review and upgrade their safety and health programs. Any improvements will be based on a five-year average.

A new NPCA Safety and Health Bulletin (#72) explains in greater detail how OSHA chooses businesses to visit and suggests ways paint manufacturers can learn more about OSHA and prepare their companies for an inspection. Copies of a "Self-Inspection Checklist" and a booklet titled *OSHA Inspections* come attached to the bulletin.

These attachments are also available from other sources. The checklists are contained in the *OSHA Handbook for Small Businesses* #2209, which may be ordered for \$4 from the U.S. Government Printing Office, (202) 512-1800 (request GPO publication #029-016-00144-1). The booklet on inspections (OSHA publication #2098) is available by calling the OSHA Publications Office at (202) 219-4667.

For additional information on inspection procedures and OSHA publications on safety and health topics, contact the local federal and state OSHA office listed under "Labor" in the government section of the local phone book. For additional information on OSHA's increased inspection activity in the paint and allied coatings industry, contact NPCA's Kevin Sall or Whitney Long, CIH.

Legislation—The Republican takeover of both Houses of Congress will surely alter the legislative agenda. However, it is still too early to speculate as to what that agenda might be in terms of an effect on the paint industry.

A number of environmental statutes are past due for reauthorization including the Clean Water Act, the Resource Conservation and Recovery Act, and Superfund. However, because the Republican agenda doesn't usually include a primary focus on environmental issues, Superfund will probably be the only one of these issues to generate a good deal of activity in 1995.

Regardless of any initiatives offered by the Clinton administration, it has been reported that legislative efforts to reform Superfund will be very different from the bill nearly passed by the 103rd Congress. The Republican leadership is determined to lean far more toward the elimination of retroactive liability and less stringent cleanup goals.

States Proposed Legislation and Regulations

Alaska

Occupational Safety & Health (Regulation)—The Alaska Department of Labor (DOL) has issued final regulations incorporating, by reference, federal standards relating to hazard communication in the workplace. Contact Sandra Woods, DOL, (907) 465-4855.

Arizona

Occupational Safety & Health (Regulation)—The Arizona Industrial Commission (AIC) issued a proposed rule that incorporates, by reference, the federal occupational safety and health standards. The new standards include corrections to personal protective equipment requirements for general industry and the retention of Department of Transportation markings, placards, and labels for general industry. Contact Derek Mullins, AIC, (602) 542-5795.

California

Air Quality (Regulation)—The California Air Resources Board (CARB) has issued a proposal to update the attainment status of a number of air quality districts in the state. Contact Rich Bradley, CARB, (916) 322-6076.

Hazardous Waste (Regulation)—The California Department of Toxic Substances Control (DTSC) has issued an emergency rule amending regulations that set criteria for obtaining interim status standardized permits by existing storage and treatment facilities, and defines requirements relating to permanent household hazardous waste collection

facilities. Contact Pamela Thompson, DTSC, (916) 324-9933.

Connecticut

Air Quality (Regulation)—The Connecticut Department of Environmental Protection (DEP) issued a proposal to adopt regulations implementing a clean air facility operating permit program which is mandated by the Federal Clean Air Act Amendments (CAAA) of 1990. Hazardous air pollutants, as well as emissions of volatile organic compounds (VOCs), are addressed by the program. Contact Ellen Walton, DEP, (203) 424-3027.

Hazardous Waste (Regulation)—The Connecticut Department of Environmental Protection (DEP) adopted a final rule which makes the state's requirements affecting underground storage tanks (USTS) as stringent as federal regulations. Contact Jacques Gilbert, DEP, (203) 566-4630.

District of Columbia

Lead (Notice)—The District of Columbia announced the establishment of a Lead-Based Paint Task Force to provide a coordinated approach to lead abatement. For additional information, contact NPCA's Steve Sides, (202) 462-6272.

Florida

Hazardous Waste (Regulation)—The Florida Department of Environmental Protection (DEP) has proposed amendments to current regulations which incorporate, by reference,

certain federal hazardous waste requirements, including documentation needed to establish that a material is not a hazardous waste and standards affecting conditionally exempt hazardous waste generators. Contact Diane Hunter, DEP, (904) 488-0300.

Georgia

Hazardous Waste (Regulation)—The Georgia Department of Natural Resources (DNR) has proposed amendments to its regulations which incorporate, by reference, federal standards relating to underground storage tanks (USTs), including requirements relating to the design and construction of such tanks, as well as those relating to leak detection, reporting, and cleanup. Contact DNR, (404) 362-2687.

Hawaii

Hazardous Waste (Regulation)—The Hawaii Department of Health (DOH) has adopted a final regulation that will allow the DOH to receive authority from the federal Environmental Protection Agency (EPA) to administer the state's hazardous waste program. Contact Steven Chang, DOH, (808) 586-4226.

Illinois

Air Quality (Regulation)—The Illinois Pollution Control Board (PCB) has proposed a regulation relating to emission standards for plastic parts and wood furniture coatings operations in the Chicago area. Contact Dorothy Gunn, PCB, 100 West Randolph St., Suite 11-500, Chicago, IL 60601.

The Illinois PCB issued a proposed rule relating to automotive and business machine plastic parts coatings, which includes definitions and general provisions. Contact Dorothy Dunn, PCB, 100 West Randolph St., Suite 11-500, Chicago, IL 60601.

A regulation proposed the Illinois PCB would establish stricter VOC standards for miscellaneous metal parts, can, coil, large appliance, and metal furniture coatings. For more information, contact NPCA's Jim Sell, (202) 462-6272.

Indiana

Hazardous Waste (Regulation)—The Indiana Solid Waste Management Board (SWMB) is soliciting comments about proposed amendments which address how generators of hazardous waste should handle the waste if it is rejected by disposal facilities. Contact Dave Berrey, SWMB, (317) 232-4417.

Occupational Safety & Health (Regulation)—The Indiana Department of Labor (DOL) has adopted final rules which incorporate, by reference, certain federal standards relating to permit-required confined spaces, air contaminant exposure limits; general industry hazard communication, standards relating to cadmium exposure, injury and illness reporting requirements, and personal protective equipment standards. Contact Dave Bear, DOL, (317) 232-3325.

Iowa

Air Quality (Regulation)—The Iowa Environmental Protection Commission (EPC) issued a final rule concerning emissions and air pollution requirements. The regulation adds a definition for VOCs by adopting the federal definition by reference and updates the permitting requirements for sources impacting nonattainment areas in order to be consistent with requirements of the Clean Air Act. The rule went

into effect on November 16, 1994. Contact Christine Spackman, Department of Natural Resources, (515) 281-8941.

Hazardous Waste (Regulation)—The Iowa Labor Services Division (LSD) has issued an emergency regulation incorporating federal standards requiring employers to retain U.S. Department of Transportation labeling and placards from vehicles, packages, and containers containing hazardous materials until the materials have been eliminated. Contact LSD, (515) 281-3606.

The Iowa LSD proposed regulations to incorporate federal standards relating to hazardous waste operations and emergency response. Contact LSD, (515) 281-3606.

Transportation (Regulation)—The Department of Transportation (DOT) adopted a final rule to incorporate, by reference, federal motor safety and hazardous materials transportation standards. Contact DOT, (515) 239-1362.

Kentucky

Occupational Safety & Health (Regulation)—The Kentucky Department of Workplace Standards (DWS) has issued several final regulations involving workplace safety. Among other things, the rules establish (1) requirements for reporting worker injuries and fatalities; (2) general personal protection standards; (3) confined space permit requirements, and (4) standards for hazard communications, including those related to the handling of cadmium. Contact William Ralston, DWS, (502) 564-2778.

Transportation (Regulation)—The Kentucky Department of Vehicle Regulations (DVR) has proposed amendments to its hazardous materials regulation in order to incorporate recent revisions in federal standards. Contact Sandra Pullen, Transportation Cabinet, (502) 564-4890.

Louisiana

Air Quality (Regulation)—The Louisiana Department of Environmental Quality (DEQ) proposed a regulation that establishes a fee system for funding monitoring, investigation and other activities as required by the DEQ. Additionally, the rule requires all ozone nonattainment areas classified as moderate and above to submit a reasonable further progress (RFP) plan which describes how an area will achieve an actual VOC emission reduction of at least 15% during the first six years after enactment of the Clean Air Act Amendments. Contact Patsy Deaville, DEQ, (504) 765-0486.

The Louisiana DEQ issued a proposed rule relating to air quality permit procedures. The regulation requires that (1) the DEQ retain records for five years; (2) compliance measures are properly submitted into permits; and (3) air quality permit procedures meet the mandates of the federal operating permit program under Title V of the Clean Air Act Amendments. Contact Patsy Deaville, DEQ, (504) 765-0486.

The DEQ adopted an emergency amendment which requires compliance with the 15% VOC reduction reasonable further progress plan in accordance with the Clean Air Act Amendments. The amendment went into effect on September 15, 1994 and will expire on January 13, 1995. Contact Office of the Secretary, Department of Environmental Quality, Baton Rouge, LA.

Occupational Safety & Health (Regulation)—The Louisiana Department of Labor (DOL) adopted an emergency amendment to current occupational safety and health regulations. The revisions clarify the requirements to participate in state occupational safety and health programs, as well as the procedures that will be used to evaluate an employer's imple-

mentation of the program. The rule became effective October 1, 1994 and expires January 29, 1995. Contact Alvin J. Walsh, DOL, (504) 342-7555.

Maine

Air Quality (Regulation)—The Maine Department of Environmental Quality (DEQ) proposed a rule controlling VOC emissions from surface coating operations and abrasive blasting at shipbuilding and repair facilities. Contact Andrea Lapointe, DEP, (207) 287-2437.

Maryland

Air Quality (Regulation)—The Maryland Department of the Environment (DOE) has adopted an amendment to current regulations involving the requirements for plastic parts coatings standards. In addition, the rule, which went into effect on November 7, 1994, revises the reasonably available control technology (RACT) applicability level for headset lithographic web printing presses requiring control equipment. Contact Deanna Miles-Brown, DOE, (410) 631-3245.

Hazardous Waste (Regulation)—The Maryland Division of Labor and Industry (DLI) issued a proposed rule which requires an employer who received a package, container, or motor vehicle which contains a hazardous material and which is required to be marked with a label, placard, or marking under the Hazardous Materials Transportation Act to retain the label, placard, or markings until the hazardous materials have been removed. Contact Commission of Labor and Industry, (410) 333-4184.

Transportation (Regulation)—The Maryland Public Service Commission (PSC) proposed amendments to regulations that would impose penalties on any owner or operator of a motor vehicle transporting flammable or combustible liquids who refused inspection of the vehicle or of the permit records. Contact Don Eveleth, PSC, (410) 767-8064.

Massachusetts

Lead (Regulation)—The Massachusetts Department of Public Health (DPH) has issued an emergency amendment to its lead abatement program that exempts short-term vacation rentals and extends the lead notification requirement to include leases with an option to buy. Contact Roy Petre, DPH, (617) 522-3700.

Montana

Hazardous Waste (Regulation)—The Montana Department of Health and Environmental Sciences (DHES) has issued final amendments affecting the standards of the underground storage tank program, including those relating to the installation, closure, and inspection process. Contact John Creach, DHES, (406) 444-2544.

Nebraska

Recycling (Regulation)—The Nebraska Department of Environmental Quality (DEQ) adopted a final regulation relating to its plastic container recycling program, including adding provisions that specify that plastic containers must be labeled with a recycling symbol.

Toxic Substances (Regulation)—The Nebraska Department of Health (DOH) has amended regulations concerning the removal of asbestos, including requirements relating to certification and notification of workers. Contact Donald Madson, DOH, (402) 471-0386.

New Jersey

Air Quality (Regulation)—The New Jersey Department of Environmental Protection (DEP) has issued final regulations relating to facility clean air operating permits that are mandated by the Federal Clean Air Act Amendments, and the emissions statements that must be provided by facilities subject to the program. Contact Janis Hoagland, DEP, (609) 292-0716.

The New Jersey DEP has proposed a rule that would establish a clean air operating permit application fee system for a variety of environmental media. Contact Janis Hoagland, DEP, (609) 292-0716.

The New Jersey DEP announced a limited amnesty program to allow waivers of civil penalties for violations relating to failure to obtain permits prior to the alteration or installation of equipment at regulated facilities. For more information, contact NPCA's Jim Sell, (202) 462-6272.

Environmental Regulations (Notice)—On November 2, 1994, the New Jersey Governor Christine Whitman signed Executive Order 27, requiring any state agency which promulgates regulations stricter than those required under federal law to provide an explanation and cost-benefit analysis of the proposed rules.

Lead—A 2248 (Collins) provides financial assistance for lead abatement work and authorizes the Economic Development Authority to issue bonds. The legislation was introduced on October 20 and sent to the Assembly Committee on Health and Human Services.

S. 1537 (Bassano and Matheussen) requires the screening of children for lead exposure and appropriates funds for that purpose. The bill was introduced on October 17 and was referred to the Senate Committee on Health.

New York

Air Quality (Regulation)—A regulation adopted by the New York Department of Environmental Conservation (DEC) incorporates, by reference, federal standards mandated by the Clean Air Act Amendments for new major stationary source facilities or ones that plan to undergo a major modification. Contact Timothy Ross, DEC, (518) 457-7688.

New Mexico

Air Quality (Regulation)—The New Mexico Environmental Improvement Board (EIB) issued a proposal that would implement the requirements of Section 112 (g) of the Federal Clean Air Act Amendments which mandate that states develop maximum achievable control technologies (MACT) on a case-by-case basis for facilities that undergo a modification or new construction. Contact Jim Nellessen, EIB, (505) 827-0048.

North Carolina

Toxic Substances (Regulation)—The North Carolina Department of Environment, Health and Natural Resources (DEHNR) has proposed revisions to current regulations relating to the requirements of the asbestos hazard management program, including standards affecting the removal of asbestos. Contact Grady Balentine, Department of Justice, (919) 733-4618.

Oregon

Air Quality (Regulation)—A proposal issued by the Oregon Department of Environmental Quality (DEQ) would

update its new source review program with new federal regulations which, among other things, require new sources of air pollutants to incorporate stringent control technologies. Contact Donald Aukell, DEQ, (503) 726-2514.

Pennsylvania

Air Quality (Regulation)—The Pennsylvania Environmental Quality Board (EQB) proposed regulations to establish a clean fuel vehicle fleet program in ozone nonattainment areas that would mandate the use of such vehicles by fleet operators. Contact Nick Havens, Department of Environmental Resources, (717) 787-4310.

South Carolina

Hazardous Waste (Regulation)—The South Carolina Department of Health and Environmental Control (DHEC) has announced its intention to amend current hazardous waste regulations in order to establish requirements that are more stringent than federal standards, including standards relating to accurate determinations of waste by generators. Contact Randall Thompson, DHEC, (803) 734-4711.

Tennessee

Air Quality (Regulation)—The Tennessee Department of Environmental Conservation (DEC) adopted final regulations which revise the requirements of its clean air program. Among the amended provisions are (1) the new source review program, including revisions to the definitions of "control strategy" and what constitutes lowest achievable emissions rate (LAER); (2) enhanced monitoring of air emissions; (3) transition procedures for major stationary sources; and (4) standards for the clean air operating permit program. Contact Malcolm Butler, DEC, (615) 532-0554.

The Tennessee DEC proposed a regulation which would establish standards for VOC emissions inventories and control standards for VOC emissions from wood furniture manufacturing. Contact Malcolm Butler, DEC, (615) 532-0554.

A proposal issued by the Tennessee DEC would, among other things, specify criteria for identifying facilities that emit VOCs. Contact Malcolm Butler, DEC, (615) 532-0554.

Texas

Air Quality (Regulation)—The Texas Natural Resource and Conservation Commission (NRCC) issued a proposal that relates to the storage of VOCs. The rule includes information on control requirements, alternate control requirements, testing and monitoring requirements, and compliance schedules. Contact Office of Air Quality, NRCC, (512) 239-1970.

The Texas NRCC issued a proposal relating to VOC emissions inventory requirements, as required by the Clean Air Act Amendments. Contact Gus Eghneim, NRCC, (512) 239-1965.

The Texas NRCC has proposed a regulation concerning the loading and unloading of VOCs. Contact Eddie Mack, NRCC, (512) 239-1488.

The Texas NRCC adopted final regulations that provide tax exemptions for facilities that must install pollution abatement equipment. Contact Gary McArthur, NRCC, (512) 239-1917.

The Texas NRCC issued a proposed rule to amend the current wastewater discharge permit procedures. Under the new regulation, the NRCC would establish a new program to evaluate renewal applications for the permits and would also assign new expiration dates to all future permits. Contact NRCC, (512) 239-1000.

Utah

Air Quality (Regulation)—The Utah Department of Environmental Quality (DEQ) issued a proposed rule which relates to the state implementation plan (SIP). The regulation includes information on the review of new and modified air pollution sources, source surveillance, ambient air monitoring program, resources, intergovernmental cooperation, prevention of air pollution emergency episodes, prevention of significant deterioration, control measures for area and point sources, fine particulate matter, control measures for area and point sources, emission limits, basic inspection and maintenance, analysis of plan impact, and comprehensive emission inventory. Contact Jan Miller, DEQ, (801) 536-4042.

Hazardous Waste (Regulation)—The Utah Department of Transportation (DOT) proposed a rule relating to safety regulations for motor carriers transporting hazardous materials and/or hazardous waste. Contact Shirleen Hancock, DOT, (801) 965-4781.

Vermont

Lead (Regulation)—The Vermont Department of Health (DOH) has issued a final regulation establishing standards for lead-based paint activities. Contact Karen Crampton, DOH, (802) 863-7231.

Toxic Substances (Regulation)—The Vermont Department of Public Safety (DPS) has proposed a regulation which clarifies procedures for hazardous chemicals/substances identification, reporting, fee payment, and public disclosure concerning such materials in Vermont. The proposal continues a reporting system which satisfies the requirements of the federal Superfund Amendments and Reauthorization Act. Contact Kelman Craige, VT Emergency Management, (802) 244-8721.

Washington

Air Quality (Regulation)—The Spokane County (WA) Air Pollution Control Authority (SCAPCA) has proposed a regulation that limits particulate and toxic air pollutant emissions from surface coating operations. The rule establishes requirements for coating application techniques, use of spray booths, use of clean-up materials, disposal procedures, and solvent content of auto refinishing coatings. Contact Eric Skelton, SCAPCA, W. 1101 College, Suite 403, Spokane, WA 99201.

The Washington Department of Ecology (DOE) intends to adopt regulations implementing revisions to the state's Model Toxic Control Act, including standards that define what conditions must exist at a site before industrial cleanup standards would apply. Contact Curtis Pahlgren, DOE, (206) 407-7187.

Wisconsin

Water Quality (Regulation)—The Wisconsin Department of Natural Resources (DNR) adopted a final rule concerning permitting of storm water run-off from industrial sites. Contact Kevin Torvell, DNR, (608) 267-7694.

Wyoming

Occupational Safety & Health (Regulation)—The Wyoming Department of Employment has proposed regulations incorporating federal standards relating to the retention of safety placards and warnings mandated by the U.S. Department of Transportation. Contact Stephen Foster, DOE, (307) 777-7786.

Aceto Corp. • ACT Laboratories, Inc. • Advanced Software Designs • Air Products Chemicals, Inc. • Air Quality Sciences, Inc. • AKZO Nobel Resins and AKZO Nobel Chemicals, Inc. • Alcan-Toyo America, Inc. • Alcoa Industrial Chemicals • Alnor Oil Company • C.M. Ambrose Co. • American Chemical Society • American Colors, Inc. • American Felt & Filter Co. • American Filter Products • American Paint & Ctgs Journal • Amoco Chemical Co. • Angus Chemical Co. • Anker Labelers USA, Inc. • Aqualon • Arco Chemical Co. • Ashland Chemical, Inc. • Atlas Electric Devices Co. • Aztec Peroxides, Inc. • B.A.G. Corporation • BASF Corp. • Blackmer • Blacoh Fluid Control, Inc. • Bohlin Instruments, Inc. • Brookfield Eng. Labs, Inc. • Brookhaven Instruments Corp. • Buckman Laboratories • Bulkcon Systems International USA Ltd • Burgess Pigment Co. • BYK-Chemie USA • BYK-Gardner, Inc. • Cabot Corp. • Caframo Ltd. • Calgon Corp. • Cappelle, Inc. • Cardolite Corp. • CB Mills, Inc. • CCP Polymers • Celite Corporation • Center for Applied Engineering • Chemical Engineering • Chemical & Engineering News • Chemical Marketing Reporter • Chemical Week Associates • CIBA-GEIGY Corporation • Cimbar Performance Minerals • The Coatings Laboratory Inc. • Coatings Magazine • Coldec Verkoop BV • Color and Appearance Technology • Color Communications, Inc. • Color Corporation • ColorCube Corporation • Color Tec Associates • Columbian Chemicals Co. • Consolidated Research Inc. • COROB S.r.l. • Coulter Corp. • CPI Purchasing Magazine • CR Minerals Corp. • Crosfield Co. • Cuno, Inc. • Custom Fibers International • CYTEC Industries • D/L Laboratories • Daniel Products Co., Inc. • Datacolor International • Day-Glo Color Corp. • J. De Vree & Co. N.V. • Degussa Corp. • University of Detroit-Mercy • Disti • Dominion Colour Corp. • Dow Chemical USA • Dow Corning Corp. • Draiswerke, Inc. • Drew Industrial • Dry Branch Kaolin Co. • DSA Consulting, Inc. • DSM Resins U.S., Inc. • Eagle Zinc Co. • Eastern Michigan University • Eastman Chemical Co. • Ebonex Corp. • ECC International • Eiger Machinery, Inc. • Elcometer, Inc. • Elf Atochem North America, Inc. • Elmar Industries, Inc. • EM Industries, Inc. • Emulsion Systems, Inc. • Engelhard Corp. • Engineered Polymer Solutions • Epworth Mfg Co., Inc. • EQ-The Environmental Quality Co. • Etna Products Inc. • European Coatings Journal • Exxon Chemical Co. • Fawcett Co., Inc. • F S C T • Filter Specialists Inc. • Fischer Technology, Inc. • Fluid Management L.P. • FMJ International Publications Ltd. • Fryma, Inc. • Fuji Silysia Chemical Ltd. • H.B. Fuller Co. • G A F Filters Systems • Paul N. Gardner Co., Inc. • Georgia Pacific Resins Inc. • The B.F. Goodrich Co. • Goodyear Tire & Rubber Co • W.L. Gore & Associates, Inc. • Grace Davison • Guertin Polymers • Haake, Inc. • The C.P. Hall Company • Halox Pigments • Harcros Pigments, Inc. • William Harrison Corp. • Henkel Corp. • Heraeus DSet Labs, Inc. • Heucotech Ltd. • Hilton-Davis Co. • Hockmeyer Equipment Corp. • Hoechst Celanex Corp. • Hoover Container Sales & Services • Horiba Instrumets Inc. • J.M. Huber Corp. • J.M. Huber Corp. • Huls America, Inc. • Huls America, Inc. • Hunterlab • Huntsman Corporation • ICIS-LOR • Ideal Mfg & Sales Corp. • InChem Corporation • Industrial Paint & Powder Magazine • INSITEC, Inc. • Interfibe Corporation • International Resources Inc. • Intern'l Specialty Chemicals, Inc. • International Specialty Prod. • ITT Marlow Pumps • S.C. Johnson Polymers • K-T Feldspar Corp. • Kady International • KAPAK Corporation • Kemira, Inc. • Kenrich Petrochemicals Inc. • King Industries, Inc. • Kline & Co. • KTA-Tator, Inc. • Labsphere, Inc. • LaQue Center • Law Environmental • Lawter International • The Leneta Company • Linpac Bulk Packaging • Liquid Controls Corp. • Littleford Day Inc. • The Lubrizol Corp. • Luzenac America • 3M, Specialty Chem Div • 3M/Zeelan Industries Inc. • MacBeth • Magnesium Elektron, Inc. • Malvern Instruments • Malvern Minerals Co. • The McCrone Group • McWhorter, Inc. • The Mearl Corp. • Michelman, Inc. • Micro Powders, Inc. • Microfluidics International Corp. • Micromeritics Instrument Corp. • Micromet Instruments • Mid-States Eng & Mfg Co. • Millipore Corp. • Milton Can Co. • Milwhite, Inc. • Mineral Pigments • Ming-Zu Chemical Industries • Minifibers, Inc. • Minolta Corp. • Mississippi Lime Co. • University of Missouri-Rolla • Modern Paint & Coatings • Morehouse Cowles, Inc. • Morton International Inc. • Mountain Minerals Co. Ltd. • MRM Elgin • Myers Engineering • Nacan Products Ltd. • Nametre Company • National Chemical Co. • National Paint & Coatings Assoc. • Netzsch Inc. • Neupak, Inc. • New Way Packaging Machinery Inc. • Norman International • North Dakota State University • Nyco Minerals Inc. • Oak Printing • Obron Atlantic Corp. • Occidental Chemical Corp. • Ohio Polychemical Co. • Olin Chemicals • Omega Recycling Technologies • Ortech • OSI Specialties Inc. • Paar Physica USA, Inc. • Pacific Micro Software Engineering • Paint & Ctgs Ind. Magazine • Paint Research Association • Particle Sizing Systems, Inc. • Pen Kem Inc. • Peninsula Polymer • Pfaudler-U.S., Inc. • Phenoxy Associates • Philadelphia Society for Ctgs Tech • Pioneer Packaging Machinery • Poly-Resyn, Inc. • PPG Industries, Inc. • PPG Industries, Inc. • P Q Corporation • Premier Mill Corp. • Progressive Recovery, Inc. • Purity Zinc Metals Co. • Pyosa S.A. De C.V. • The Q-Panel Co. • Quantachrome Corp. • R Tech Equipment • Raabe Corp. • Radtech International • Ranbar Technology, Inc. • Rheox, Inc. • Rohm and Haas Co. • Rohm Tech Inc. • Ronningen-Petter • Charles Ross and Son Co. • Russell Finex, Inc. • San Esters Corp. • Sandoz Chemicals Corp. • Sanwa Chemical Ind. Co. Ltd. • Schenectady Chemicals • Schuller International Inc. • Semi-Bulk Systems • Serac, Inc. • Shamrock Technologies Inc. • Sheen Instruments Ltd. • Shell Chemical Co. • Sherwin-Williams Chemicals • Shimadzu Scientific Inst. • Silberline Mfg Co., Inc. • Sino-American Pigment Systems • Software 2000 Inc. • Sonoco Products • South Florida Test Services • Southern Clay Products Inc. • Univ. of Southern Mississippi • Specialty Minerals, Inc. • Springfield Specialties • Standard Industries, Inc. • Startex Chemical Co. • Steel Structures Painting Council • Stretch-O-Seal Corp. • Sub-Tropical Testing Serv. • Sud-Chemie • Summit Precision Polymers Corp. • Sun Chemical Corp. • Sunkyong Industries • Systech Environmental Corp. • 21st Century Containers • TA Instruments, Inc. • Tayca Corp. • Tech Pak, Inc. • Tego Chemie Service USA • Thiele Engineering Co. • Thurman Material Handling Systems • Transac, Inc. • Trendition House, Inc. • Trinity Air Technologies • Troy Corp. • U.S. Borax, Inc. • U.S. Sack Corp. • Ultrablend Systems, Inc. • Union Carbide Corp. • Union Miniere • Union Process, Inc. • United Mineral & Chemical Corp. • Van Waters & Rogers Inc. • R.T. Vanderbilt Co., Inc. • Versa-Matic Pump Co. • Viking Pump, Inc. • Vorti-Siv • Wacker Silicones Corp. • Washtech Systems Inc. • West Coast Societies • Wilden Pump & Eng. Co • Witco Corp. • X-Rite, Inc. • Zaclon, Inc. • Zeneca Biocides • Zeneca Resins • Aceto Corp. • ACT Laboratories, Inc. • Advanced Software Designs • Air Products Chemicals, Inc.



Fall 1994 Board of Directors Meeting

Thirty-six members and 25 guests attended the Fall Meeting of the Board of Directors of the Federation of Societies for Coatings Technology, on October 11, 1994, in New Orleans, L.A.

The following persons were in attendance:

Officers

President John A. Lanning
 President-Elect Joseph P. Walton
 Secretary-Treasurer Darlene Brezinski

Society Representatives

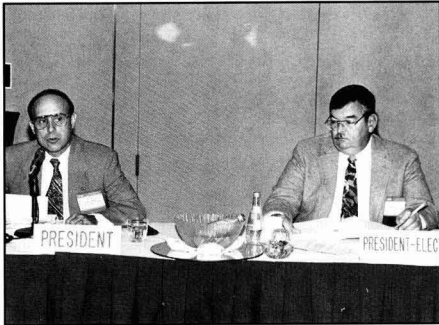
Baltimore Joseph D. Giusto
 Birmingham Gerry J. Gough
 C-D-I-C William Hollifield
 Chicago Evans Angelos
 Cleveland Brenda Carr
 Dallas Charles Kaplan
 Detroit Van Evener
 Golden Gate Timothy J. Donlin
 Houston Joseph Caravello
 Kansas City Mark Algaier
 Los Angeles Jan Van Zelm
 Louisville Larry Pitchford
 Mexico Arturo Ita
 Montreal Suzanne Richardson
 New England Maureen Lein
 New York Michael Frantz
 Northwestern Larry Brandenberger
 Pacific Northwest William E. Shackelford
 Philadelphia Wayne A. Kraus
 Piedmont Forest Fleming
 Pittsburgh William C. Spangenberg
 Rocky Mountain Dick Mullen
 St. Louis Terry Gelhot
 Southern Scott McKenzie, Jr.
 Toronto Arthur K. Hagopian
 Western New York Gerald Ivancie

Other Members

John Ballard Louisville
 Milton A. Glaser Chicago
 Colin D. Penny Baltimore
 Freidun Anwari Cleveland
 Thomas Hill Western New York
 Peter Hiscocks Toronto
 J. Andrew Doyle NPCA

Guests

Federation Past-Presidents Carlos Dorris, William Holmes, James McCormick, John Oates, and Carroll Scholle. (Board Members John Ballard, Milton A. Glaser, and Colin D. Penny are also Past-Presidents of the Federation.)
 George R. Pilcher, President of the Coatings Industry Education Foundation.
 Doug Huemme, President, National Paint & Coatings Association.
 Mark Bernstein, Chairman of the Board, Canadian Paint & Coatings Association.
 Jan Satrom, President, and Ernest Stewart, Executive Vice President, National Decorating Products Association.
 Francis Borel, Secretary General, Federation of Associations of Technicians in the Paint, Varnish, Lacquer, and Printing Ink Industries of Continental Europe (FATIPEC).
 Yoshio Sasaki, Vice-President, Japan Society for Colour Material (JSCM).
 Christopher Pacey-Day, General Secretary, Oil & Colour Chemists' Association (OCCA).
 Michael Symes, President, Skandinaviska Lackteknikers Forbund (SLF).
 Raymond McConnell, President, Surface Coatings Association Australia (SCAA).
 Phil Taylor, President, Surface Coatings Association New Zealand (SCANZ).
 Thad T. Broome, Chair, FSCT By-Laws Committee.
 Abel Banov, Co-Publisher, American Paint & Coatings Journal.
 Society Members John C. Weaver (Cleveland); Bud Jenkins (Los



From left: President John A. Lanning (Louisville) and President-Elect Joseph P. Walton (Cleveland)

Angeles); Racquel Cortes, Martha Colin, and Jorge Hijuleos (Mexico); and Yvon Poiras and John Westendorf (Pacific Northwest).

Staff

Michael Bell, Director of Educational Services; Victoria Graves, Director of Meetings & Conventions; Patricia Viola, Director of Publications; and Robert F. Ziegler, Executive Vice President.

The report of the Spring 1994 Board of Directors Meeting was approved as published in the August 1994 issue of the *JOURNAL OF COATINGS TECHNOLOGY*.

A MOMENT OF SILENCE WAS OBSERVED IN MEMORY OF EDWARD RYAN, OF THE PITTSBURGH SOCIETY AND A MEMBER OF THE JOINT COATINGS/FOREST PRODUCTS COMMITTEE, WHO LOST HIS LIFE IN THE RECENT AIR ACCIDENT NEAR PITTSBURGH WHILE RETURNING FROM A MEETING OF THE COMMITTEE.

Reports of the Officers and Staff

PRESIDENT LANNING

Looking back upon my term of office, which is accelerating even faster at this point, I am reminded of the changes taking place in the industry and the ones we can expect in the future. I can remember when Federation activities moved along without much fanfare or



Secretary-Treasurer Darlene Brezinski (Chicago) and Executive Vice President Robert F. Ziegler

excitement. Board of Directors meetings were routine and precipitated little dialogue. This has all changed during the last several years and promises to continue. One might say we're reaching a new plateau.

Increasing communication with the NPCA is producing major changes in the format and programming of the Annual Meeting and Paint Show. These changes are expected to improve content and reduce expenses to our exhibitors. Format changes to the technical programming should increase members' interest and attendance at the Technical Sessions. Continued focus can be expected as we address the needs of our members and the industry they serve.

Due to the enthusiasm of the Mexico Society, we are looking past our home borders for the first time with great anticipation. Spring Week in Cancun, a possible Mini-Convention in Mexico, publications in Spanish, permission to expand the Mexican Society further South, cause one to ask, What's next?

The changes taking place will challenge Staff, the Officers, the Directors and especially the Planning Committee. The Planning Committee can expect to be more active than ever as they review changes to the Federation's strategic plan and make recommendations for implementation.

The membership reclassification issue produced sharp debate. As I said earlier, Board meetings are no longer boring and I believe this issue will be back again along with others. Perhaps we will even debate the formation of a Russian Paint Society at some point in the future.

Moving back to more traditional topics, my wife Pat and I felt honored to represent the Federation in Victoria, British Columbia, Birmingham, and Harrogate, England. Soon we will leave for Australia to meet with the Surface Coatings Association of Australia and New Zealand for their very first Coatings Conference. This year's activities have been exciting, educational and a treasure for a lifetime. The Federation is as solid as ever and viewed with high esteem worldwide. Both of us thank the Board for allowing us the opportunity to represent the Federation in so many places.

JOHN A. LANNING,
President

PRESIDENT-ELECT WALTON

Following the Board of Directors meeting at the FSCT Spring Week I have had an opportunity to attend the following meetings: the Host Committee meeting and Executive Committee meeting in New Orleans; the Technical Advisory Committee meeting with Society Technical Committee Chairs in Chicago; the FSCT/NPCA Joint Coordinating Committee meeting in Chicago; and the Annual Convention and 50th Anniversary Celebration of ANAFAPYT in Ixtapa, Mexico. At each of these meetings I had an opportunity to interact with people throughout our industry in order to best be able to serve the members of the Federation.

Quite a bit of time this summer has been spent conversing with members of the Federation in order to put together the various committee and chairperson appointments for the upcoming year. We have been very fortunate throughout the years with the high quality of service from our members and I anticipate that next year's appointees will continue this tradition.

Darlene Brezinski and I have also been talking to various committees about the need to attract a wider audience to the Annual Meeting and Paint Show in order that we can maintain this function which is the financial backbone of the FSCT. The support and cooperation of our committees will enable us to accomplish this.

This year's Annual Meeting and Paint Show looks as if it will be quite successful. I commend the Annual Meeting Program and Host Committees for all of their hard work in this endeavor.

As always, the staff has been extremely competent and I both commend them for their efforts and thank them for their assistance in helping me to prepare for the next year.

JOSEPH P. WALTON,
President-Elect

SECRETARY-TREASURER BREZINSKI

Since the last Board of Directors Meeting the following functions were attended.

JPICC Meeting—Washington, D.C., May 25-26, 1994—This meeting, which was hosted by NPCA, was very beneficial and informative. It provided the opportunity to meet with members of the NDPA, NPCA, and PDCA to share information, discuss programs of common interest, and review mutual problems we all share in the industry. Particularly noteworthy and informative was an update on the NPCA Industry Outreach Program which is of great benefit to all of us in the coatings industry.

Western Coatings Societies' Board Meeting—Carmel, CA, August 5-7, 1994—This meeting is focused on the activities of the member Societies. It was a wonderful opportunity to meet more of our members and observe their working and planning together to achieve common goals. Each of the Societies is very active and is providing ongoing beneficial programs for its members. The Cal Poly short courses on polymers and coatings chemistry also appear to be a great success and benefit the local Societies.

Professional Development Committee—Chicago, IL, August 16-17, 1994—This committee continues to strive toward providing technology leadership through seminars, short courses, etc., for the industry. The committee is to be commended for responding so rapidly to requests for providing a "hands-on" training and technical program at the Paint Show.

The staff continues to do a wonderful job of controlling costs as we continue to explore other avenues of increasing revenue. The past year has been rewarding in meeting and interacting with so many dedicated individuals who continue to give of their time and energy in an effort to advance the industry, their Societies and the Federation.

DARLENE BREZINSKI,
Secretary-Treasurer

EXECUTIVE VICE PRESIDENT ZIEGLER

FINANCIAL

As of August 31, 1994, Federation financial accounts showed totals of: Income — \$2,287,250; Expense — \$1,768,772, for a net excess of \$518,478 (vs. \$623,690, in 1993). Several publication income accounts are under budget and steps have been taken to remedy this, such as staff marketing additions and outsourcing advertising sales efforts. Production costs for the Panorama System is over budget due to a greater than expected increase in the volume of MSDS additions to the CD. Other than the above, accounts are in line.

PUBLICATIONS

JCT—While recognizing the technical reputation of the *JCT*, members and readers alike have spoken of the need for more practical articles and features. The Publications Committee has approved the introduction of such articles and is encouraging the membership to respond. In addition, the *JCT* is taking this opportunity to update its look and become more "reader-friendly," with improved page layouts and typography. The update is scheduled to begin with the January 1995 issue. The *JCT* will continue to publish relevant, refereed technical articles for which it is so well known and respected. We sincerely thank Dr. Robert Brady, Chair, and the committee for their support.

Paint Stone—The latest effort in member communication and FSCT and Society promotion has been successful in both respects. Now being published from August through April, we encourage the Societies to utilize this opportunity to promote their activities to the



Terry Gelhot (St. Louis) and Scott McKenzie, Jr. (Southern)

industry. (The *Paint Stone* is also mailed to all NPCA industry management members.)

Series Booklets—As reported at the May 1994 Board Meeting, three new booklets have been published in 1994: "Metal Surface Characteristics Affecting Organic Coatings," by Dr. Bruno Perfetti; "Painting of Plastics," by Dr. Rose Ryntz; and "Color and Appearance," by Drs. Robert Marcus and Percy Pierce. These bring to 23 the total number of technical booklet titles being offered by the FSCT in the Series.

Panorama Coatings MSDS CD Retrieval System—Launched earlier this year, the Panorama System is gaining acceptance by the industry as an integral part of companies' archival material. By year's end update the Panorama CD will contain over 17,000 individual raw material MSDS, giving subscribers a useful device for complying with regulations. The FSCT is working, with the assistance of the NPCA, to complete the acquisition of MSDS by several major suppliers. NPCA is also assisting with the marketing of the System to its membership as well as the update of the Raw Material Index. International interest remains strong and the FSCT is working towards a liaison with overseas associations and distributors. At the present time (9/94) there are 90 company subscriptions.

MEMBERSHIP

We are pleased to report that Society and FSCT membership drives have been very successful in retaining members and recruiting new membership. Prior to the November update, the current membership total is 7,542, broken down into the following categories: Active — 4,531; Associate — 2,237; Other (Educator/Student, Retired, Honorary) — 630; Affiliate — 144. During the same period in 1993 the total membership stood at 7,223.

Outstanding increases in membership by Societies will be recognized at the Fall Meeting of the Board in New Orleans.

ANNUAL MEETING AND PAINT SHOW

The FSCT Paint Industries' Show continues to show growth and success as the world's largest exhibition of coatings-related raw materials, manufacturing equipment, and services. The 1994 event will be the second largest ever produced by the FSCT with 308 exhibiting companies/organizations (a new record) in over 91,000 sq. ft. of exhibit space. (Largest was the 1992 (Chicago) Paint Show with 295 exhibitors and 94,100 sq. ft.; 1993 (Atlanta) had 301 exhibitors in 88,950 sq. ft.) The FSCT greatly appreciates the continued support of these suppliers.

While the absence of support of some large supplier companies is of concern, assurances have been made that this decision was based on business-related reasons and not on the quality of the Show. It is expected that these companies will be in attendance at future Paint Shows.



Joseph D. Giusto (Baltimore) and Gerry J. Gough (Birmingham)

Meanwhile, we sincerely thank Dr. Gerry Mattson, of USM, and his Host Committee, who will be dressed in blue vests, ready to assist attendees and staff alike during the many activities in New Orleans.

The Federation also deeply thanks Ronda Miles, of Union Carbide Corp., and the Program Committee for developing a fine array of technical presentations. Advance registration is running above that of 1993 and the attendees will be treated to a program of over 50 presentations centering on the Annual Meeting theme, "Excellence Through Innovation."

SPRING WEEK

We thank the Northwestern Society and its personnel for hosting the very successful 1994 Spring Week meetings in Minneapolis on May 12-15. In addition to sponsoring a delightful tour of the city and its famous gargantuan shopping mall, the Society also treated the attendees to delightful weather.

The 1995 events will be hosted by the Mexico Society and the FSCT looks forward to another successful event in Cancun, May 17-21. Plans are ongoing for the development of a seminar which will feature an international format and theme. Details will be forthcoming.

FSCT/NPCA COOPERATIVE EFFORTS

The Joint FSCT/NPCA Industry Advisory Committee met on September 12 to discuss the status of cooperation and future efforts. Discussions were friendly and several topics were examined, including the continued support of the Panorama System as well as the update of the Raw Material Index. Of special interest is the development of concurrent annual meetings of the two groups with some joint programming. With the approval of the Board, this is scheduled to take place in 1996, in Chicago.

The continuing involvement of the Societies in State Paint Council activities was noted by NPCA as extremely helpful in



Brenda Carr (Cleveland) and Charles Kaplan (Dallas)

gaining technical support for these important groups. (A full report was presented in the Board material in May and published in the August 1994 issue of the JCT.) The Federation strongly encourages the involvement of Society members.

STRATEGIC PLANNING

As noted in the report of the August 12 meeting of the Executive Committee, discussions will be held following the Annual Meeting to establish goals and priorities in relation to strategic planning items. Taking part will be the Executive Committee, Planning Committee and Staff. A report of the meeting will be distributed to the Board with recommendations.

OFFICER/STAFF VISITS

Since the last report to the Board, visits have been made to OCCA's SURFEX Show in England, during which the Panorama System was demonstrated; the Mexico Society to discuss plans for the 1995 Spring Week; the West Coast Societies Board Meeting; the Joint SCAA/SCANZ Conference and meeting of Coatings Societies International, in Brisbane; and the meeting of the Joint FSCT/NPCA Industry Advisory Committee, in Chicago. We sincerely appreciate the generous hospitality and interest shown by these organizations.

HEADQUARTERS STAFF

It is expected that two staff positions will be filled in the near future: Marketing Manager and Marketing Assistant. These positions, approved by the Executive Committee, will increase FSCT efforts in promoting the many services and products being offered to industry and furthering the success of the FSCT.

I wish to thank the dedicated members of your staff who have worked diligently to fulfill the FSCT's mission to its membership. They are: Michael Bell, Director of Educational Services; Victoria Graves, Director of Meetings and Conventions/Membership Services; Patricia Viola, Director of Publications; Charles Schmidt, Controller; Kathleen Wikiera, JCT Managing Editor; Jonna Coachman, JCT Assistant Editor; Mary Evangelisto, JCT Editorial Assistant; Audrey Boozer, JCT Subscription Fulfillment; Lisa McGlashen, Secretary to Mr. Ziegler; Mary Sorbello, Secretary to Mr. Bell; Marie Wikiera, Assistant to Ms. Graves; Linda Madden, DTP Operator; Meryl Cohen, Order Dept.; and Dorothy Kwiatkowski, Receptionist.

On behalf of the Staff, I sincerely thank the Officers, Board, Committees and their employers for their generous support of Federation efforts. The active involvement of these volunteers is the indispensable ingredient in the success of the FSCT.

ROBERT F. ZIEGLER,
Executive Vice President

DIRECTOR OF EDUCATIONAL SERVICES BELL

COMMITTEE LIAISON

EDUCATIONAL COORDINATING COMMITTEE

The Educational Coordinating Committee has met once since the last meeting of the FSCT Board of Directors, on June 2-3, 1994 in St. Louis. This meeting was with the Constituent Society Educational Committee Chairs. The next meeting of the committee is scheduled for Monday, November 7, 1994 in Cleveland, OH.

The committee has been working on the following projects as part of its "Test Drilling" activities: the High School Science Teachers Kit, which is expected to be available early next year; the development of a Society Speakers Program, to be unveiled in the Spring of 1995; and the development of a Curriculum Outline to assist Societies with the development of seminars and the like.

The committee is also involved in the following: working with the

Southern Society for Coatings Technology to handle the administration and judging of the A.L. Hendry Award; reviewing the applications and distributing the funds for the Small Society Scholarship program (up to \$400 in matching funds for Society educational efforts); and with its Educational Needs Survey, which is being done in conjunction with the NPCA Management Information Committee.

The committee will be presenting the A.L. Hendry Award at the Annual Meeting, during the Annual Business Meeting, and will be reviewing the Small Society Scholarship requests at its November meeting, while also finalizing the plans for the "Test Drilling" projects.

TECHNICAL ADVISORY COMMITTEE

The last meeting of the Technical Advisory Committee was held on August 17-19, 1994 in Chicago. This meeting was with the Chairs of the Constituent Society Technical Committees. The next meeting of the committee is scheduled for Friday, October 14, 1994 during the Annual Meeting.

The committee has been involved with the following projects:

Spring Week 1994 Seminar—The committee developed the seminar, "Adhesion in Coatings: Technology and Characterization." The seminar had 76 attendees and scored very well on the evaluation forms completed by the attendees. Based on this success, the committee has requested the opportunity to develop another Spring Week seminar in the future.

ASTM and NIBS Lead Abatement Program—The committee will remain involved in the ASTM activities related to lead abatement, yet has decided against continuing on with the NIBS program due to lack of activity on the part of NIBS towards a defined goal.

Society Technical Committees—The TAC "Adoptive Society" program has continued to assist the TAC in communicating with the Constituent Societies. The program was very influential in the attendance increase at the recent meeting the TAC held with the Society Technical Chairs.

APJ/Voss Award and Society Speaker Award Administration—The TAC will begin the administration of both awards in 1995.

Joint Coatings/Forest Products Committee—This committee meets twice a year and is comprised of ten members of the coatings industry and ten representatives of the wood industry. The committee usually meets in the spring in Madison, WI at the USDA Forest Products Lab and in the fall in Chicago. The FSCT Executive Committee, at the recommendation of the FSCT Planning Committee, recently voted to give this group full committee status within the Federation. The Chairman of the Joint Coatings/Forest Products Committee is Bob Springate, of the Chicago Society.

The committee is currently working on a series of practical articles covering many facets of architectural coatings. Several of the articles have appeared in the *American Painting Contractor*, with additional coverage given in other publications.

The Joint Coatings/Forest Products Committee suffered a loss after its September meeting in Chicago when one of the attendees, Ed Ryan of PPG Industries, was among the casualties of the crash of US Air Flight 427, on September 8 in Pittsburgh. Ed was returning home after the committee meeting. His contributions to the group and his good nature will be sorely missed. The FSCT extends its most heartfelt condolences to his family.

CORROSION COMMITTEE

The Corrosion Committee held its last meeting on August 2, 1994 in Philadelphia, PA. The committee will next meet on Thursday, October 13, 1994 at the FSCT Annual Meeting in New Orleans, LA.

The committee has been working on the following projects:

1994 Annual Meeting Symposium—The committee has finalized the plans for its symposium at the 1994 Annual Meeting entitled,



Peter Hiscocks (Toronto) and Freidun Anwari (Cleveland)

"Innovations in the Development of VOC Compliant Corrosion-Inhibitive Coatings: Testing and Technology." The committee has assembled five speakers to discuss this topic and expects an interesting and informative session. The session will be held on Thursday, October 13, 1994 at 1:00 pm.

1995 Annual Meeting Symposium—At its August meeting, the committee spent considerable time analyzing potential topics and formats for the 1995 symposium, and determined that a change from the usual four or five technical paper format was in order. The 1995 symposium will consist of a panel discussion-type format and should include a topic of interest to the attendees and hopefully create more attendance for the session.

Corrosion Monograph—Approval has been given to begin developing a monograph to be added to the Federation *Series on Coatings Technology*. The monograph will be entitled, "Methodology for Assessing Corrosion Inhibiting Performance in Coatings." The committee is now working on a timeline to complete the monograph, and work should begin on the project in early 1995.

Interaction with other Corrosion-Related Societies—The committee has established contact with NACE International with the intention of developing joint educational activities. The committee also maintains a close relationship with the Steel Structures Painting Council (SSPC) and ASTM.

MANUFACTURING COMMITTEE

The FSCT Manufacturing Committee has undergone a great change in the last few months, with increased activity with the National Paint and Coatings Association's Manufacturing Management Committee. This includes a name change to the Joint FSCT/NPCA Manufacturing Management Committee. The next meeting of the committee will be held on Thursday morning, October 13, 1994 at the Annual Meeting.

The committee has been involved in the following activities:

1994 FSCT Annual Meeting Symposium—The committee has developed a session entitled, "The Human Side of Process Safety Management." The Human Resources Subcommittee has produced the program and it will feature four experts discussing the factors of PSM that need to be considered during implementation. The session will be held on Thursday, October 13, 1994 at 9:00 am.

Society Interaction—The committee recently completed "The Guide for Society Manufacturing Chairs," patterned after the successful document developed by the FSCT Technical Advisory Committee. The purpose of the guide will be to assist the chairs of the Constituent Society Manufacturing Committees to better meet the needs of members interested in manufacturing. The guide has been sent to the Chairs of the Manufacturing Committees of the Constituent Societies and to all Society Presidents. The committee is also



Mark Bernstein, Chairman of the Board of the Canadian Paint & Coatings Association



Doug Huemme, President of National Paint & Coatings Association

looking for ways to have involvement in manufacturing from all 26 Societies. At this time, approximately 17 Societies have manufacturing committees.

PROFESSIONAL DEVELOPMENT COMMITTEE

The Professional Development Committee has met once since the last meeting of the FSCT Board of Directors, on August 16-17, 1994 in Chicago. The committee will next meet on Tuesday, October 11, 1994 during the Annual Meeting.

The committee has been involved in the following projects:

"Formulating for the New Clean Air Act" Seminar—The committee will be requesting funds to conduct the "Clean Air" seminar twice during 1995, in the spring in Cleveland and next fall in Denver. The selected dates are Tuesday and Wednesday, March 21-22, 1995 in Cleveland and Tuesday and Wednesday, November 6-7, 1995 in Denver. The committee has made some adjustments to the seminar based on attendee input and hopes the changes will further add to the popularity of the program.

"Polymer Chemistry" Seminar—The committee has reviewed the results of its survey cards distributed at FSCT educational events and plans to present a seminar entitled, "Polymer Chemistry for the Coatings Formulator" in June 1995. Chicago has been selected as the site of the seminar, based on previous success in this locale.

Annual Meeting Session—The PDC will hold a unique session at this year's Annual Meeting. Entitled "Analyses of Painted Surfaces Through Analytical Methodology," the session will be "hands-on" and will allow the attendees to interact with the speakers and view the equipment that is discussed in the session room.

ANNUAL MEETING PROGRAM COMMITTEE

The Annual Meeting Program Committee has assembled a diversified program that should meet the needs of the attendees at this year's Annual Meeting. The theme is "Excellence Through Innovation" and includes programming on corrosion, analytical techniques, manufacturing, color, and several other pertinent topics. Committee Chair Ronda Miles of the Dallas Society and her committee have addressed the concerns of previous technical programs and have made adjustments accordingly.

New for 1994 are the Early Bird Sessions on Thursday morning at 8:00 am. These concurrent sessions will cover Waste Minimization and Team Development. Also included are the Third Annual Poster Session and the Technical Focus Speaker.

The 1995 Annual Meeting Program Committee has also met once to plan the event for St. Louis. The committee met in Chicago on September 27 and will meet again on Wednesday, October 12, 1994 at the Annual Meeting. Louis Holzknicht of the Louisville Society will chair the 1995 committee.



Ernest Stewart, Executive Vice President, and Jan Satrom, President, of National Decorating Products Association



Raymond McConnell, President of Surface Coatings Association Australia (SCAA)



Michael Symes, President of Skandinaviska Lackteknikers Forbund (SLF)

MISCELLANEOUS

The following activities are being done independent of committee activity or the result of the work of several committees working in unison:

Technical Focus Speaker—The Technical Focus Speaker will again kick off the technical portion of the Annual Meeting. Mark Holt, of Ciba-Geigy, will deliver a presentation entitled, "Additives in Coatings: Meeting the Needs of a Changing Industry." The Professional Development, Technical Advisory, Educational Coordinating, and Annual Meeting Program Committees all worked together to select the speaker.

FSCT Video Offerings—The newest offering, "VOC Determination," has been selling quite well, with over 20 copies being sold thus far. Additional offerings, "Good Tests, Bad Testing" and "Structure/Property Relationships for Thermoset Coatings," continue to be made available for loan to Societies for monthly meetings.

List of Talks Available—The List of Talks Available has grown to over 120 speakers. Steps are being made to improve the quality of the speaker offerings to assist the Societies in attracting audiences for their monthly meetings.

Certification—Much of the last few months has been spent investigating the pros and cons of developing a certification program



Yoshio Sasaki, Vice President of Japan Society for Colour Materials (JSCM)

for the coatings industry. This study included meetings with individuals involved in administering certification programs for other industries and evaluating the steps necessary to start such a program.

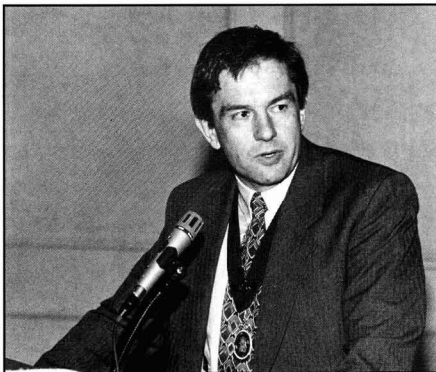
Roon and APJ/Voss Awards—The selections have been made for both awards. The administration of the APJ/Voss Award will be done by the Technical Advisory Committee beginning in 1995.

FSCT Travel—Since the last meeting of the FSCT Board of Directors, I have attended the meeting of the FSCT Planning Committee in June and the Annual Meeting Host Committee Meeting in August. This is in addition to any meeting mentioned in the course of the report.

MICHAEL G. BELL,
Director of Educational Services

Comments from Guests

Representatives of industry associations attending the meeting presented greetings from their respective groups. Speaking were: Mr. Bernstein, of the Canadian Paint & Coatings Association;



Phil Taylor, President of Surface Coatings Association New Zealand (SCANZ)



Francis Borel, Secretary General, Federation of Associations of Technicians in the Paint, Varnish, Lacquer, and Printing Ink Industries of Continental Europe (FATIPEC) presents FSCT President Lanning with a commemorative photograph



Wayne Kraus (Philadelphia) and Forest Fleming (Piedmont)

Messrs. Huehme and Doyle, of National Paint & Coatings Association; Ms. Satrom and Mr. Stewart, of National Decorating Products Association; Mr. Borel, of FATIPEC; Dr. Sasaki, of JSCM; Mr. Symes, of SLF; Mr. McConnell, of SCAA; and Mr. Taylor, of SCANZ.

Also addressing the Board was Dr. Weaver, who called for participation by the membership in D-1 ASTM discussions regarding VOC and ISO.

Review of Actions of Executive Committee

August 12, 1994

That to control travel expenses, it be recommended to the Board that the policy regarding reimbursement for transportation expenses to Federation meetings be revised as follows: For reimbursement, all eligible members traveling to FSCT meetings must contact the FSCT Travel Desk (Uniglobe Wings Travel) and utilize its services if travel costs quoted are less than that available elsewhere. The revised policy, effective January 1, 1995, will be reviewed annually.

That the Federation office update its computer system, both hardware and software, as proposed by staff.

That the Executive Committee, Planning Committee, and Staff meet to formulate action plans, setting goals related to strategic planning.

That the Chicago Society, responsible for the Panorama MSDS CD Retrieval System, be proposed for the Union Carbide Award.

That the Federation Office be expanded into the lease space to accommodate potential staff increases.

That the Federation offer a 401 (k) retirement program to staff.

(On a motion by Mr. Van Zelm, seconded by Dr. Brezinski, the above actions of the Executive Committee were unanimously approved.)

October 10, 1994

That the Third Quarter 1994 Statement of Income and Expense be accepted as presented, showing Income at \$2,492,310; Expense at \$2,075,199.

That the proposed concurrent FSCT and NPCA Annual Meeting schedule be approved and adopted whenever possible.

That discussion on the 1995 grant to NPCA be tabled until after the meeting of the FSCT Finance Committee.

That exhibit space rates be increased from \$16.50 to \$16.75 per sq.ft. for the 1995 Paint Industries' Show.

That the selling price of the Federation Series on Coatings Technology booklets be increased to \$15.00 each for members; \$25.00 each for non-members.

That the proposed guidelines for selection of the Mattiello Memorial Lecturer be approved.

That the 1995 staff salary budget be increased 3%, plus allocations for additional marketing staff positions.

(On a motion by Mr. Hollifield, seconded by Mr. Pitchford, the above actions of the Executive Committee were unanimously approved.)

By-Laws

For First Reading and Adoption

STANDING RULE VIII(B)—DUTIES OF FEDERATION COMMITTEES

WHEREAS the Executive Committee recommended changes to the duties of various FSCT Committees and the Board approved these changes at the May 15, 1994 meeting. Therefore be it

RESOLVED that Article SR VIII, Section B be revised to eliminate all reference to the Memorial Committee, the Paint Industries' Show Committee, the A.F. Voss/APJ Awards Committee, and the Society Speakers Awards Committee.

Further be it

RESOLVED that Article SR VIII, Section B be revised regarding the Technical Advisory Committee. The change shall consist of adding an additional duty to this committee by adding directly following paragraph (5) an additional paragraph reading:

(6) Select Voss/APJ and Society Speakers Awards. The Technical Advisory Committee shall fulfill all responsibilities stated in the following section titled, "Annual Meeting Awards" that pertain to the A.F. Voss/American Paint Journal Awards and that pertain to the Society Speakers Awards.

(On a motion by Mr. Mullen, seconded by Mr. Giusto, the Board unanimously approved the above proposed amendment to the Standing Rules.)

Proposed Amendments to FSCT By-Laws

The following amendment was proposed by the Executive Committee and the Board approved this action at its May 15, 1994



Larry Brandenberger (Northwestern) and William E. Shackelford (Pacific Northwest)

meeting. The following By-Laws revisions will be presented for first reading at the *Spring 1995 Board Meeting*.

I. DUES INCREASE

WHEREAS the Federation of Societies for Coatings Technology Board of Directors approved the following action on May 15, 1994 be it

RESOLVED that the first paragraph of the By-Laws Article XII, Section A be amended to read as follows

BY-LAWS ARTICLE XII—DUES

A. Active and Associate Members

Each Constituent Society shall pay to the Federation Office annual dues of twenty five dollars (\$25.00) in U.S. funds per capita for each Active and Associate Member of the Constituent Society.

Following the defeat of the amendment to allow any class (except Educator/Student) to sit on the Board as a Society Representative at the May 15, 1994 Board Meeting, the Detroit Society made the following proposal:

Due to their size, small Societies find it inherently more difficult to locate members to serve as Representatives to the FSCT Board of Directors. It, therefore, proposed

That a Society that cannot find an Active Member to serve as Society Representative be allowed to petition the Board for a waiver of hardship to allow the use of an Associate Member. This hardship waiver would be judged by a formal set of criteria that the Executive Committee would utilize before granting or rejecting the request, with the Board establishing said criteria.

The By-Laws Committee was directed to consider the proposal and suggest criteria. The following By-Law revision will be presented for first reading at the Spring 1995 Board Meeting.

II. SOCIETY REPRESENTATIVE—ELIGIBILITY

WHEREAS the Detroit Society has proposed and upon proper action by the Board of Directors be it

RESOLVED that a new and an additional paragraph be added to the By-Laws under Article IV (Organization) and as an addition to Section B. The new Paragraph to be added just prior to the list of "Duties of the Board."

Any Society that is unable after diligent effort to secure an Active Member to serve as Society Representative may petition the Board of Directors for a waiver of hardship to allow an Associate Member to serve as Society Representative. The petition must satisfy the following criteria to be acceptable by the Board of Directors.

- (1) A specific candidate must be presented.
- (2) The candidate must be an Associate Member of the local Constituent Society.
- (3) The candidate must have a history of participation in the local Constituent Society and the FSCT. This history must cover a period of not less than 10 years.
- (4) The candidate must be able to serve as an FSCT Board Member without any bias toward the product or services of his/her present employer. Further, the candidate's employer must give unconditional permission for the candidate to fulfill the duties of a member of the FSCT Board.
- (5) The candidate must be a representative of a small Society that has polled all Active Members and has found it impossible to find a suitable and willing Active Member to serve as Society Representative. (For the purpose of this action a small Society is defined as one with no more than 200 total members and no more than 100 Active Members.)
- (6) The candidate must be able and willing to carry out all duties as a Board Member as presented throughout Article IV.



William Hollifield (CDIC) and Evans Angelos (Chicago)

(7) The candidate must first be presented to the Executive Committee and the Executive must recommend or not recommend to the Board.

LATIN AMERICA SECTION

At the May 15, 1994 Board Meeting, the Mexico Society territory was expanded to include both Central and South Americas, to form a Society "Latin America Section." At the time, it was mentioned that member services to this section would need to be enhanced at additional cost. There is envisioned special issues of JCT, mailings, etc., all in Spanish, with related additional costs, as well as additional travel expenses for FSCT Officers, staff and Mexico Society representatives.

The current (and proposed) member dues will not cover the cost of postage for the JCT. Although the cost of servicing Society members has not been a consideration of dues, there should be some criteria set forth where another level of dues is justified for members requiring enhanced services, including a subscription to the JCT, currently \$45 for non-European subscribers and \$60 in Europe.

The By-Laws Committee was directed to consider this and draft appropriate revisions to the By-Laws.

After due consideration no consensus was reached. The Committee requests that the Chair meet with members of the Mexico Society and the Executive Committee to address concerns and to reach agreement on proposed language.

(In consideration of the Mexico Society's efforts to recruit members during the Annual Meeting, Mr. Evener moved that a "Show only" membership dues be set at \$35.00. Seconded by Dr. Brezinski and unanimously approved.)

Comments From By-Laws Committee

- (1) The By-Laws Committee has no comment on the general dues increase for Active and Associate Members.
- (2) The By-Laws Committee does not favor the change in the By-Laws that is required to implement the proposal made by the Detroit Society relating to allowing other than Active Members to serve on the Board of Directors. The By-Laws Committee request that all refer to the minutes of the May 1994 Board of Directors meeting for detail comments on this issue.
- (3) The committee revisions as approved by the Board of Directors at the May 1994 meeting as written in this report for By-Laws changes seem proper. The By-Laws Committee unanimously favors approval.

(4) The By-Laws Committee has mixed (pro and con) comments on the proposed increase in dues for non-North American Societies. So, as a committee there is no comment.

THAD T. BROOME,
By-Laws Chair

Elections

The names of the following have been placed before the Board for election at the meeting of October 11, 1994:

President-Elect—Darlene Brezinski (Chicago Society), of Consolidated Research, Inc. (One-Year Term)

Secretary-Treasurer—Jay Austin (Chicago Society), of Halox Pigments (One-Year Term).

Executive Committee—Gerry Gough (Birmingham Club), of ICI Packaging Coatings (Holden Surface Coatings Ltd.) (Three-Year Term).

Board Members at Large—Freidun Anwari (Cleveland Society), of BFGoodrich Co.; F. Louis Floyd (Baltimore Society), of Duron, Inc. (Two-Year Terms each).

Board Past-President Member—John J. Oates (New York Society) (Two-Year Term).

On a motion by Mr. Van Zelm, seconded by Mr. Evener, the slate of nominees, as proposed by the Nominating Committee, was unanimously elected into office.)

Society Business

Recognition of Society Membership Increases — Brenda Carr, Chair of the FSCT Membership Services Committee made presentations of Certificates of Appreciation to the following Societies in recognition of outstanding increases in membership during the past year:

Rocky Mountain Society —22%
Philadelphia Society —9.26%
Southern Society —10.72%

Western New York Society — Mr. Ivancie advised the Board of recent changes in the Society's organization. Due to industry consolidation and a relocation of a major company, the Society has experienced a downturn in membership which resulted in a decrease in resources available for continued activities. The Society reorganized and will now operate under a President and Society Represent-



Thomas Hill (Western New York) and John Ballard (Louisville)

tative only. FSCT dues only will be collected directly by the Headquarters Office; there will be no Society dues.

Southern Society — Mr. McKenzie announced the formation of a new Society Section in Birmingham, Alabama.

C-D-I-C Society — Mr. Hollifield announced the celebration of the Society's 75th Anniversary in 1995.

Committee Reports

ANNUAL MEETING HOST COMMITTEE

All Host Subcommittee Chairs for the 1994 Paint Industries' Show attended the Host and the Program Committee meeting held at the New Orleans Marriott on August 11, 1994. The comprehensive agenda as set by Bob Ziegler, Executive Vice President, and Tori Graves, Director of Meetings and Conventions, ably served the purpose of reviewing the progress of our committees as well as answering questions of the Subcommittee Chairs. The meeting was particularly important for the Program Operations Subcommittee and for the Social Guest Program Subcommittee because of the small but important changes in the Show format involving those committees. I continue to be confident that we have the human resources to make the Host Committee responsibilities uneventful—as in no problems. Certainly I am pleased to reiterate the fact that we have significant numbers of committee members from the Southern Society, from the Texas Societies and from USM. Meeting and working with more people in the industry has been a real bonus for me.

Since current plans are for the Show to return to New Orleans every four years, I encourage consideration for the videotaping of work areas, highlighting committee members carrying out their duties, not just for archival records, but for the use of future New Orleans Host Chairs. In case you were not doing so already, the same videotape arrangements could be used to make a dynamic record of other aspects of the Show as a useful complement to the photographic record.

I will look forward to greeting each of you and the thousands of other coatings enthusiasts in New Orleans in October.

GERALD MATTSON,
Chairman

CORROSION COMMITTEE

The Corrosion Committee held its second meeting of the year on August 2, 1994, at the Radisson Hotel-Philadelphia (PA) Airport. Items of discussion were as follows:

1994 Annual Corrosion Program—This year's symposium, entitled "Innovation in the Development of VOC Compliant Corrosion Inhibitive Coatings: Testing and Technology," promises to be an excellent opportunity for the coatings manufacturer to get an industry update on some of the more exciting VOC compliant alternatives for development of corrosion inhibitive coatings.

Potential Format Changes for Future Annual Meeting Programs—The committee is considering a move away from the conventional format of corrosion related papers/presentations to that of a panel discussion. It is believed that such a change would be timely due to recent industry controversy regarding polymer selection, coating selections, and accelerated testing in the development of low VOC, corrosion-inhibitive coatings. It was determined that a quality moderator is needed to make such a format successful.

1995 Annual Corrosion Program—The above format change may be put into effect at the 1995 program in St. Louis. Several possible scenarios are now under consideration. Key areas of interest include: Pros and cons of new accelerated corrosion test methods, compliant technology selection and its dependence on coating re-

quirements, and numerous others. Efforts are now underway to identify the most viable panel topic and to select the theme for the 1995 Annual Corrosion Program.

Corrosion Committee Publication Award—The committee reviewed the results of judging of papers eligible for the 1994 Corrosion Committee Publication Award and determined that none of the few papers eligible scored high enough, per award criteria, to merit the award. The decision came after much discussion and is unfortunate. However, it is believed that many corrosion-related papers with scientific merit are being excluded from eligibility since they were not published in the JCT. Thus, in an effort to expand the number of quality award candidates, guideline revisions for the award are now under consideration.

Corrosion Monograph Project—The FSCT Series Editors have given their approval for the development of a corrosion monograph entitled, "Methodology for Assessing Corrosion Inhibiting Performance in Coatings." Committee efforts are now focused on procuring a potential author and securing funding in the 1995 budget.

Cleveland Society Corrosion Project—Now in its second year, the Society's project on "Correlation of Accelerated Exposure Testing and Exterior Exposure Sites," is progressing well and is producing interesting findings. It remains within budget.

Corrosion Committee Protocol—The committee is working with the FSCT Planning Committee in the development of a protocol which will provide a sense of long-term continuity to committee efforts.

M.A. JACKSON,
Chairman

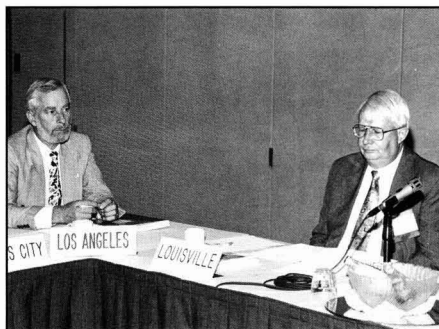
EDUCATIONAL AND EDUCATIONAL COORDINATING COMMITTEES

Since the last report to the Board, the Educational Committee has met for its annual session in St. Louis, MO, on June 2, 1994, and the Educational Coordinating Committee (ECC), in Cleveland, OH, on April 11, 1994. An additional brief ECC meeting was held before the start of the full Educational Committee meeting in St. Louis. We have been working on several major projects, which we have initiated as a result of our test drilling efforts. Planning and organizing these activities and identifying new opportunities is now occupying our top priority. Results are detailed below.

Coatings/Science Resource Package—Most of our Constituent Societies participate in educational programs wherein Society members go into their communities as representatives of their industry and of science in general. As our world becomes increasingly complex in its technology and reliance on science, an educated public and young people interested in science are essential. It is an important opportunity that each of us has to be ambassadors for science and for coatings technology. To further these efforts, we are working on the Coatings/Science Resource Kit. After much discussion by the ECC and in focus groups at our Educational Committee meeting, we propose to gather documentation which will support education in the following focus areas:

- General Science and Chemistry
- Demonstrations
- Science-Fair Type Projects
- Community Interaction/Mentoring/Implementation.

These documents would provide ways for our membership to go out into the community. In addition, they would allow teachers, especially in high schools, to use coatings related learning experiments and materials in their classrooms, either supported by a member or independently. With this in mind, we have funded a "mini-project" involving a high school teacher and gifted student at North Dakota State University. This project should lead to several



Jan Van Zelm (Los Angeles) and Larry Pitchford (Louisville)

experiments or "lesson plans" which could be incorporated into a high school curriculum.

We have asked that successful examples of educational activities from our Constituent Societies involving members and local organizations or schools be communicated to us. The FSCT will support availability of this information and broaden its scope.

Some time was spent at our Educational Committee meeting hearing a presentation on mentoring by Dr. Albert Edney (Montanto). This was an interesting and exciting talk by a person who has been active in one-on-one mentoring in the greater St. Louis area. Broadening our educational horizons must be a goal of the Federation.

Improving Monthly Meetings—the FSCT Society Speakers Program—Strong technical programs have been identified as the most important issue in successful Society meetings. The Federation should help our Constituent Societies to do this better. We have proposed that the FSCT invite and sponsor development of technically important papers and talks by specialists in the raw materials companies and/or universities with coatings programs to be presented at monthly meetings of the Constituent Societies. Our goal is that the FSCT provide and fund one speaker to each Society every two years. We are currently putting this program together. Several Societies have expressed an interest and potential speakers have been sounded out. Putting these two together has been a challenge, but we feel that a prototype of the program will be operating in the Spring of 1995.

We are excited by the prospect of this program, a meaningful way for the Federation to provide the opportunity to improve monthly meetings, the cornerstone of a healthy, active Society.

The Southern Society A.L. Hendry Award—The reorientation of the Hendry Award to emphasize undergraduate work and to increase interest by also rewarding the sponsoring laboratory, so that it may further its undergraduate research activities, is completed. This has resulted in greater participation, but we still need more papers. We would encourage local Society members to aid participation in their region either by acting as a mentor or by contacting local colleges or universities. We hope that the program will continue to grow as we publicize the Hendry Award more.

FSCT Matching Funds for Society Educational Activities—After a successful program last year, where nine Societies were granted aid for their educational activities, the Federation Executive Committee approved our proposal to continue to provide matching funds this year. We have received five requests thus far, with proposals being accepted until October 30, 1994. Support is limited to \$400 per Society annually, with the focus being to assist small to medium size Societies and sections of Societies which have limited funds for educational efforts, especially scholarships and grants. Funds have also been used to help cover costs of our Constituent Societies in



Arthur K. Hagopian (Toronto) and Gerald Ivancie (Western New York)

sending members to coatings related short courses, in sponsoring educational nights as meeting programs, and in furthering participation in science fairs. The ECC will continue to administer this program. Please encourage your Society to participate.

FSCT Technical Focus Award—The Technical Focus Award speaker, kicking off the Annual Meeting Program, was a great success last year. This award recognizes current and timely contributions of an educational or technical nature, especially those of a younger member of the Federation. The award includes a cash prize of \$500 and a lead-off spot at the beginning of the Annual Meeting program. The second recipient of the Technical Focus Award will be Mr. Mark S. Holt of Ciba-Geigy Corp. He will open our technical program on Wednesday, October 12, 1994, at the Ernest Morial Convention Center in New Orleans. The Annual Meeting Program Committee is currently managing this program and members from the ECC, PDC, the Technical Advisory Committee (TAC), and Annual Meeting Program Committee participate in the selection process. I will be Moderator for this session.

NPCA Interaction—The ECC has been working with the NPCA Management Information Committee (MIC) to develop a survey of the coatings industry with respect to its future personnel needs. This type of information would help us to better allocate our funds dedicated to education.

The survey has been developed. It calls attention to the universities which have existing coating technology programs in addition to requesting information on the number, training level, and skills required of future coatings industry technical people. This will serve as input to our Professional Development programs and to the CIEF.

The survey was sent to MIC members; 14 returned it. This initial work showed that the information could be captured using the current questionnaire. This will be sent out to the full NPCA membership in the near future.

The ECC and Educational Committee have been actively seeking to expand the educational programming of the Constituent Societies. We have focused on developing and executing projects which serve the educational needs of the Constituent Societies and local membership. Our test-drilling method has successfully identified possible ventures. Several of these have developed into projects which are becoming reality; others are just taking shape. Please help us as we continue this endeavor—your input and support are vital.

DONALD W. BOYD,
Chairman

MANUFACTURING

In the spring of 1994 the FSCT Manufacturing Committee held its first joint meeting with the NPCA Manufacturing Management

Committee. The results were gratifying. The unified committee offers opportunity for expense savings as well as increased resources for education. The official name of the committee was changed to the Joint FSCT/NPCA Manufacturing Management Committee. No meetings were held since the spring meeting. Future meeting dates are as follows: Oct. 13, 1994—New Orleans—joint meeting; Tour of the Dupont titanium plant scheduled for Oct. 12, 1994; Spring 1994—San Francisco—joint meeting; Plant tours to include Fuller O'Brien and, potentially, Rohm and Haas.

The New Orleans Manufacturing Seminar entitled "The Human Side of Process Safety Management" will be held on Thursday, October 13, 1994 at 9:00 am. The session will focus on what a manager needs to do to head the process safety management program and will provide ideas to assist employees in adapting to the changes while still maintaining a high level of production efficiency.

The following speakers will discuss different segments of the 14 part standard:

Tom Wehrenberg, Law Environmental—Framework of the Regulation;

Ray Plewa, PPG—PHA, Team Involvement and Accident Investigation;

Mike Heglas, Glidden—Audit, Procedures and Training, Contractors;

Jeff Wilson—Management of Change, Pre Start Up Safety Review.

We are looking forward to a large turnout for this very timely seminar.

The committee has recommended a member who has contributed significantly to the paint industry in the area of manufacturing, to receive the Golden Impeller Award presented annually by Morehouse-Cowles. This year's recipient will be Horton Russell, Devco and Raynolds. Horton will receive his award prior to the Manufacturing Seminar on Thursday.

A guide for local Society Manufacturing Committee Chairs has been developed and will be provided to each Society. The guide will help the local chairmen establish a Manufacturing Committee and make it beneficial to furthering the education of members and their companies. It is hoped that this document will be a useful resource.

DON L. MAZZONE,
Chairman

MEMBERSHIP SERVICES

The Federation has had an increase in membership of approximately one percent for the 1993-94 year. The committee attributes this increase to three main factors:



Michael Frantz (New York) and Maureen Lein (New England)

(1) The continuing hard work of Constituent Society Membership Chairs and Society members to recruit new members.

(2) The Annual Membership Drive which netted over 60 new members this year. (There were over 159 inquiries as a result of the membership drive.)

(3) The new "Last Chance to Renew!" flyer. The flyer was sent to all members who did not review by January 1. Over 119 members responded and renewed as a result of the new reminder mailing.

This year, the Committee set up a program to establish more personal contact with each Society Membership Chair. This was a very successful program. Committee members fielded a number of questions and got a lot of good comments and suggestions. Society Membership Chairs were especially pleased with the "Last Chance to Renew" flyer that followed up on members who did not renew and the Annual Membership Drive.

One good question that arose from this program was, "What Society covers West Virginia?" Since this state is not mentioned anywhere in the FSCT Standing Rules, it was decided that members from West Virginia should join whatever Society is most convenient for them to participate in.

The Membership Services Committee also prepared a Committee Mission Statement Protocol at the request of the Federation Planning Committee.

BRENDA L. CARR,
Chairman

PLANNING

The following are some of the issues addressed by the Planning Committee during the past year:

Strategic Planning—Paint Show Market Research—The report prepared by Lawrence-Leiter on the results of their Survey of 1993 Paint Show attendees was reviewed and recommendations were made to the Executive Committee on changes that would address some of the problem areas that the report revealed.

Federation Operation Procedures—Bob Ziegler and staff prepared a draft of current Federation Operating Procedures Manual. The document, though not complete, was quite thorough and extensive. Recommendations were made for improvement and expansion of the document.

Federation Committees—Planning Committee members conducted an in-depth review of numerous Federation Committees by first developing a questionnaire and then interviewing committee chairpersons. The process, which resulted in the development of recommendations that may improve committee functions, were submitted to the Executive Committee.

SAUL SPINDEL,
Chairman

PUBLICATIONS

The Publications Committee met on June 2, 1994 in Pittsburgh, PA. The Editorial Review Board of the JOURNAL OF COATINGS TECHNOLOGY, which meets every second year, did not meet this year.

The Publications Committee heard plans for the redesign of the JCT in January 1995 and saw models of several pages in the new design. The committee supports this change, the first in 20 years, and looks forward to the January 1995 issue.

The Publications Committee also discussed some ideas for broadening the appeal of the JCT and increasing its readership. These ideas focused on appealing to members of the Federation who are new to the coatings industry and those who are interested in articles of a more practical nature. Four new initiatives to bring about these changes were suggested:

(1) Solicit authors of recognized expertise and commission them to write papers of a practical nature. (2) Encourage authors of



Joseph Caravello (Houston) and Mark Algaier (Kansas City)

monographs in the FSCT *Series on Coatings Technology* to extract material from their booklet and rewrite it as short articles. (3) Contact FSCT Committees for suggestions of topics and authors which might be of interest. (4) Publish a "Call for Papers" in *The Paint Stone* and on the Comment page in the JCT.

The resignation of M. Jay Austin from the Editorial Review Board was accepted with regret but with best wishes for his new responsibilities within the Federation. Dr. James O. Stoffer of the University of Missouri-Rolla has accepted an invitation to join the Board; the number of members remains steady at 23.

The Federation Series of monographs on Coatings Technology remains strong. Three new titles have recently appeared: "Metal Surface Characteristics Affecting Organic Coatings," by Bruno Perfetti; "Painting of Plastics," by Rose Ryntz; and "Color and Appearance," by Robert Marcus and Percy Pierce. Suggestions for additional titles are welcome.

The number and quality of manuscripts submitted to the JOURNAL OF COATINGS TECHNOLOGY continues to be good, and the time between receipt of a paper and reply to the author remains short.

ROBERT F. BRADY, JR.,
Chairman

TECHNICAL ADVISORY

The Technical Advisory Committee (TAC) met in Chicago, with the Society Technical Chairs for their annual meeting. In addition, the TAC met to discuss the outcome of the Spring Week Seminar it sponsored and the Lead Abatement Issue. All TAC members were in attendance.

Joint Meeting with Constituent Society Technical Chairs—The annual joint meeting of the TAC and Society Technical Chairs was held in Chicago, on August 18-19, 1994.

On August 19, the individual Societies made presentations on the status of their technical projects. In addition, J.P. Walton, FSCT President-Elect, reviewed the current activities of the FSCT and the other committees' activities. President-Elect Walton also discussed the joint activities of the FSCT and NPCA.

Robert Brady, Chairman of the Publications Committee and the Editorial Review Board, and Pat Viola, Editor of the JCT and Director of Publications for the FSCT, provided an update on the guidelines to follow for submitting a paper for publication. Pat Viola also introduced a new kind of article to be published in the JCT which will allow a conduit for technical information to be shared with the readers. These types of articles are geared to be informative to a wider audience.

Hiro Fujimoto, Advanced Technologies, gave a presentation outlining the guidelines for conducting a successful round-robin. After-dinner speakers were Don Brooks, CEO, and Wayne Niemeyer,



J. Andrew Doyle (NPCA) and Milton A. Glaser (Chicago)

Senior Research Scientist, from McCrone Associates. Their presentation focused on the use of microscopy as an analysis tool.

On August 19, two tours were conducted. The first tour was of McCrone Associates. This tour included a comprehensive explanation and viewing of various types of microscopes, such as the Scanning Probing Microscope, for use as an analyzing technique for polymers or film characterization.

The second tour was of the Binks Manufacturing facility. This tour focused on the various spray techniques including the advances in spray guns and transfer efficiencies. Binks covered electrostatic and powder spraying, as well as air assisted and air assisted airless.

Spring Week, 1994—A review of the seminar, "Adhesion in Coatings: Technology and Characterization," was held. The seminar topic was chosen from feedback of surveys conducted by the PDC during previous seminars.

The response from the 74 attendees was very positive. Various aspects of adhesion were covered in this seminar, with particular emphasis on the chemistry of adhesion. Unique to this seminar was that the speakers were asked to supply either a paper or a copy of their slides. This proved to be effective. Credit for organizing this seminar should go to co-chairs, Dr. Rose Ryntz and Edward Ferlauto.

Lead Abatement—Edward Ferlauto, the TAC liaison involved with this project, reports that the ASTM subcommittee E06.23 has four standard practices which have been submitted to a main committee ballot. The four involve standard practices for sample digestion of soils, field collection of settled dust samples, field collection of dried paint samples and field collection of soil samples, all for lead determination by Atomic Spectroscopy techniques.

Mr. Ferlauto pointed out that there are other organizations who also monitor this issue and recommends that this lead subcommittee



Colin D. Penny (Baltimore) and Joseph D. Giusto (Baltimore)

of the TAC be expanded and perhaps a joint project with the NPCA be established.

Regarding the NIBS lead project, due to the inactivity of this group, Mr. Ferlauto recommends no further involvement.

AF Voss/APJ Award and Speakers Award—Based on the TAC's involvement with the Society Technical Chairs and their programs, and acting on the Planning Committees' recommendation, the Board has approved the additional responsibilities of the TAC regarding these Annual Meeting awards. The TAC assumes responsibility in 1995 and looks forward to this opportunity.

UV/EB and Powder Subcommittees—Based on discussions by the Planning Committee at their June meeting, it was recommended that sub-groups of the TAC be organized for UV/EB and Powder Coatings. The TAC will further pursue discussions with the Planning Committee on these recommendations.

GAIL POLLANO,
Chairman

Society Reports

Baltimore

Six monthly meetings featured technical presentations, three of which were hosted by the Educational, Technical, and Manufacturing Committees. . . The Educational Committee presented a one-day seminar for beginners and laymen, which was well attended. . . Herman Shuger Memorial Award was presented to Theodore J. Grumbine, of Lasting Paints, for signal service to the industry. . . Merit citations were presented to Gordon Allison, of McCormick Paint; Thomas J. Brice, of Duron Inc.; Richard Chodnicki, of Van Horn & Metz; Ed Countryman, of Bruning Paint; and James M. Smith, of Eastech Chemicals. . . Scholarships were presented to Anika Thompson and Christopher LaBaw, both children of members.

Birmingham

Seven technical meetings were held, covering subjects such as VOC control in coatings, silicone additives, epoxy resins, experimental design, high-solid, water-based coatings, and accelerated testing of anticorrosive pigments. Attendance numbers averaged 90-100. . . Technical highlights included winning first prize Voss Award, presented for the Club's "Solids Density" project. . . Working with the British Coatings Federation to develop a "common interest" approach to paint technology courses and review such education in the U.K.

CDIC

Significant accomplishments made in the areas of manufacturing and legislative involvement. . . Participation in the Ohio Paint Council began with appointment of Hugh Lowrey as CDIC representative. This position has been added to the Executive Committee. . . Manufacturing Committee Chairman position reinstated with appointment of Dave Sellers. Two manufacturing programs underway. . . Presented scholarship to Jill Swint, of Akzo Nobel Coatings, Inc. . . Meeting schedule and program agenda have been adjusted to increase interest and attendance at monthly meetings. . . Plans are underway for celebration of Society's 75th anniversary, April 10, 1995.

Chicago

Seven regular business meetings were held, with attendance averaging 100. . . Membership totals 771, an increase of 9.5% from previous year. . . Two grants in aid awards of \$2000 each were presented, awarded

by merit; joint CSCT/Chicago Paint and Coatings Association Educational Committee awarded five \$2000 grants in aid, to sons and daughters of either CSCT or CPCA members, chosen by lottery . . . CSCT/CPCA jointly sponsored SYMCO 94 featuring theme of "Changing Times" . . . Boards of the two organizations had four meetings to improve communications. . . . Will continue to support Elmhurst College Bachelor's program and the Master's Degree in Coatings and Polymers at DePaul University . . . Will sponsor, with CPCA, a short course in Coatings Technology in January 1995. . . . Plans underway for celebration of 75th anniversary celebration of Society.

Cleveland

Educational Committee provided career day speakers, science fair judges and advisors, and hosted tours of coatings facilities to two colleges, five high schools, and ten grade schools . . . Sponsored 37th annual Technical Symposium . . . Environmental and Manufacturing Committees each sponsored technical meetings . . . Society Scholarship Fund was renamed the CSCT Memorial Scholarship Fund in honor of deceased members Charles Graf, Harold Werner, Fred Schwab, Francis "Tex" Reed, George Selden, and Helen Skowronska . . . Membership increased approximately 14% . . . Technical Committee's paper on "Clear Liquid Separation in Paints Thickened with Cellulosic/Associative Thickeners," was published in JCT. Part II of this study was presented at 1993 Paint Industries' Show . . . Paper on long-term correlation study also was presented at 1993 Show and received first place award for speaker, Ben Carlozzo, and tied for first place in A.F. Voss/APJ Award competition.

Dallas

Membership totals 154 . . . Technical presentations were made at monthly meetings, with special emphasis made on the selection of the technical programs presented at meetings. May meeting honored Society Past-Presidents . . . Joint meetings with Dallas Paint and Coatings Association included cosponsoring a Texas Paint Council meeting . . . Society will host 52nd Southwest Paint Convention in March 1995 . . . Federation-level activity for Society included participation in the Annual Meeting and Paint Industries' Show in New Orleans by Program Committee Chair Ronda Miles and Program Operations Subcommittee Chair Chip Newcomb.

Detroit

Membership totals 432 . . . Working in cooperation with Detroit Paint and Coatings Association. Joint meetings were held every other month, with alternating responsibility, starting in September and concluding in May . . . New course on "Problem Solving in Coatings Using Analytical Instrument Techniques" was added to continuing education efforts at the University of Detroit-Mercy . . . Actively participated in "Metropolitan Detroit Science Fair and Career Day" . . . Scholarships and educational awards of approximately \$5000 were presented in area schools and universities . . . Supervised the annual Future Of Coatings Under Study Program, which was well-received by an audience of 160 persons . . . Contest to design the cover of the DSCT newsletter was won by Scott Jakubowski, son of member Jim Jakubowski.

Golden Gate

Membership totals 262 . . . 22nd Biennial Western Coatings Symposium to be held at San Francisco Hilton on February 20-22, 1995. Theme for the event is "New Opportunities—Challenges and Solutions". . . Manufacturing Committee considering ways to attract more manufacturing people to monthly meetings by arranging for a speaker on a manufacturing topic at beginning of meeting . . . Three \$1,000 scholarships given . . . Hosted the 41st annual meeting of the Western Societies for Coatings Technology at Carmel, CA, which was also attended by Secretary-Treasurer



William C. Spangenberg (Pittsburgh) and Dick Mullen (Rocky Mountain)

Darlene Brezinski and Executive Vice President Robert F. Ziegler . . . Executive Board approved formation of an Investment Committee and clarified the duties and eligibility of Symposium General Chairman . . . Past-President Garnet Grieve (1938-1939) was honored at meeting with FSCT 50-Year pin. The Board dedicated the 1994-95 Membership Roster to the memory of Society Past-President Jack Duis, who died this past year.

Kansas City

Ten meetings held during the year, including seven technical meetings, and the joint meeting with the St. Louis Society at the Lake of the Ozarks in June. At joint meeting, a suppliers' tabletop exhibition was introduced and was very successful.

Louisville

Diverse technical presentations included emphasis on the coatings manufacturing process. Additional topics were optimization of dispersion techniques, new waterborne resins, and the latest developments in process equipment . . . Society restored its Spring Technical Symposium, entitled, "Coatings A to Z," which featured topics pertaining to formulation, regulation, and quality control evaluation of the coatings industry . . . LSCT Outstanding Service Award was presented to Louis Holzknacht of Devco Coatings Co. for his excellent work and leadership in the Society . . . Continued support of Introduction to Coatings Technology course offered by the University of Louisville and the LSCT educational grant providing



Van Evener (Detroit) and Timothy J. Donlin (Golden Gate)



Arturo Ita (Mexico) and Suzanne Richardson (Montreal)

tuition expenses to an individual attending a FSCT-sponsored short course.

Mexico

Membership totals increased 14.41% over 1993-94. Continuing to recruit people from other organizations to increase membership . . . Sponsored a three-day seminar on "Basic Statistical Tools Applied to Improve Quality and Productivity," with 25 attendees . . . Held Seventh Annual Technical Symposium in Cuernavaca, Mor., covering several topics from manufacturing to ecology, safety and economy, with 86 attendees . . . Thirteen technical talks presented at monthly meetings, averaging 65 attendees . . . Sponsored Third Paint and Ink Technician's Day to celebrate all the major contributions to the coatings industry in Mexico made by any member of the Mexico Society. Attendance totalled 99. . . . Twenty-three Executive Committee meetings held . . . Increased number of technical books in Mexico Society library. . . . Currently working on Spanish translation for the FSCT *Series on Coatings Technology* to be published in Mexico.

Montreal

Nine monthly meetings held, with seven technical presentations and a mini-symposium on low VOC coatings-related subjects. Average attendance was slightly lower than previous years, about 10-15% of membership . . . Membership totals 270, down approximately 10% . . . Technical Committee is currently working on a variety of projects, including: joint project with Northwestern Society on "The Effect of Acid Rain on the Degradation of Coatings," the French translation of the Los Angeles Society's pamphlet on graffiti, and the influence of ultra-fine TiO₂ on the durability of transparent coating. The Committee is also attempting to improve the industry's image by publishing articles in local newspapers. . . . Society supported Montreal Regional Science Fair . . . Society is concerned with steadily declining attendance at regular business meetings. A survey of membership is being taken to determine why members do not attend regular meetings . . . Concerned with currency discrepancy between U.S. and Canadian dollar . . . Society's motion to change the FSCT By-Laws to allow associate members to be eligible to hold Society representative office was defeated at FSCT Spring Meeting.

New England

Closer cooperation between the Society and the New England Coatings Association resulted in joint meetings between the two organizations, attracting greater meeting attendance for both . . . In Massachusetts, the State Paint Council was instrumental in defeating legislation which would have hurt small paint manufacturers . . . Held successful membership drive and hosted meetings in several loca-

tions in Massachusetts to serve geographically dispersed membership . . . Awarded \$2500 in scholarships to six recipients, all children of Society members . . . NESCT and NECA planning to participate in project to provide the coatings and labor needed to improve the home of a needy family . . . Will participate in another "Paint Swap."

New York

Seven monthly meetings were held . . . Membership totals 542, a slight increase over the last two years . . . Joint NYSCT/Metropolitan New York PCA Legislative Update and Exhibition was held involving a full day of presentations on current legislation and exhibits of environmental regulatory services vendors . . . Technical Committee paper, "Silicone Additives for High Solids Coatings," was presented at 1993 Annual Meeting. Lawrence Waelde, of Troy Chemical, was awarded second place in Society Speakers competition . . . The Committee continues to work on two additional studies on evaluation of rheological modifiers and defoamers . . . Two one-semester courses on coatings technology, "Chemistry of Coatings" and "Rheology of Coatings" were held . . . Society Scholarship Committee administered two \$1000 scholarships—the NYSCT Scholarship and the Melvin M. Gerson Memorial Scholarship, funded by Daniel Products Co., Inc. The recipients were Eric Sean Williams and Dominic Lazaro, respectively . . . Mattiello Memorial Library Fund scholarship was presented to Praveen Kesani . . . Cooperation continues to advance between NYSCT and MNYPCA. The President of each group is invited to participate at both Board and regular meetings of the other group . . . Most pressing problem faced by Society is continuing erosion of attendance at monthly meetings.

Northwestern

Seven technical presentations were made at monthly meetings. Topics of general interest were also presented . . . 23rd Annual Symposium held, focusing on "Technological Tools for Improved Formulation and Process Control" . . . "Education Night" was focus of April meeting, with presentations by FSCT Secretary-Treasurer Darlene Brezinski, Director of Educational Services Michael Bell, Dr. Urban and Dr. Fisher of North Dakota State University, and Erik Habeck of Valspar Corp. A check for \$2500 was presented to Dr. Fisher for scholarships in coatings at NDSU . . . 50-Year pin was presented to Michael H. Baker; 25-Year pins awarded to Kam Pai Panandiker, R.A. "Dick" Swanson, Norm Gill, Stan Vout, Al Starkey, Rich Johnson, and D.O. Either . . . Technical Committee paper, "Selection of Corrosion Test Methods Based on Mechanism Principles," was presented at 1993 Annual Meeting and will be published in JCT . . . At 1994 Annual Meeting, paper on "A Study of the Effect of Acid Rain on Alkyd, Polyester, and Silicone Modified High Solids Coatings," will be presented . . . Review paper on "Lead-Based Paint and the Lead Abatement Issue" was published in the July JCT. . . . Environmental/Legislative Committee monitored three bills affecting the coatings industry . . . Society hosted FSCT Spring Week activities and co-sponsored tour of the Twin Cities.

Pacific Northwest

Membership totals 275, an all-time high . . . Society elected to eliminate Associate Member classification . . . Each of the three sections distributed \$1000 in scholarship funds: Vancouver, BC Section gave two \$500 scholarships to undergraduate college students; Seattle Section provided \$1000 for attendance at the California Polytech Introductory Short Course; and Portland Section provided two \$500 scholarships for attendance at the same short course. . . . Continued policy of contributing 20% of surplus funds from spring symposium to the California Polytech Paint School . . . Vancouver Section conducted 12-week paint technology short course at Kwanleen College; Seattle Section presented an eight-week basic coatings short course; Portland Section conducted an environmental seminar, with 84 in attendance . . . Spring Symposium held at Empress Hotel in

Victoria, B.C. . . . Deryk Pawsey was named Society Honorary Member.

Philadelphia

Eight technical presentations held at monthly meetings . . . Monthly Technical Committee Meetings highlighted by technical talks . . . Technical Seminar held on "Extender Pigments—More Than Dead Space" involved nine speakers discussing the use of different types of extender pigments in the manufacture of surface coatings. 145 people attended . . . Sale of the "Formulator's Data Disk" was launched at the FSCT Paint Show in Atlanta. Support has been strong. The first revision, scheduled for November, has been delayed . . . Liberty Bell Award, the Society's highest honor, was presented to Peter Kuzma, of VIP Products Corp. Ben Franklin Award was presented to J. Richard Kiefer, Jr., retired from McCloskey Varnish Co. The award honors the elder statesmen in the Society who continue to contribute to the group.

Piedmont

Membership increased by 21 members . . . Ten monthly meetings held . . . Educational Committee awarded two \$1000 scholarships: one to Tracy Cheatham, an undergraduate chemistry major at North Carolina A&T State University; and the other to Tausha Fanslau, a graduate chemistry major at the University of Kentucky . . . Technical Committee completing plans for second Mini-Technical and Exhibition Show . . . Society continues to support local universities, civic groups, and "Toys for Tots" program . . . Cooperative efforts with local NPCA group continue.

Pittsburgh

Membership increased, as Society successfully implemented programs such as "prospective member nights" and "member bring a prospect" program . . . First college scholarship awarded by Society. \$1000 award was made to Jennifer Rediske, daughter of a member, who is attending University of Southern Mississippi . . . Full program of technical talks scheduled, including joint meetings with SSPC. In addition, mini-seminar planned with Society, SSPC, PDCA, and NACE.

Rocky Mountain

Current membership is 67 . . . Society has instituted newsletter distributed on regular basis . . . Society's first scholarship, given with assistance of FSCT-matching funds, was granted to Christine LesCamela who attended a paint formulating short course . . . First yearbook in many years to be available . . . Efforts to initiate section of the Society in Arizona have met with limited success. A technical meeting has been scheduled . . . June meeting was large success, with over 40 members and guests in attendance . . . Technical Committee's

work on "Influence of Insulation on Color Stability of Coatings," will result in the Society's first technical paper since 1972. Collection of data is complete.

St. Louis

Education played an integral part in Society activities, highlighted by booth in the St. Louis Public Schools Career Awareness Fair in May. Society members staffed a booth and described career opportunities in coatings to eighth graders . . . Technical Committee completed a study of "Effect of Varying the Stoichiometry in High-Solids, Two-Component Epoxy Coatings" . . . Joint activities with St. Louis Paint & Coatings Association included joint environmental meeting, two social affairs, and joint state affairs committee regulatory seminar. Society was visited by FSCT Technical Advisory Committee at November monthly meeting . . . Society was saddened by loss of two members: Society Past-President John Kemper, of Sinnett-Elpaco Coatings; and Honorary Member, G.O. Stephenson, long-time editor of *American Paint & Coatings Journal*.

Southern

Membership totals 497, an increase over last year . . . Society met for its 58th Annual Meeting and Program in Norcross, GA. "Sharing Knowledge" was the theme, and event enjoyed excellent attendance at technical presentations and buying and selling seminar . . . Due to seven-state geography in Society, the Society is divided into five sections, and a committee is actively pursuing the addition of a section in Birmingham, AL. 59th Annual Meeting to be held in Savannah, GA, during spring of 1995.

Toronto

Membership of 435 is two percent lower than last year, due to corporate restructuring and slow recovery from the recession . . . Ten students successfully completed three-semester coatings course at George Brown College . . . Distant Learning Program will begin with fall program . . . A collection of 25 years of JCT and technical books were donated by Society to George Brown College . . . The Technical Committee initiated a new project, entitled "Non-Toxic Anti-Corrosive Pigments in an Aqueous Binder" . . . Long-standing project on the aging and weathering behavior of basic coil coating polyester is being finalized and is planned for presentation next year . . . Manufacturing Committee conducted several monthly meetings, attracting additional members. Program for the coming season is under development . . . Annual Symposium, "The Changing Challenges to Today's Coatings Chemist," was held in March, with 99 participants. Topics ranged from regulatory impact on paint research to waterborne technologies, to new painting equipment . . . On November 19, the Society will celebrate its 75th anniversary with a gala dinner dance. Special committees are working on various aspects of the celebration, expected to attract 200-250 people.

*The next meeting of the
FSCT Board of Directors
will be on May 20 at the
Fiesta Americana,
Cancun, Mexico*

Meeting of the Stockholders of the Coatings Industry Education Foundation

The annual meeting of the Stockholders of the Coatings Industry Education Foundation was called to order by President of the Board of Trustees, George R. Pilcher at 2:20 pm on October 11, 1994, in New Orleans, LA.

A quorum of the Stockholders was present.

President Pilcher made the following report:

The Trustees of the CIEF have met once since their last report to the Federation Board: on April 18-19, 1994, in Cleveland. The next Trustees Meeting is scheduled for October 12, 1994, in conjunction with the Annual Meeting and Paint Industries' Show in New Orleans.

The Joseph A. Vasta Memorial Scholarship in Coatings Science—The Vasta Scholarship Fund is in excellent shape, and has clearly attained a degree of recognition once reserved for older, more established scholarships. The 1993 scholarship was awarded to Ms. Christy Sue Smith, the top-performing senior in the Polymer Science Program at the University of Southern Mississippi, and the 1994 Vasta Scholarship will be awarded to a student at North Dakota State University. Donations to the Vasta Fund for 1994 have totaled \$500, through July 31; donations to date total \$53,521. Although the interest generated by the Vasta Fund currently falls short of the \$2500 scholarships, the Trustees voted to supplement the short-fall—at least for the near-term future—from general CIEF funds.

The Coatings Industry Honor and Remembrance Fund—This new fund, established in 1992 at the suggestion of Colin Penny, is off and running. The initial donations and pledges, though July 31, 1994, total \$16,750, and represent the support of seven individuals, four Societies, and one corporation. Letters of explanation were sent during the Summer of 1992 to the presidents of all FSCT Societies—and again, in December, 1993 to both the Society presidents and the NPCA Association presidents—seeking their generous support for this Fund, which offers a truly significant means of recognizing outstanding contributions by industry members, both past and current. I am pleased to report that the following Societies responded with generous gifts: Houston Society, \$1750; Dallas Society, \$750; Baltimore Society, \$1000; Birmingham Club, \$200.

In New Orleans, the Trustees will present a plaque, either at the opening ceremonies or at the Thursday Luncheon, for installation in FSCT headquarters, listing all donors to the Honor and Remembrance Fund, with sufficient space so that new donors can be added as time passes. This fund has come a long way in a short period of time, but—to begin generating sufficient interest for important educational activities—the fund will need to at least double. We urge all member Societies, industry employers, and individuals to consider furthering their commitment to the education of tomorrow's coatings chemists by making a donation to the Honor and Remembrance Fund today.

Review Schedule for Recipient Schools Established—To assure that a proper assessment can be made regarding the effectiveness of the programs at the various institutions with coatings programs receiving financial support from CIEF, each school will be visited, on a rotating basis, by one or more Trustees, who will review the entire program. During 1994, the following institutions have been

visited and formally reviewed, and the results will be discussed at our October meeting: Kent State University — Mary Brodie; North Dakota State University — Percy Pierce; University of Southern Mississippi — Sid Lauren; De Paul University — Darlene Brezinski.

The review schedule for 1995 will also be established at the New Orleans meeting.

Educators' Luncheon Held at the Annual Meeting in Chicago—The Trustees will hold the third annual "Educators Luncheon" for representatives of the nine coatings schools currently identified by CIEF as having substantial coatings programs. The purpose is to allow the educators and Trustees to meet and get to know each other and also to discuss on-going funding programs and mutual concerns. Our first luncheon, in 1992, was highly productive, and resulted in the final set of "CIEF Funding Proposal Guidelines" which cover, in a comprehensive fashion, staffing, focus, student composition, past funding, selection criteria, handling of funds, targeted uses for new funds, and methods to assess usefulness of CIEF funds for the coatings programs which are seeking CIEF support. These goals and methods were further refined at our 1993 luncheon, and deadlines for submissions by the schools—and replies by the Trustees—were revised to more easily accommodate the educators' needs and activities at the outset of the academic year. This year, we will discuss how effective the revised Funding Proposal protocol has been, and whether or not it needs any further adjustments.

Recommendations for Appointments to the Board of Trustees—The Trustees have recommended to incoming FSCT President Joseph P. Walton the reappointment to three year terms of the following CIEF Trustees: George R. Pilcher and Donald W. Boyd.

Transfer of the Ernest T. Trigg Foundation to CIEF—The control of the funds for the NPCA's Trigg Foundation, in the amount of \$95,972.31, is now in the hands of the CIEF, although legal ownership of the NPCA Trigg Foundation has yet to be transferred to CIEF. These funds will significantly enhance CIEF's ability to provide educational support for tomorrow's coatings chemists and technologists, and also serve as an excellent example of the way in which NPCA and the Federation can collaborate in areas of mutual interest. At the upcoming October and January meetings, the Trustees will determine how the Trigg Foundation funds can best be used for optimal educational impact.

Educational Funds Granted for Academic Year 1994-95—Requests for funding of \$225,695 outran the \$136,250 that the Trustees were able to give, by \$89,445. Since all requests represented genuine, well-documented needs, it was with deep regret that the Trustees were compelled to turn 40% of them down. This was done only after considerable, detailed discussion on the merits of each and every proposal, and reflects strictly on the lack of available funding, not the worthiness of the proposals. As has always been our policy, CIEF will seek matching funds for all scholarship and fellowship requests, and will require matching funds for all capital and research grants. The following table summarizes both the funding requests and the actual CIEF pledges against these requests:

Institution	Type of Request				CIEF Funds Committed
	Capital Grant	Scholarship	Fellowship	Research Grant	
De Paul University	\$10,500	—	\$7500	\$3500	\$7500 Fellowship \$10,500 Capital Grant \$3500 Research Grant
California Polytechnic State University	\$12,000	\$6000	—	—	\$6000 Scholarship \$12,000 Capital Grant
University of Waterloo	—	—	\$8000	—	\$8000 Fellowship
University of Missouri-Rolla	—	\$10,000	\$12,000	—	\$10,000 Scholarship \$9000 Fellowship
University of Southern Mississippi	—	\$15,000	\$11,500	—	\$15,000 Scholarship
North Dakota State University	\$7500	\$11,250	\$18,000	\$27,945	\$11,250 Scholarship \$9000 Fellowship \$7500 Capital Grant
Eastern Michigan University	\$30,000	\$15,000	\$12,000	—	\$15,000 Scholarship \$12,000 Fellowship
Kent State University	—	—	\$8000	—	—
Sub-Totals	\$60,000	\$57,250	\$77,000	\$31,445	Scholarships: \$57,250 Fellowships: \$45,500 Capital Grants: \$30,000 Research Grants: \$3500
TOTAL FUNDS REQUESTED:	\$225,695				
TOTAL FUNDS PLEDGED:	\$136,250				

The coatings industry currently "captures" around 47% of the students supported by CIEF funds, at a cost of <\$7000 per student, which the Trustees consider to represent quite an impressive capture ratio, at a very reasonable cost.

Strategic Planning—At our May meeting we got an excellent start on a directed, long-term planning program for CIEF, which included discussions on our mission, the multi-disciplinary nature of our industry, public opinion vis-à-vis the coatings (chemical) industry, education of "industry-ready" potential employees, the creation and maintenance of centers of coatings expertise, training, "remote learning," the potential for coatings courses at junior colleges, and many other topics. This will be an on-going process, and will be a major topic of discussion at our October meeting in New Orleans, when we hope to finalize our new Mission Statement and list of long-term objectives.

Elections to the Board of Trustees

Nominated to the CIEF Board of Trustees by the President of the FSCT, per By-Laws, were the following candidates for three-year terms of office: George R. Pilcher (CDIC Society) and Donald Boyd (Pittsburgh Society).

(On a motion by Mr. Van Zelm, seconded by Mr. Anwari, the slate of nominees was unanimously elected to office.)

Mr. Penny requested the floor and made comments supporting the CIEF Honor and Remembrance Fund. He requested that the Stockholders bring notice of the Fund's importance to their respective Societies and thanked those Societies which have, so far, made contributions.

There being no further business to conduct, President Pilcher adjourned the meeting at 2:30 pm.

In Memoriam

*We report with deep regret the passing
of the following members during the past year*

Baltimore

Arthur Partrick (Retired) Charles A. Wagner Co., Inc.

Birmingham

Terry T. Tye PPG (U.K.) Ltd.
Victor Yarsley (Retired) Fulmer Institute

Chicago

Louis E. Ludwig (Retired) Sherwin-Williams
Society Past-President
50-Year Member
Albert E. Counter 50-Year Member
Michael Miskewitch Premier Coatings

Cleveland

James Broggini (Retired) W.J. Ruscoe Co., Inc.
Charles Graf (Retired)
Society Honorary Member
Francis "Tex" E. Reed (Retired)
Sheffield Bronze Paint Co.
Fred Schwab Coatings Research Group, Inc.
Federation Board Member
25-Year Member
Society Honorary Member
George Selden Interchem Corporation
Society Past-President
Society Honorary Member
Helen Skowronska (Retired) Sherwin-Williams
Society Past-President
25-Year Member
Federation Board Member
Harold Werner Glidden Corporation

Golden Gate

Jack Duis Pacific Coast Chemicals
Society Past-President

Los Angeles

Leo Forth, Jr. (Retired) Sherwin-Williams
Society Past-President

New York

Thomas Gilchrist Pan Chemical Corporation
Wilbur M. Sullivan (Retired) Union Carbide

Northwestern

Mooney Fuller ... (Retired) Midland Corp., Forman Ford
Richard Gurney (Retired) Glidden,
Hirshfield's Diamond Vogel

Northwestern (Winnipeg Section)

John Teefir Ouimet (Retired) Canadian Pittsburgh
Industries

Pacific Northwest

John Adam James Filchak (Retired) Regional Director
of Quality Control in Auburn
Federation Executive Committee

Philadelphia

Arthur Partrick (Retired) Charles A. Wagner Co., Inc.
Harold M. Werner Glidden Corporation

Pittsburgh

Henry A. Ball (Retired) Ball Chemical Co.
Ed Ryan PPG Industries, Inc.

St. Louis

John Kemper Sinnett-Elpaco Coatings Corporation
G.O. Stephenson (Retired) American Paint Journal

Southern

Charles Lewis Davis, Jr. Vi-Chem, Inc.
Society Past-President

Toronto

Donald Campbell Para Incorporated

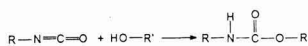
The Effect of Polyurethane Curing Conditions on the Delamination of Pressure Sensitive Films

B.W. Ludwig and M.W. Urban*
North Dakota State University†

The application of vinyl films as graphics materials to the surface of urethane coatings used in OEM and vehicle refinishes is a common practice. However, if urethane coatings are not properly cured, the vinyl films may delaminate due to the evolution of gases within the coatings. In this study, the influence of curing temperature and time on the extent of delamination observed for several vinyl films having various degrees of permeability was examined. Using a newly developed "photoacoustic umbrella" Fourier transform infrared spectroscopy (PA FTIR) technique, CO₂ has been identified as the gas responsible for the delamination of the graphics films. The mechanism of CO₂ production and its relationship to the curing conditions are also discussed.

INTRODUCTION

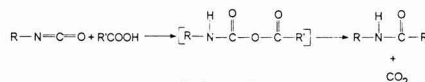
Among coatings systems, polyurethanes represent a group which exhibit outstanding properties; therefore, their utilization is found in many application areas, in particular OEM and automotive refinishes. Their excellent properties are achieved by the formation of urethane linkages, which result from the reactions of the highly reactive isocyanate and an alcohol.¹ An example of this reaction is shown in *Scheme 1*, in which the R and R' groups can range from simple aliphatics/aromatic species to other macromolecules.



Scheme 1

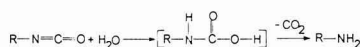
*Person to whom correspondence should be sent to.
†Polymers and Coatings Dept., Fargo, ND 58105.

Due to high reactivity of isocyanates at ambient temperatures, other reactions can readily occur. For example, if isocyanate reacts with carboxylic acid, as shown in *Scheme 2*, amides and carbon dioxide are produced.¹



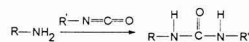
Scheme 2

Isocyanates are also known to react with water, which results in the formation of unstable carbamic acid, which dissociates to give an amine and carbon dioxide.^{1,2}



Scheme 3

The amine functionality can further react with another isocyanate to form a urea.^{1,2}



Scheme 4

Although reaction *Schemes 1-4* show the formation of monomeric species, they can be easily adapted to high molecular weight macromolecules. For example, if R or R' represent macromolecular segments, *Schemes 1, 2, and 4* will result in high molecular weight species, and their molecular weight will be determined by the size of the R and R' groups.

Another feature of these reactions is the formation of gaseous species, such as carbon dioxide which can cause

Table 1—Summary of Coating Systems and Curing Conditions

Coating System	Manufacturer	Curing Conditions
Sunfire 421	Sherwin Williams	Ambient
Autocryl	AKZO	Ambient
Durethane (Du 8000) ...	PPG	Ambient
Deltron (Dau 8001)	PPG	Ambient
Starthane (Starthane 8001)	PPG	Ambient
Imron 5000	DuPont	Baked @ 180°F, 30 min
Imron 6000	DuPont	Baked @ 180°F, 30 min
2K-2	BASF	Baked @ 265°F, 17 min

bubbles in thick films. Although such reactions certainly will not cause environmental problems, they may not be desirable if CO₂, or any other gas, is not allowed to escape from the polyurethane network. Such situations may occur if a nonpermeable overlayer, such as a vinyl decal, is applied over the surface of the coating before the reactions resulting in production of gaseous products are complete. Under such circumstances the gases may accumulate at the coating surface—vinyl layer interface, and if sufficient pressure is achieved, a delamination of the overlayer may occur. The coatings used in this study are commonly used for OEM and vehicle refinish. A common problem is the bubbling of vinyl sheetings which have been applied before the coating has sufficiently cured. Thus, there is a clear need for quantitative data concerning the effect of temperature and humidity on the cure time required to avoid delamination of vinyl sheetings.

This study focuses on qualitative and quantitative aspects of polyurethane reactions. Specifically, we will examine two package urethane systems in terms of the type and amount of gaseous products that are evolved during and after film formation. Using a photoacoustic (PA) FTIR approach to gas

phase analysis,⁴⁻⁸ we attempt to identify and quantify the gases evolved during polyurethane formation, and establish guidelines for achieving the optimum curing conditions. An ultimate goal of this study is to explore new PA FTIR capacity in the analysis of curing and post-curing reactions.

EXPERIMENTAL

Coating Preparation

Two-package urethane coatings, summarized in Table 1, were prepared according to the manufacturers' directions.³ In a typical experiment, a urethane crosslinking agent was manually stirred into the primary resin. Because mixing may introduce air bubbles, such mixtures were allowed to stabilize for 30 min prior to drawing of films on 4 in. x 12 in. tin plated steel panels using a Gardner film casting knife. An automated drawdown device, which moves the blade at a constant rate of 1 in./sec, was used in order to achieve uniform film thickness. The coatings, which required elevated crosslinking temperatures were baked according to the manufacturers' directions, which are listed in Table 1. Following film preparation, one set of panels was (post)cured at 60°F, and the other at 75°F. In all cases, the thickness of the cured coatings was 80 ± 10 μm. Typical coatings used in these applications consist of polyacrylic or polyester based polyalcohol resins diluted primarily with aromatic and ester solvents, and oligomeric, multifunctional isocyanate crosslinkers.

Testing of Pressure Sensitive Vinyl Films

The following pressure sensitive vinyl-based films were provided by 3M Company: Scotchlite 690, Scotchlite 680, Scotchlite 580, Controltac I, and Controltac II. The reflective

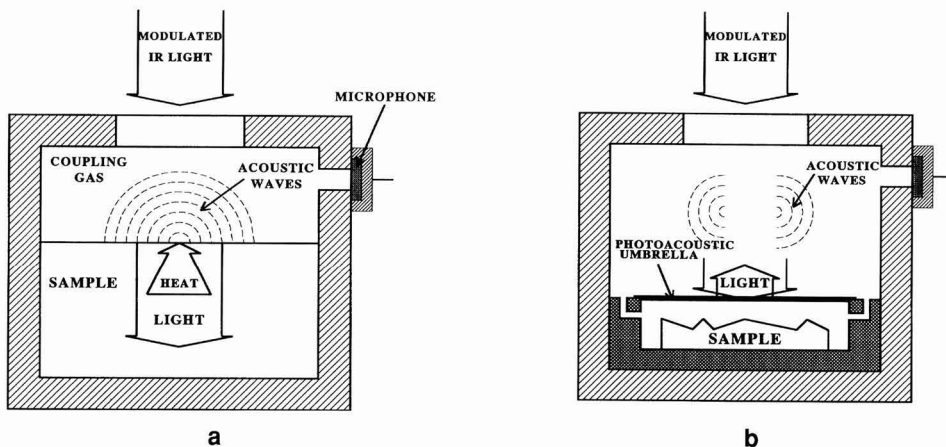


Figure 1—(a) Schematic of the photoacoustic experiment showing the arrangement of sample and microphone detector, and detailing the acoustic waves generated by the absorption of the incident IR light; (b) Schematic of the photoacoustic experiment utilizing a "photoacoustic umbrella" which allows detection of gases given off by a sample underneath

Table 2—Tentative IR Band Assignments for Polyurethane Solids (Figure 2)

IR Band (cm ⁻¹)	Species	Assignment	Reference
530	Urea	δ N-C-N	9
1074	Urethane	ν C-O-C	10
1248	Urethane	δ C-N-H	10, 11
1386	Urea	δ CH ₃	9
1462	Urea	ν N-C-N	9
1525	Urethane	δ N-H	10, 11
1663	Urea	ν C=O	9
1734	Urethane	ν C=O	10
2272	Isocyanate	ν N=C=O	12, 13
2955	Urethane	ν C-H	10
3372	Urethane	ν N-H	10

Note: ν = stretching; δ = deformation.

Scotchlite films contain a vapor coat which hinders the diffusion of gases. At 24 hour intervals, following resin draw-down on the panels, 2 in. x 3 in. vinyl coupons were applied to the coating surfaces listed in Table 1 by pressing the coupon using a plastic blade specially designed for that purpose (3M Co.). The degree of delamination of the vinyl films was recorded photographically 24 hr after application, and objectively by determining the fraction of the coupon surface which was detached from the coating surface due to gases accumulating at the interface. The process of applying films and monitoring the degree of delamination continued until no changes in a film coupon were monitored within 48 hr of its application to the coating.

In our effort to establish how curing temperature below manufacturers' recommendations may affect the delamination process, two randomly selected coatings were prepared as described above and cured at 40°F. Due to the extremely low curing temperature, the application of coupons was initiated four days after the coatings were applied to the substrate. Due to a relatively slow curing rate, and corresponding delayed evolution of bubbles, photographs were taken and the degree of delamination was assessed four days after coupon application. In addition to the recommended curing for the 2K-2 coating system (Table 1), selected samples were cured at 205° and 235°F for 17 min. Again, because the evolution of bubbles was slow, four days were allowed to elapse prior to estimating the extent of delamination.

Spectroscopic Measurements

Photoacoustic Fourier transform infrared spectroscopy (PA FTIR) experiments were conducted to determine the makeup of the gas evolving from the coatings and to quantify their contents. A schematic of the PA FTIR experimental setup is presented in Figure 1a. In a photoacoustic experiment, modulated infrared light enters an acoustically isolated photoacoustic cell, and those wavelengths of incident modulated radiation which correspond to vibrational modes of chemical bonds present in the sample are absorbed. As a result of reabsorption, energy is given off in the form of heat. As heat reaches the surface, pressure variations in the coupling gas over the sample are induced at the frequency of modulated light. These pressure fluctuations are detected by a sensitive microphone, and the resultant signal is Fourier

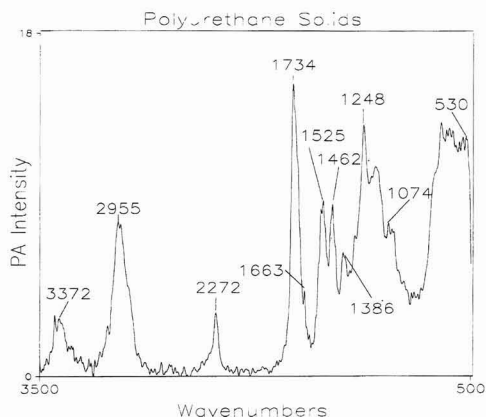


Figure 2—Photoacoustic spectrum of polyurethane sample cured at 75°F and 30% relative humidity for 7 days

transformed into an infrared spectrum.⁴ Figure 1b presents a modification of the species present in the vapor phase above a solid sample.⁵⁻⁸ An aluminum "photoacoustic umbrella" prevents penetration of the incident IR beam into the solid sample; thus, only gaseous species which have diffused out of the sample are detected.⁶⁻⁸ In a typical experiment, a specimen is placed in an aluminum holder and the spectra of gases evolved from the coating are periodically collected. PA FTIR spectra recorded in this study were collected at a resolution of 4 cm⁻¹ on a Digilab FTS-10 spectrometer, and each spectrum consists of 400 co-added scans ratioed against a carbon black reference background.

RESULTS

In view of the urethane chemistry presented in the introduction, let us first establish what gases are emitted from the polyurethane surface during film formation. Figure 2 illustrates a PA FTIR spectrum of urethane coating, collected after 7 days of curing at 75°F and 30% relative humidity. The bands, along with their tentative assignments, are listed in

Table 3—Tentative IR Band Assignments for Vapor Phase Over Curing Polyurethane (Figure 3)

IR Band (cm ⁻¹)	Species	Assignment	Reference
667	CO ₂	δ O=C=O	13
1072	Butyl acetate ^a	ν _s C-O-C	12, 13
1246	Butyl acetate	ν _a C-O-C	12, 13
1375	Butyl acetate	δ _s CH ₃	12, 13
1460	Butyl acetate	δ _a CH ₃	12, 13
1767	Butyl acetate	ν C=O	12, 13
2341	CO ₂	ν C=O	13
2365	CO ₂	ν C=O	13
2970	Butyl acetate	ν C-H	12, 13

(a) Solvent; ν_s = symmetric stretching; ν_a = asymmetric stretching; δ_s = symmetric deformation; and δ_a = asymmetric deformation.

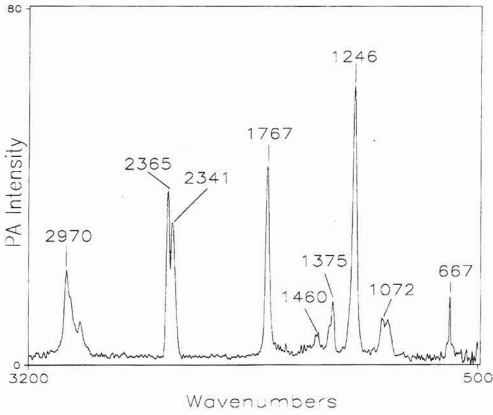


Figure 3—Photoacoustic spectrum of gases collected over a polyurethane sample cured at 75°F for 24 hr

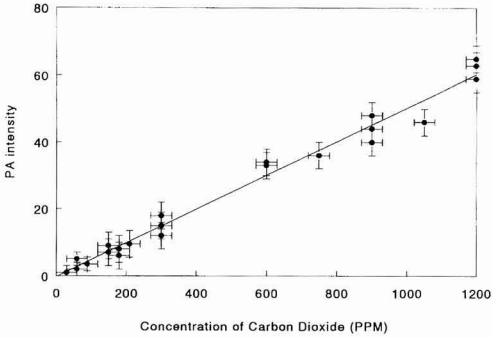


Figure 4—Calibration curve relating the observed photoacoustic intensity to the known concentration of CO₂ within the cell

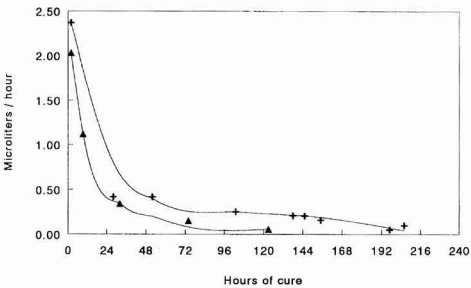


Figure 5—The amount of CO₂ generated by the coatings Sunfire and Deltron, cured under ambient conditions, as a function of time. (+) Sunfire; (▲) Deltron

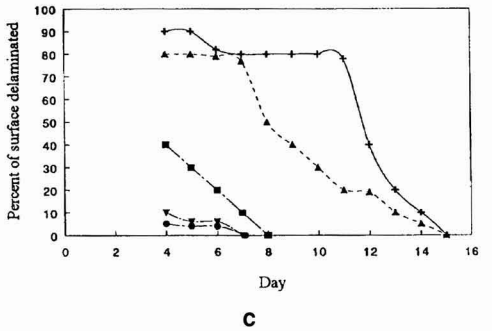
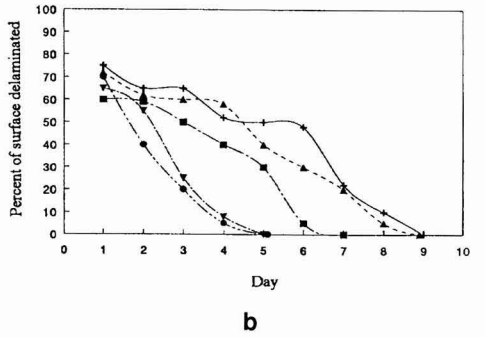
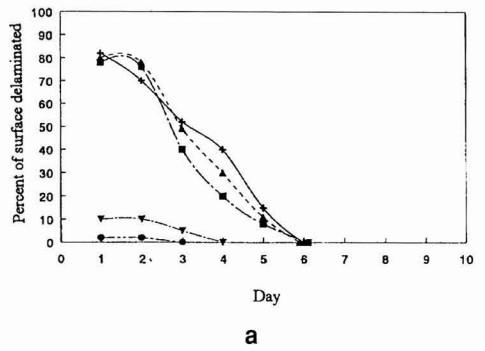
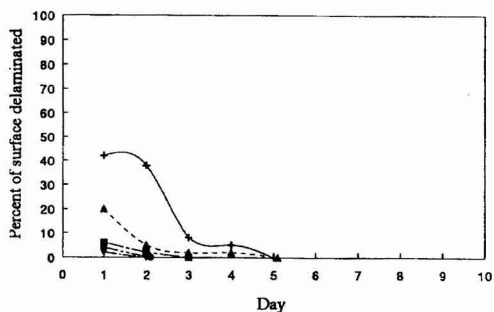
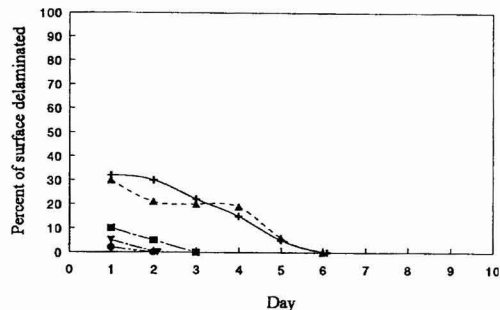


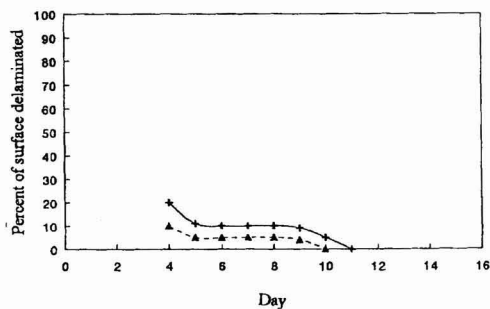
Figure 6—Percent of surface delamination of Scotchlite 690 (+), Scotchlite 680 (▲), Scotchlite 580 (■), Controltac 180 - 1 (▼), Controltac 180 - 2 (●), overlayers on Sunfire coating cured at (a) 75°F; (b) 60°F, and (c) 40°F



a



b



c

Figure 7—Percent of surface delamination of Scotchlite 690 (†), Scotchlite 680 (▲), Scotchlite 580 (■), Controltac 180 - 1 (▼), Controltac 180 - 2 (●), overlayers on Deltron coating cured at (a) 75°F; (b) 60°F, and (c) 40°F

Table 2. The majority of the bands are attributed to urethane linkages. The band at 2272 cm^{-1} is due to the $\text{N}=\text{C}=\text{O}$ stretching vibration of unreacted isocyanate groups, whereas the bands at 1663, 1462, 1386, and 530 cm^{-1} are attributed to the normal vibrations of urea linkages. Figure 3 shows PA FTIR spectrum of the gases collected over a urethane sample cured for 24 hr. In this case, the spectrum was recorded using a so-called "photoacoustic umbrella," which allows the observation of species present in the vapor phase without interference from absorptions due to species in the solid state (Figure 1b).⁴⁻⁸ The bands at 667, 2341, 2368 cm^{-1} correspond to the deformation and stretching vibrations of the gaseous CO_2 which evolves from the coating as a result of crosslinking reactions. The remaining bands listed in Table 3 are due to solvent vapors and will not be discussed.

In order to quantify the amount of CO_2 produced during curing of the urethane coatings, a calibration curve that relates the amount of CO_2 in the PA cell and the PA FTIR intensity is needed. Figure 4 illustrates the relationship between the PA FTIR intensity of the 667 cm^{-1} band due to $\text{C}=\text{O}$ bending mode in CO_2 , plotted as a function of a known amount of CO_2 introduced into the cell. Using this calibration curve, the amount of CO_2 evolved during the curing process at any time of the reaction can be determined. An example of the amount of CO_2 evolving from two urethane coatings as a function of curing time is depicted in Figure 5. The data plotted on the graph is obtained from the height of the peak at 667 cm^{-1} (Figure 3). Correlation of the band height with the calibration curve allows a quantitative assessment of the amount of CO_2 produced during curing processes. As illustrated in Figure 5, the urethane coatings vary in the amount of CO_2 generated, depending on the coating system.

In order to determine how CO_2 production will affect adhesion of pressure sensitive vinyl films, five films (Scotchlite 690, Scotchlite 680, Scotchlite 580, and two variations of Controltac 180, 3M Company) were applied over each coating at 24 hr intervals, after the coating was deposited on a substrate. Figures 6-10 show the amount of overlayer delamination of coatings cured at 60° and 75°F. While the Y axis of all plots represents the fraction of a vinyl coupon surface which has become delaminated from the coating surface, the X axis identifies the number of days each coating was cured before the film coupon was applied.

In an effort to demonstrate how temperatures excessively below that recommended by the manufacturer may affect the curing process, randomly selected coatings were allowed to cure at 40°F. The results are shown in Figures 6 and 7 for Sunfire and Deltron, respectively. As expected, excessive delamination is observed for much longer periods of time than for the same coatings cured at 60°F. In the case of the Sunfire coatings (Figure 6c), the Controltac overlayers experience delamination for an additional 24 hr, and 600 series Scotchlite overlayers for an additional seven days, when the temperature is reduced from 60°F to 40°F. Figure 7c illustrates the results of a 40°F cure for Deltron coatings, and indicates that relative to the coatings cured at 60°F, the gas evolved leads to delamination of Scotchlite 600 coupons for an additional five days.

In addition to the effect of curing temperature on the duration of CO_2 production for ambient cured coatings, the

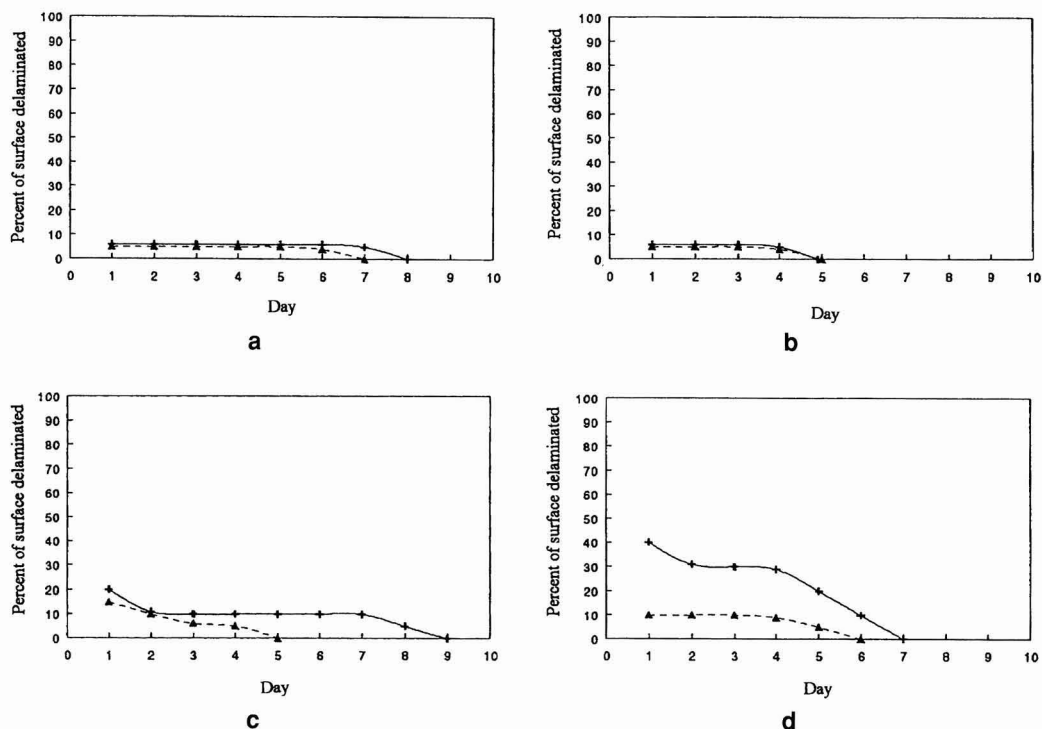


Figure 8—Percent of surface delamination of Scotchlite 690 (t), Scotchlite 680 (▲), overlayers on 2K-2 coating: (a) cured at 235°F and post cured at 75°F; (b) cured at 235°F and post cured at 60°F; (c) cured at 205°F and post cured at 75°F; and (d) cured at 205°F and post cured at 60°F

effect of baking at elevated temperatures is desired. The 2K-2 coating (Table 1) was chosen as the subject of these experiments due to its excellent performance when cured at the recommended baking temperature. It appears that when 2K-2 coating is cured at 265° and post cured at either 60°F or 75°F, no delamination is detected. Figures 8a and 8b, which illustrate the data for 2K-2 coatings baked at 235°F, show that lower baking temperatures result in increased CO₂ production during post curing. Further decrease of the baking temperature to 205°F results in more extensive delamination. This is illustrated in Figures 8c and 8d.

DISCUSSION

Analysis of the spectral results presented in Figure 3 indicates the bands at 667, 2341, and 2365 cm⁻¹ are due to CO₂ evolved from the polyurethane system. This gas is responsible for delamination of the overlayer vinyl films from the urethane surfaces. At this point let us go back to the chemical reactions involved in polyurethane chemistry and address the origin of the CO₂ production. Figure 2 shows a PA FTIR spectrum of a partially cured polyurethane coating

exposed to 30% relative humidity at 75°F for seven days, and indicates the presence of urea linkages demonstrated by the bands at 1663, 1462, 1386, and 530 cm⁻¹. These bands are due to carbonyl stretching, N-C-N stretching, CH₃ deformation, and N-C-N deformation, respectively. This information provides evidence for the origin of the CO₂ production which results from the reaction of isocyanate groups with water. Scheme 3 illustrates this reaction which results in the formation of an amine, that subsequently reacts with isocyanate (Scheme 4) to produce the detected urea. Therefore, the degree of delamination, which occurs at the overlayer-urethane coating interface, depends on the concentration of free isocyanate groups and H₂O. When nonpermeable Scotchlite® film is applied over the urethane coating, absorption of water by the coating is inhibited. In the early stages of cure, when the isocyanate content is high, and the concentration of water is low, the amount of produced CO₂ will be proportional to the concentration of water absorbed by the coating. At longer curing times, when the concentration of isocyanate is considerably decreased due to continuous reactions (Scheme 1), the isocyanate will be a rate determining reagent, and the amount of CO₂ produced after the application of the film will begin to decrease.

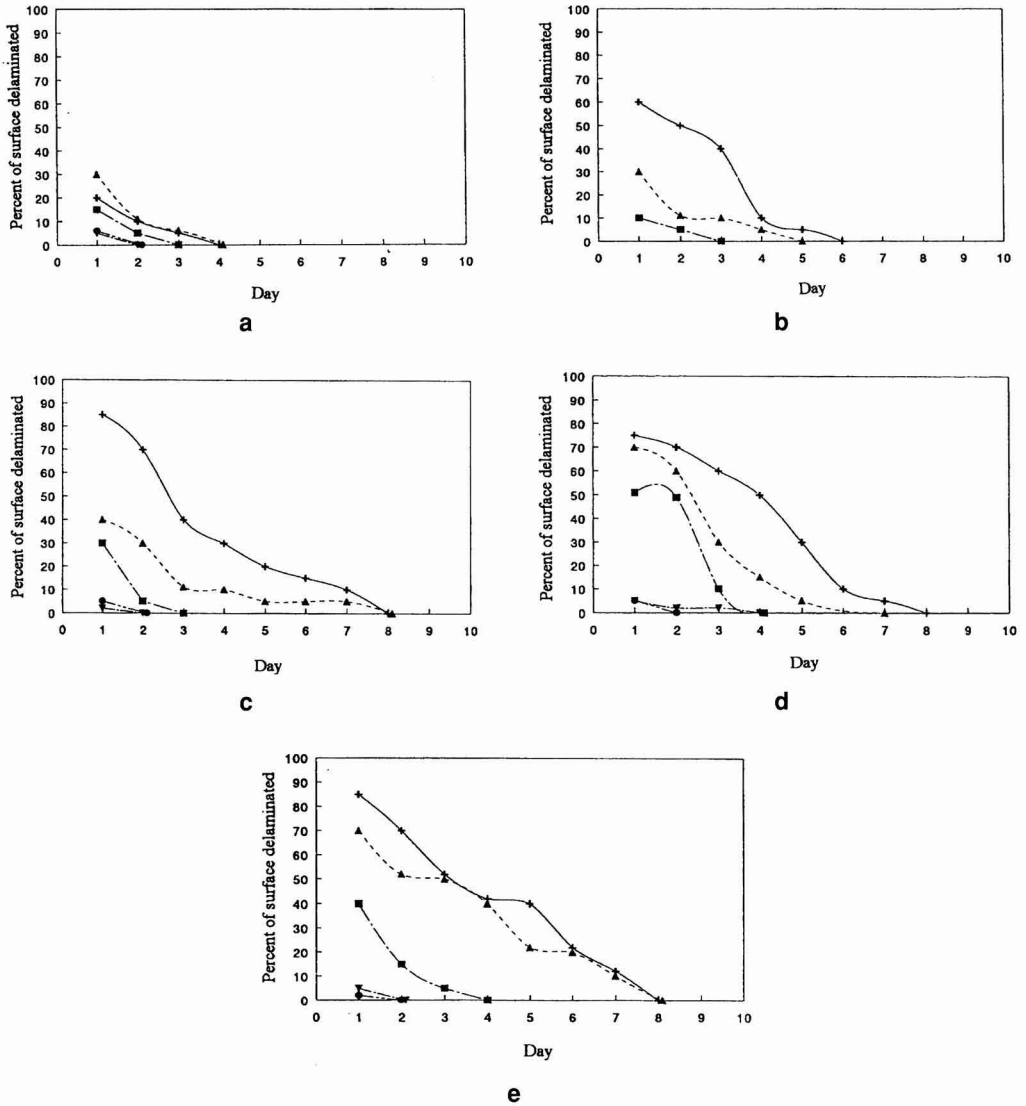


Figure 9—Percent of surface delamination of Scotchlite 690 (t), Scotchlite 680 (▲), Scotchlite 580 (■), Controltac 180 - 1 (▼), Controltac 180 - 2 (●), overlayers on urethane coatings cured at 75°F: (a) Imron 5000; (b) Imron 6000; (c) Starthane; (d) Autocryl; and (e) Durethane

With these observations in mind let us focus on the effect of temperature on the amount of CO₂ evolved during curing. The data presented in Figure 6 demonstrates the effect of cure temperature on the isocyanate concentration. When urethane is cured at 75°F, as seen in Figure 6a, the degree of delamination remains unchanged for the first two days, fol-

lowed by a rapid decline, and cessation of delamination after five days. The results of curing at 60°F depicted in Figure 6b demonstrate a more gradual decline of delamination, indicating that the consumption of the free isocyanate occurs at much slower rates. When the curing temperature is reduced to 40°F (Figure 6c), the extent of delamination for the 600

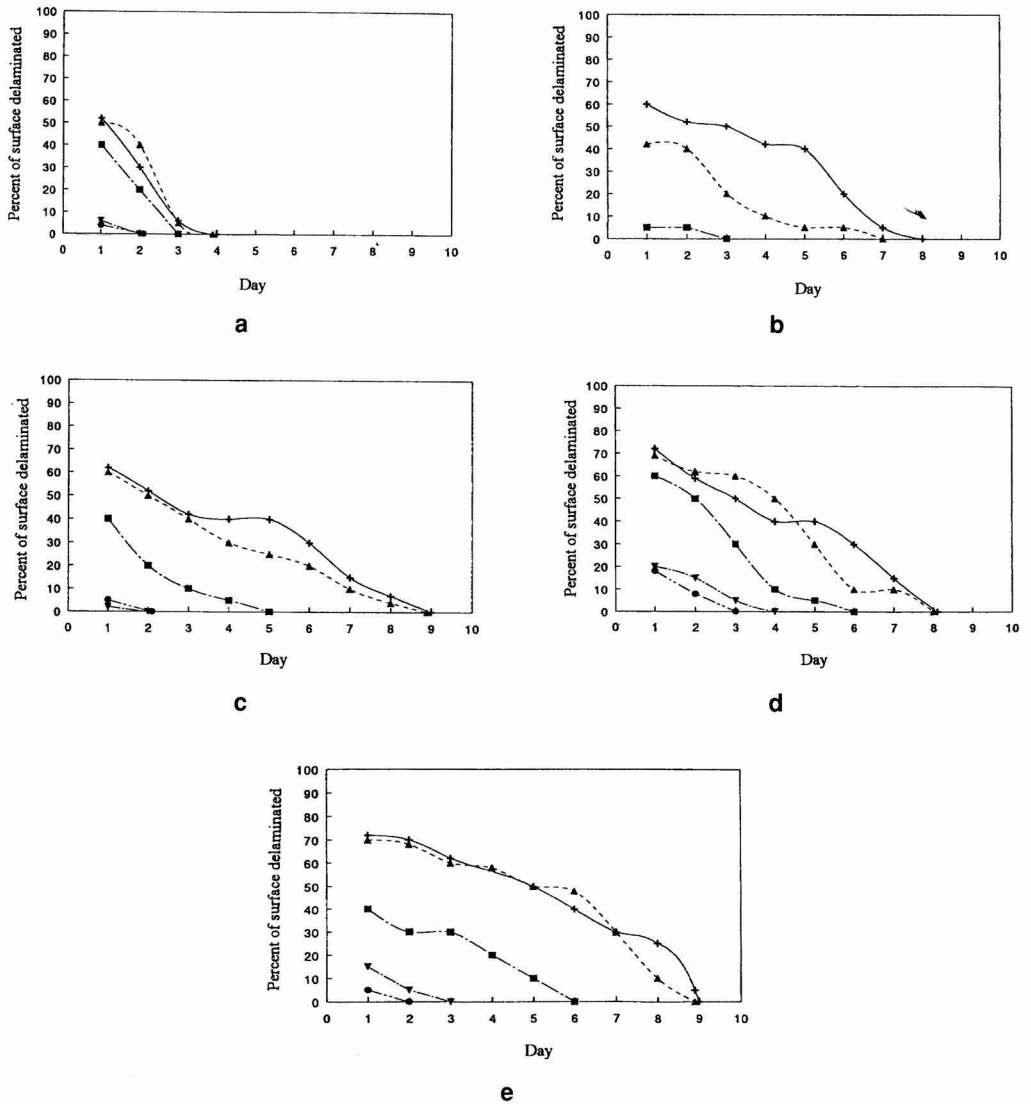


Figure 10—Percent of surface delamination of Scotchlite 690 (†), Scotchlite 680 (▲), Scotchlite 580 (■), Controltac 180 - 1 (▼), Controltac 180 - 2 (●), overlayers on urethane coatings cured at 60°F: (a) Imron 5000, (b) Imron 6000; (c) Starthane, (d) Autocryl; and (e) Durethane

series Scotchlite films remains constant for an extended period, followed by a rapid decline of the overlayer—coating interface separation. As isocyanate groups are consumed, there is a critical point beyond which the isocyanate becomes a rate determining reagent in the CO₂ production, thus limiting the volume produced in a given time period. Lower cure

temperatures result in a delay of this point. The same process accounts for similar trends observed for the coatings in *Figure 7* cured at 75°, 60°, and 40°F. For all coatings, when the cure temperature is reduced from 75°F to 60°F, the process of delamination is extended and varies from specimen to specimen (*Figures 9 and 10*).

The importance of the baking temperature is illustrated in the results for the 2K-2 coating (Table 1). When curing is carried out at the recommended baking temperature, there is not enough unreacted isocyanate within the coating to cause delamination. The results of reducing the baking temperature are shown in Figure 8, and indicate that at reduced temperatures unreacted isocyanate groups exist, and upon reacting with water, generate CO₂, which diffuses out of the coating.

As indicated earlier, the rate of carbamic acid formation (Scheme 3) depends upon H₂O concentration. Because the amount of water available to take part in CO₂ producing reactions depends upon the relative humidity during curing, it is important to address the effect of relative humidity. In our experiments the relative humidity at 75°F averaged 30%. The coatings cured at 60°F experienced an average relative humidity of 40%. These relative humidity values represent partial vapor pressures of H₂O for the two curing conditions of 890 and 708 Pascals, respectively. The difference in the amount of water vapor to which the coatings were exposed most likely accounts for a large difference in curing times observed for curing at 75°F and 60°F. The greater concentration of H₂O present under the 75°F curing conditions results in a more rapid consumption of the isocyanate functionalities presented in Schemes 3 and 4. Quantitative studies to determine the effect of H₂O partial vapor pressures on the kinetics of isocyanate consumption in an ambient cured polyacrylic-isocyanate coating are in progress.¹⁴

Finally, it is necessary to address the issue of overlayer permeability. The difference in performance between the Scotchlite and Controltac films is attributed to the differences in film permeability. The Scotchlite films are less permeable to gases and vapors than the Controltac films. The Scotchlite 690 film, which overall exhibited the most severe delamination, contains an impermeable to CO₂ polyester layer. In contrast, Scotchlite 680 contains glass bubbles, whereas the Scotchlite 580 film does not. The inclusion of glass bubbles decreases permeability of the film nearly to the same extent as the polyester layer incorporated in the Scotchlite 690 series. In the case of the Controltac 180 series, Controltac I films contain glass bubbles, while Controltac II contains glass beads. Over the course of the experiments, Controltac II overlayer demonstrated slightly better resistance to delamination. Both Controltac films are permeable to CO₂ produced during the curing of the coatings, as demonstrated by the rapid disappearance of delamination initially formed under these films.

CONCLUSIONS

These studies illustrate that PA FTIR spectroscopy equipped with proper gas phase modifications can be used to

assess not only the origin of chemical reactions resulting from polyurethane curing, but it can also provide quantitative data. It appears that the gas produced upon the ambient curing of polyurethane coatings is CO₂, which results from the reactions of isocyanates with water. The presence of the CO₂ at the film—polyurethane interface causes delamination of the overlayers adhered to the coating surface, and its magnitude can be diminished by proper curing conditions and/or permeable overlayers. Excessively high curing temperatures and the exposure to enhanced humidity environments result in shorter times required to achieve complete cure. Under high humidity curing conditions, the reactions shown in Schemes 3 and 4 are accelerated, which combined with the unchanged rate of the urethane forming reaction (Scheme 1), results in more rapid consumption of the isocyanate functionalities. The internal structure of the overlayers, particularly in regard to their permeability, is an important contributor to the extent of delamination.

ACKNOWLEDGMENT

The authors are thankful to the 3M Company for supporting this research project.

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High Performance Polyurethane Coating Systems Utilizing Oxazolidine-Based Reactive Diluents

G.N. Robinson, T.L. Johnson, and M.D. Hoffman
ANGUS Chemical Co.*

Recent changes in environmental regulations have required that volatile emissions from coatings be reduced. Currently, many approaches are being offered to help reduce volatile organic compounds (VOC) in industrial coatings. The use of reactive diluent chemistries has proven to be a viable concept in meeting current VOC compliance mandates. As newer regulations limit VOC more severely, more effective reactive diluents will be essential to meet the lower VOC requirements. A new class of ultra-low viscosity oxazolidine-based reactive diluents has been found which demonstrates excellent reactivity while also improving coating performance. As a result of this development, current solvent-borne industrial urethane coating technology can be made to meet the new VOC regulations as well as offering an effective solution toward compliance of any future mandated VOC levels.

INTRODUCTION

The use of polyurethane chemistry has allowed for the development of high-quality protective coating systems. Polyurethane systems are resistant to chemicals, exposure to weather, and especially to abrasion and impact. The unique performance properties afforded by polyurethane chemistry, coupled with its ability to undergo low energy cure, have allowed formulators the opportunity to tailor coatings to meet various application objectives.¹

In two-component polyurethane systems, the polymer coating is produced by reaction of the isocyanate group with any compound containing a reactive hydrogen.² Typical coat-

ings based on polyisocyanates are reacted with hydroxyl bearing coreactants such as polyester or acrylic polyols to form urethanes [equation (1)], or with amine functional coreactants to form ureas [equation (2)].



Initially, polyurethane coatings produced from the reaction of isocyanate with a hydroxyl functional coreactant were formulated with polyester polyols. These coatings possessed good performance for most applications. With the increased demand for improved durability at lower cost, the use of acrylic polyols was adopted. These products provided improved cost due to their low isocyanate demand while attaining superior hydrolytic stability over polyesters. As the need for higher solids developed in order to comply with environmental regulations, blocked amine functional reactants were introduced. Early products were utilized in special applications to reduce solvent levels, but found limited use due to disadvantages in film performance.³

The 1990 Clean Air Act imposed even more stringent controls upon air emissions and restricted the amount of organic solvents emitted from a paint system. High-solids technology thus evolved further to meet the demand for reduced solvent levels. High-solids paints are generally formulated with lower molecular weight compounds which have lower viscosity resulting in minimum solvent usage for application. In the case of polyurethane systems, the drive for higher solids has led to the examination of molecular weights of all polyisocyanates and coreactants. In response to this need, polyisocyanate and polyol components have been optimized to give the lowest viscosity through molecular weight adjustment, while maintaining performance.^{4,5} While molecular weight can be lowered to improve application viscosities, excessive reduction of molecular weight can

Presented at 21st Annual Waterborne, High-Solids, and Powder Coatings Symposium, February 9-11, 1994, New Orleans, LA.

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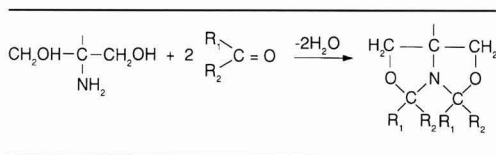


Figure 1—Oxazolidine structure

Table 1—Viscosity Dilution Effects Oxazolidine Reactive Diluents

Polyol Type	Concentration (wt%)	Oxazolidine		Viscosity ^a (cps)
		RD-20 (wt%)	RD-4 (wt%)	
Polyester ^b	100	—	—	3090
	90	10	—	2320
	80	20	—	1775
	70	30	—	1390
	90	—	10	2520
	80	—	20	2010
Acrylic ^c	100	—	—	4525
	90	10	—	3075
	80	20	—	2235
	70	30	—	1670
	90	—	10	3175
	80	—	20	2600
Polyether ^d	100	—	—	444
	90	10	—	332
	80	20	—	260
	70	30	—	216
	90	—	10	340
	80	—	20	264
No polyol	—	100	—	22
No polyol	—	—	100	25

(a) Brookfield RVT viscometer (Spindle #3 @ 20 RPM).
 (b) Desmophen 670A-80 (Miles Inc.).
 (c) Desmophen LS2945 (Miles Inc.).
 (d) Poly G20-112 (Olin).

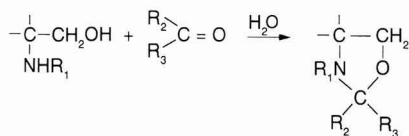


Figure 2—Oxazolidine structure

lead to performance problems.⁶ Therefore, further reduction of viscosity requires the use of newer chemistries such as reactive diluents which are effective in reducing application viscosity without adversely changing coating properties.

It was the intent of this study to develop a new class of ultra-low viscosity oxazolidine-based reactive diluents which would demonstrate excellent reactivity while improving coating performance. In particular, these new reactants should be designed to provide reasonably long pot life without increasing cure times.

Reactive Diluents

Reactive diluents are low-viscosity coreactants designed to reduce volatile organic compounds (VOCs) in coating systems. While they generally provide the ability to reduce the viscosity of the polymeric composition similar to a solvent, they must also undergo reaction with the polymer matrix to effectively reduce VOC. Reactive diluents should not be confused with high boiling solvents or solvated polyols. Low viscosity coreactants or reactive diluents are offered in various chemical types, which include: (1) low molecular weight esters or urethane diols; (2) ketimines/aldimines; and (3) oxazolidines.

The urethane diols are generally efficient coreactants in polyurethane coating systems. However, due to their high intrinsic viscosity,⁷ their use in lowering application viscosities in high-solid systems poses considerable constraints.

Most ketimines and aldimines undergo rapid hydrolysis to yield a reactive amine group. This amine subsequently reacts very rapidly with isocyanate. The result is a very attractive cure response with an unacceptably short pot life.

Oxazolidines, on the other hand, provide the formulator with low viscosity coreactants for use in high-solids polyurethane coating systems. These materials have a low reactivity toward isocyanates, but upon hydrolysis generate an amine and hydroxyl functionality. This makes them very attractive for use in two-component systems with long pot lives and reasonable dry times. Early products utilizing the oxazolidine chemistry, however, suffered from performance limitations such as film yellowing.

Characteristics of Oxazolidines

The various limitations associated with previous coreactants for polyurethane systems spawned interest in the search for low viscosity reactants that would not be detrimental to film performance. It is known that oxazolidines are a class of compounds that can function as isocyanate coreactants.⁷ Oxazolidines are saturated heterocyclic compounds which can be prepared by reacting β-amino alcohols with aldehydes or ketones.⁸⁻¹⁰

In general, oxazolidine compounds are relatively easy to use and nonhazardous to handle. These properties provided an added inducement to investigate the modification of oxazolidines such that they might function as coreactants for polyurethane systems.

Oxazolidine Reactivity

It is known that most oxazolidines produced through the reaction of an amino alcohol with formaldehyde, could not

function as reactive diluents due to their inherent hydrolytic stability. Highly reactive oxazolidines, however, can be produced through changes to the molecular structure of the oxazolidine ring.¹¹

Oxazolidines can also be designed to be weak bases and to possess no reactive hydrogens. These two features are critically important to oxazolidine compatibility with isocyanates. The oxazolidine produced from a β-amino diol with two moles of carbonyl, as identified in Figure 1, is a bicyclic oxazolidine with no reactive hydrogen. The oxazolidine produced from a secondary or hindered amine and a carbonyl, identified in Figure 2, is an oxazolidine with a different molecular weight and structure with no reactive hydrogen. The chemistry of the oxazolidine ring is such that it may be conveniently incorporated into a variety of polyfunctional matrices. The appropriate oxazolidine can be rapidly converted by moisture to the parent alkanolamine, identified in Figure 3, which then fully reacts with polyisocyanate to develop a superior coating.

After investigating a wide range of molecules, it was observed that two candidates, a bicyclic oxazolidine (RD-20) with a functionality of 2 and an aldimine-oxazolidine (RD-4) with a functionality of 3, exhibited the desired combination of characteristics: extremely low viscosity at 100% solids, and good compatibility with polyisocyanates.

Oxazolidines as Reactive Diluents

In order to verify that these two particular oxazolidine compounds would function as effective reactive diluents, it was not enough to only measure their intrinsic viscosity. A study of their relative ability to lower the viscosity of common high viscosity polyol components was additionally warranted. Several polyols (acrylic, polyester, and polyether) were chosen for this study. Each commercial polyol was diluted as supplied with various levels of the oxazolidine reactive diluents. The results are reported in Table 1.

It is apparent that not only do these oxazolidine-based reactive diluents have ultra low viscosities, but that they also serve extremely well in reducing the intrinsic viscosity of common polyol coreactants. No problems in stability were encountered.

While evidence suggests that properly chosen oxazolidines are effective reactive diluents, their true efficacy in reducing VOC needed to be established in a viable urethane formulation. For this purpose, a two-component polyurethane coating utilizing an acrylic polyol was prepared as a control system. Two experimental formulations were produced utilizing one of the ultra low viscosity oxazolidine coreactants in each system.

The oxazolidine reactive diluents were added as a 20% (weight) replacement of polyol solids since this level of coreactant offered a viable approach to reducing VOC below 2.8 lbs/gal in each formulation. The concentration reduction of the higher viscosity polyol and the solvency effect of the oxazolidine reactive diluent allowed for further reduction in solvent content. All systems were formulated at the same NCO/OH ratio (1.05:1) and application viscosity (18 sec - Zahn #3).

After preparation of the coating, VOC levels were determined on each formulation by the protocol established in EPA Test Method No. 24 with an induction time. The VOC

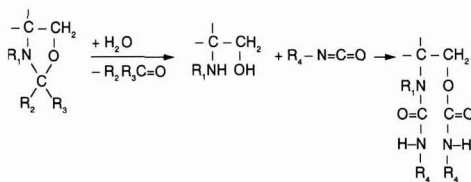


Figure 3—Oxazolidine reactivity

Table 2—VOC^a Reduction Two-Component Polyurethane Coatings

	Control	Oxazolidine	
		RD-4	RD-20
Initial VOC	2.95	2.54	2.72
2 hour VOC	2.96	2.50	2.64
24 hour VOC	2.96	2.50	2.60

(a) Pounds/gallon, EPA Method 24.

Table 3—Two-Component Polyurethane Coating

Materials	Parts by Weight		
	Control	Oxazolidine ^a	
		RD-4	RD-20
Acrylic polyol	398.58	303.02	331.31
Oxazolidine RD-4	—	48.48	—
Oxazolidine RD-20	—	—	54.90
Wetting agent	18.85	19.53	20.34
Rutile titanium dioxide	376.94	419.97	423.06
Methyl ethyl ketone	91.12	76.16	65.04
Methyl isobutyl ketone	46.20	38.38	32.53
Ester solvent	46.20	38.39	32.53
Aliphatic isocyanate	126.13	202.01	196.04
Properties			
Solids - by weight	71.69	77.85	79.26
Viscosity - #3 Zahn (sec)	18	18	18
VOC - lbs/gal (actual)	2.96	2.50	2.60

(a) 20% of polyol solids replaced by oxazolidine reactive diluent.

Table 4—VOC^a Levels, Pot Life and Cure Response

	Control	Oxazolidine			
		RD-4		RD-20	
Polyol solids replacement %	0	10	30	10	30
24-hour VOC	3.38	3.07	2.72	3.10	2.82
Pot-life ^b	4.0	2.5	2.0	3.5	6.5
Cure response ^c	4.0	5.0	5.5	5.5	18.0

(a) Pounds/gallon, EPA Method 24.

(b) Measured in hours from an initial viscosity of 18 sec - Zahn #3, to a final viscosity of 30 sec - Zahn #3.

(c) Measured in hours upon a Gardner Dry Time Recorder (Model B-K).

Table 5—Additive Effects on Cure Response

	Control (No Additive)	Oxazolidine	
		RD-4 0.1% PD ^a	RD-20 .03% PD ^a , .008% DBTDL ^b
Initial VOC ^c	2.98	2.61	2.94
24-hour VOC ^c	2.97	2.58	2.64
Pot life ^d	4.0	3.0	3.0
Cure response ^d	6.5	6.5	7.5

- (a) Pentanedione.
 (b) Dibutyltin dilaurate.
 (c) Pounds/gallon.
 (d) Hours.

levels for the control and two oxazolidine coreactant systems are shown in *Table 2*. The results show that the oxazolidine coreactants RD-4 and RD-20 completely reacted into these polyurethane systems thus providing VOC levels which were 0.46 lbs/gal and 0.36 lbs/gal lower than the control, respectively.

Cure Response and Pot Life

In order to develop information on the oxazolidine coreactants' effects upon speed of cure and pot life, two-component polyurethane formulations were prepared similar to the study on VOC reduction (see *Table 3*). The level of oxazolidine reactive diluent utilized in each test formulation was varied from 0-30% by weight, with a corresponding reduction of polyol and an increase in isocyanate content in order to maintain the NCO:OH ratio. Solvent levels were also adjusted such that each formulation had an identical application viscosity.

The information shown in *Table 4* demonstrates the positive impact upon VOC levels afforded by each respective oxazolidine reactive diluent. As might be predicted, the reduction of VOC level is commensurate to the amount of oxazolidine utilized in each given formula.

This study also demonstrates the impact of each oxazolidine coreactant upon system pot life and cure response. In this uncatalyzed system, oxazolidine RD-4 appears to shorten pot life over the control, although not

beyond the limitations of most applications. Pot life was defined as the time required for system viscosity to rise from 18 sec - Zahn #3 up to a limit to 30 sec - Zahn #3. Cure response was measured by the Gardner Dry Time Recorder (Model B-K).

In the formulation containing the oxazolidine RD-20 coreactant, both pot life and cure response times are lengthened with increasing levels of the reactive diluent. These data indicate that the designed structures of the oxazolidine coreactants will provide variable rates of reactivity.

Studies next centered on the adjustment of cure response without affecting pot life through the use of a catalyst such as dibutyltin dilaurate and a modifier pentanedione. Subsequent trials with the same formulations now charged with lower or higher amounts of these additives provided the necessary variability to cure response without detracting from pot life. The additive effects of dibutyltin dilaurate and pentanedione to optimize the final performance of the model two-component polyurethane coating is indicated in *Table 5*. These additives utilized at very low levels, allowed for optimal adjustment of cure response while maintaining good pot-life characteristics. They are thus recommended where performance profiles mandate their use.

Application of Oxazolidines

The ability to effectively function as reactive diluents suggests a number of possible applications for these oxazolidine-based molecules which are listed on the Toxic Substance Control Act Inventory list. They could be used to provide substantial reductions in VOC in two-component polyurethane coatings found in the transportation, industrial maintenance, or product finish end use markets. It is also entirely possible that oxazolidines might be used to formulate stable one-component polyurethanes which, when moisture-cured, do not give off carbon dioxide and its corresponding gas bubbles.

While the oxazolidine-based reactive effectively reduced VOC in a trial formulation, the determination of effects on film performance was still required.

FILM PERFORMANCE: The conventional two-component polyurethane coating shown in *Table 3* was utilized in order to determine the affect of each oxazolidine coreactant upon

Table 6—Mechanical Properties

	Control	Oxazolidine RD-4			Oxazolidine RD-20		
		10%	20%	30%	10%	20%	30%
Polyol solids replacement (%)	0%	10%	20%	30%	10%	20%	30%
Pencil hardness ^a	4H	4H	4H	4H	4H	4H	4H
Sward hardness (%)	70	55	50	65	64	60	70
Flexibility (%) ^b	32	32	32	32	32	32	32
Impact resistance							
Direct	35	35	25	40	45	105	155
Reverse	<5	<5	<5	5	<5	45	90
Abrasion Resistance (mg) ^d	78	71	69	68	68	59	55

- (a) Seven-day ambient cure.
 (b) Conical mandrel.
 (c) Foot - pounds.
 (d) Taber abrader, CS-17 wheel, 1,000 gm weight, weight loss after 1,000 cycles (mg).

Table 7—Chemical Resistance Solvent Rubs—Score^a

	Control	Oxazolidine RD-4			Oxazolidine RD-20		
		10%	20%	30%	10%	20%	30%
Polyol solids replacement (%).....	0%	10%	20%	30%	10%	20%	30%
Isopropanol							
50 cycles	10	10	10	10	10	10	10
100 cycles	10	10	10	10	10	10	10
Toluene							
50 cycles	10	10	10	10	10	10	10
100 cycles	10	10	10	10	10	10	10
MEK							
50 cycles	10	10	10	10	10	10	10
100 cycles	10	10	10	10	10	10	10

(a) Scoring: 1-poor, 10-best.

system film properties. A ladder series test was again employed where 0-30% by weight of the polyol was replaced with an equivalent solids level of each oxazolidine reactive diluent. Coating films prepared with the control and oxazolidine-based coreactants were evaluated for mechanical properties (Table 6) and chemical resistance (Table 7).

Mechanical property testing demonstrated the effects on performance of the ultra low viscosity oxazolidine reactive diluents in a typical formulation. Film integrity appears to be relatively unchanged (as measured by pencil hardness ASTM D 3363) either as a function of oxazolidine choice or concentration level. Sward hardness (ASTM D 2134) results demonstrated films containing lower levels of the oxazolidine reactants were more elastic. Elongation by conical mandrel (ASTM D 522) remained unchanged.

Flexibility/hardness as measured by impact resistance (ASTM D 2794), however, established an interesting effect. The three-functional oxazolidine RD-4 showed no real consistent effect when used to replace various levels of the polyol. The two-functional oxazolidine RD-20 coreactant, however, improved both direct and reverse impact results as it replaced more of the polyol utilized in this formulation.

Separately it was noted that both oxazolidine reactive diluents were able to impart substantial improvements to this system in the area of abrasion resistance. The oxazolidine RD-20 gave the most substantially improved results here as measured by the Taber abrader (ASTM D 4060). Improved abrasion resistance of this magnitude would be particularly attractive in the formulation of higher performance industrial coatings (e.g., aircraft, industrial maintenance, or auto refinish).

Table 7 illustrates the results of chemical resistance testing in the form of solvent rubs (ASTM D 4752 NCCA). Because oxazolidine-based reactive diluents impart urea and urethane linkages into a polymer backbone which already contains these linkages, it is no real surprise that chemical resistance remained essentially unchanged.

WEATHERING PERFORMANCE: A final evaluation of coating durability was conducted through accelerated weathering. Coatings formulated with 20% by weight oxazolidine coreactant (based on Table 3) were exposed to QUV "A" (with condensation cycle) weathering (ASTM G 53) for up to 1,000 hr. Specular gloss (ASTM D 523) at 60 and 20°

incidence was recorded as well as color shift (ASTM D 2244) measured in Delta E values. The results are reported in Table 8.

Very little effect upon gloss or color shift was seen in either oxazolidine-modified formulation versus the control. It should be noted that none of these formulations incorporated a UV stabilizer.

CONCLUSION

The bicyclic oxazolidine (RD-20) and aldimine-oxazolidine (RD-4) have been shown to perform as highly effective reactive diluents. The oxazolidine molecules possess extremely low intrinsic viscosity at 100% activity and function as very good diluents when blended with higher viscosity polyols. They also provide controlled reactivity as coreactants for polyisocyanates in high-solids coatings.

Experiments using the oxazolidine-based reactive diluents in two-component polyurethane coatings proved the ability of these materials to function as viable technology to significantly reduce VOC in higher-solids systems. Performance improvements can also be expected in the areas of impact

Table 8—Durability Comparisons Accelerated Weathering—QUV "A"

	Control No Oxazolidine	Oxazolidine ^a	
		RD-4	RD-20
Specular Gloss			
60° initial	87	88	87
300 hr	86	87	86
600 hr	87	85	87
1000 hr	85	84	87
20° Initial	80	85	80
300 hr	79	81	79
600 hr	75	73	78
1000 hr	71	71	78
Color (Delta E)			
300 hr	0.64	0.85	1.13
600 hr	0.85	0.82	1.12
1000 hr	1.32	1.30	1.55

(a) 20% of polyol solids replaced by oxazolidine reactive diluent.

resistance as well as abrasion resistance when these compounds are employed as an integral part of high-solids polyurethane coatings.

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Melamine Phosphates and Pyrophosphates in Flame-Retardant Coatings: Old Products with New Potential

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The use of melamine salts of phosphoric and pyrophosphoric acid in flame-retardant coatings, particularly intumescent coatings, is reviewed. Recent insights into mode of action suggest that several vapor phase and solid phase actions occur, involving both the melamine and the phosphoric acid portions of the salt molecule. Melamine phosphates cover a wide range of stabilities and vary in water solubility. Melamine pyrophosphate is the most thermally stable and the least water soluble of the available melamine phosphates. Fire-retardant coating applications are known for the melamine phosphates in coatings based on tung oil, chlorinated rubber, various vinyl latices, epoxy and amino resins.

INTRODUCTION

Melamine salts of phosphoric acids have been known as flame-retardants for over 40 years and have found substantial usage in flame-retardant coatings. The current upsurge of interest in nonhalogen flame-retardant polymer systems has stimulated coatings compounders to take a new look at phosphorus compounds. Researchers have recently begun to examine the mode of action of these compounds.

Three chemically distinct commercial melamine phosphates, including one pyrophosphate, are commercially available from U.S. and European manufacturers; however, in our recent preparation of reviews^{1,2} on phosphorus flame-retardants, we found that very little has been published on the distinguishing characteristics and utility of the individual

melamine phosphates. Also, we did not find comparisons to the other commonly used phosphorus nitrogen additive, ammonium polyphosphate. Some discussion of the melamine phosphates is found in a review by University of Aston authors covering the literature up to about 1977.³

Our present review brings together information from the literature dealing with these compounds, plus a comparison of thermal properties of the melamine phosphates and ammonium polyphosphate. We also offer some comments found in the literature regarding possible mode of action and clues to phosphorus-nitrogen "synergism" (effects greater than additive),^{4,5a} supplemented by indications from our own thermal analysis results.

Although performance comparisons under realistic conditions in coatings are not found in the literature, perhaps the present overview will be of some guidance to the formulator. In view of the frequent reports of interactions of flame-retardant components, including the useful phenomenon of "synergism," an experimental comparison is warranted.

Background on Flame-Retardant Coatings

We will not attempt a broad review of this topic but will provide some leading references^{5b-h,17} and definitions for those coating technologists unfamiliar with flame-retardant coatings.

Some degree of flame retardancy, including resistance to ignition, reduced flame spread rate (ranging up to self-extinguishing), protection from heat damage, and compliance with applicable fire codes or regulations may be achieved^{5c,5f-g} by suitable coatings on otherwise more flammable substrates such as wood, or heat-damageable substrates such as metal. A major category of flame-retardant coatings are those known as "intumescent" coatings, which

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Table 1—Melamine Phosphates Commercially Available in the United States

Chemical Names; Molecular Formula	CAS Registration Number	EINECS Number	Manufacturer	Trade Name (or common name used by manufacturer)	Phosphorus Content	Particle Size	Solubility in H ₂ O(g/100 cc) at T °C
Melamine phosphate; Melamine orthophosphate; 1,3,5-Triazine- 2,4,6-triazine, phosphate (1:1) [CAS name]; C ₃ H ₆ N ₆ •H ₃ PO ₄	20208-95-1	2436015	Albright & Wilson	Amgard® NH	13.4% (theory 18.8%)	95% < 200 mesh, 95% > 75 μm	0.7 (room temp.?)
			Akzo	Fyrol® MP	13.8%	< 300 mesh, < 44 μ	0.35 (20°) 2.9 (100°)
			DSM	Melamine Phosphate	12% min	99% < 30-40 μ, 90% < 20- 30 μ, 50% < 5-15 μ, 10% < 5 μ	0.30 (22°C)
			Chemie Linz	Melamine phosphate	Not stated on product data sheet	Unground; 93% < 200 μ; ground ≈ 35 μ	0.5 (20°C)
			Cytec ^a	Aeroguard® MP	13.8%	100% through 40 mesh	0.6
Dimelamine phosphate; Dimelamine orthophosphate; 1,3,5-Triazine- 2,4,6-triazine, phosphate (2:1) [CAS name]; 2(C ₃ H ₆ N ₆)•H ₃ PO ₄	56974-60-8	2604935	Albright & Wilson	Amgard ND	8.3% (theory 8.9%)	95% < 200 mesh, 95% < 75 μ	0.2 (room temp.?)
			DSM	Di-melamine phosphate	8% min	99% < 30-40 μ, 90% < 20- 30 μ, 50% < 5-15 μ, 10% < 5 μ	0.15-0.2 (22°)
			Cytec	Aeroguard MP-21 ^b	8.9% (Theoretical)		0.2 (25°C)
Melamine pyrophosphate; Diphosphoric acid, compd. with 1,3,5-triazine- 2,4,6-triazine [CAS name]; 2(C ₃ H ₆ N ₆)•H ₄ P ₂ O ₇	15541-60-3	2395901	Cytec	Aeroguard MPP	14.5% (theory 14.4%)	3.0% > 100 mesh, 5.7% > 230 mesh, 22.0% > 325 mesh	0.03 (22°) 0.07 (50°)
C ₆ H ₂₄ N ₁₈ O ₈ P ₂ MW=574.3			Cytec	Aeroguard MP-32 ^b			

(a) Formerly American Cyanamid Company, Chemicals Group.

(b) Developmental product.

swell when exposed to fire or radiant heat to form a porous foamed mass, usually carbonaceous, which acts as a barrier to heat, air, and pyrolysis products.

Classically, intumescent fire retardant coatings contain a char-forming (carbonific) agent which can be a polyol, a catalyst for char formation (usually a phosphoric acid derivative, ammonium polyphosphate for example) and a foaming (spumific) agent, typically melamine. Melamine phosphates may, to varying degrees, play the roles of spumific agent, catalyst, and charformer, with further endothermic and flame inhibitory effects as discussed further. A compendium of commercially available flame-retardant coatings has been

recently published, including an introductory discussion of markets and regulatory aspects.^{5b} Several useful basic studies on the mass and heat transfer aspects of intumescent flame retardant action have also been published.^{5c-e} Application aspects have been reviewed.^{5f-h} Further references to intumescence chemistry will be discussed.

It is important to note that the present review refers in most cases to evaluations based on small scale testing. The reader is warned that one of the salient problems of flame retardancy is that small scale tests are not reliable predictors of full scale fire behavior. Moreover, fire retardant coating performance is dependent on the total formulation, its mode

of application, thickness, the appropriateness of the coating to the substrate to be protected, exposure to weathering, the presence of topcoats if any, and the characteristics of the fire source. Performance testing is highly recommended under realistic full scale conditions.

Commercially Available Melamine Phosphates

Three melamine phosphates are commercially available in the U.S. from domestic and European sources. The compounds differ in their percentages of phosphorus, their thermal stabilities, their water solubilities, and their particle size distributions. No one U.S. manufacturer offers all of them. Table 1 shows these compounds, their suppliers, and some of their properties as provided by the manufacturers.

Melamine phosphates of the same chemical name but from different suppliers may not be exact equivalents in flame-retardant performance. Particle size distribution, crystal morphology, water-release properties, and small compositional differences have been shown to play a significant role in performance, at least with melamine phosphates in intumescent coatings.⁶

Manufacturing routes are set forth in many patents, not reviewed here, since it was not possible to ascribe particular processes to particular commercial products. In general, melamine is reacted, sometimes in the presence of water, with the corresponding phosphoric acid. Some of the described processes involve prereaction with an acid such as hydrochloric acid to make a soluble melamine salt, followed by reaction with the sodium salt of the phosphoric acid. Fessler and Tredinnick^{7,8} report that this latter method produces melamine pyrophosphate with an optimum crystal morphology for dispersion in aqueous emulsion-based paints.

Several melamine metaphosphates have been described in the literature^{9,10} but are not commercially available.

Comparison of Water Solubility

The most detailed comparison of water solubility (g/100g) is from a Russian study.¹⁰ Their data is as follows:

Melamine Derivative	20°	40°	60°	80°	100°
Orthophosphate	0.35	0.63	1.16	1.88	2.94
Pyrophosphate	0.09	0.17	0.24	0.32	0.54

Solubility values provided by the manufacturers (see Table 1) are reasonably consistent with these numbers.

The melamine phosphates have very low solubilities in organic solvents, even in polar ones such as DMF or alcohol.

Dissolution of the melamine phosphates can be expected to be somewhat influenced by other materials present, so formulators should rely on experimental determination of leaching, weathering, and scrubability. Since the melamine phosphates are salts of a weak base and moderately strong acids, one would expect that in formulations on the basic side, reaction could occur such that the phosphate moiety would form salts of any base present stronger than melamine, with liberation of free melamine. Likewise, any acid stronger than the phosphoric acid would liberate the phosphoric acid from the melamine salt, although this is a situation unlikely to be encountered in coatings formulations.

In principle, encapsulation could further reduce the water solubility of melamine phosphates for use in flame-retardant paint. Directions for encapsulation with an epoxy resin are given in a patent.¹¹

It is of interest to compare the solubility behavior of melamine phosphates with that of ammonium polyphosphates. The latter may seem initially to have low solubility, especially when coated; however, when exposed to hot water, ammonium polyphosphates eventually dissolve with irreversible hydrolysis to ammonium orthophosphate, a very water-soluble salt with a distinctly acidic pH. By contrast, the melamine phosphates exhibit a true equilibrium solubility.

Comparison of Thermal Stability of Melamine, the Melamine Phosphates and Ammonium Polyphosphate

Thermogravimetric curves (run under nitrogen at 20°C/min in the Polytechnic laboratory) for all of the three principal melamine phosphates are shown in Figure 1. Curves for melamine itself and ammonium polyphosphate are also shown for comparison. Melamine pyrophosphate demonstrated the highest thermal stability in the initial decomposition range below about 350°C. Throughout the entire temperature range, it was the most stable compound of the melamine phosphate group.

The lowest thermal stability is that of dimelamine phosphate, which appears to give up one mole of melamine about as easily as melamine itself, and shows some earlier weight loss, as well.

Both melamine pyrophosphate and melamine phosphate lose weight very gradually from about 300°C up to the limit of the thermogravimetric analysis (825°C), although the weight in the higher temperature region appears to be leveling off. The final weights at 825°C correspond quite well with that predicted by the conversion of the melamine phosphates to (PNO)_x where phosphorus is the limiting element controlling the amount of (PNO)_x formed. This chemistry is

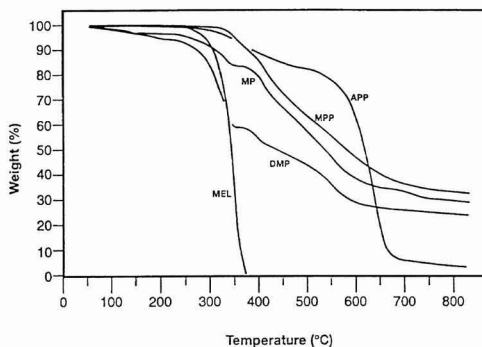


Figure 1—Thermogravimetric analysis curves: MEL = melamine; DMP = dimelamine phosphate; MP = melamine phosphate; MPP = melamine pyrophosphate; APP = ammonium polyphosphate (all commercial flame-retardant grades, run under nitrogen at a temperature increase rate of 20°C/min)

consistent with that described by Sommer.¹⁶ The theoretical weight % yield of PNO from melamine phosphate is 27%; the observed residual weight at 825°C in the TGA was 27% of the original weight.

Melamine pyrophosphate, having a somewhat higher phosphorus content than melamine (ortho)phosphate, gives a proportionately larger yield of the presumed (PNO)_x. The theoretical weight % yield for the formation of two moles of PNO from one mole of (di) melamine pyrophosphate is 28%. The residue at 825°C in the TGA was 31%, consistent with the formation of (PNO)_x.

We hypothesize that the formation of (PNO)_x, a very thermally stable crosslinked polymer, may be one cause of the sometimes-observed "synergism" in flame-retardant formulations containing both phosphorous and nitrogen compounds.^{4,5} Whether this hypothesis can be supported by experimental evidence remains to be seen. Synergism is not consistently seen with phosphorous-nitrogen compounds and its occurrence seems to be unpredictable, even with additives already having a P-N bond.¹⁴

Ammonium polyphosphate has a very different thermal behavior. It loses very little weight up to about 300° and then undergoes a gradual weight loss, diminishing in rate to about 500°C, then undergoes a more rapid weight loss between about 500°C and about 650°C. The weight loss in the 300-500°C range corresponds to ammonia loss, the weight loss in the 500-650°C range corresponds to loss of most of the polyphosphoric acid. Contrary to a widespread misconception, the condensed phosphoric acids are distillable with decomposition in this temperature range.

Physical and Chemical Changes Accompanying the Thermal Breakdown of Melamine Phosphates

A detailed study of the mode of breakdown of melamine (ortho)phosphate, including the fate of the melamine, was conducted by Costa et al.¹⁵ Initially, most of the melamine is retained in the condensed phase in combination with the phosphoric acid. The first significant chemical change is the conversion of melamine orthophosphate to the pyrophosphate. To a lesser degree, melamine is released and can vaporize. Other reports show that to whatever extent melamine is released, it can exert a flame-retardant effect by providing a heat sink (endotherm) and a non-combustible vapor.¹⁶

At higher temperatures, both the melamine and the phosphoric acid portion can undergo self-condensation to higher molecular weight substances with vaporization of ammonia and water. Water is, of course, a non-fuel and ammonia is an energy-poor fuel, either one inhibiting the flame. Possible further melamine loss also occurs in this range. Eventually in the range of 600°C, the residual product is a thermally very stable nonvolatile presumably polymeric inorganic substance, which can serve to protect whatever char was formed from the polymeric matrix in which the flame-retardant was used. Based largely on the disclosure of Sommer,¹² we postulate that this stable substance may be (PNO)_x.

It is an unsettled question as to whether the residues from pyrolyses of flame-retardants, under TGA conditions for example, are similar to residues that would result under actual fire conditions.

However, any or all of the previously described thermal changes and reactions could plausibly contribute to flame retardancy, for instance by providing noncombustible vapors, by acting as a heat sink, and by forming a protective coating on the substrate or on the char. The pyrolysis products, having P-O-P or P-N linkages, are also likely to have phosphorylating agent characteristics and thus help catalyze char formation from many types of polymers, especially polymers containing oxygen functional groups.

Where a char-forming ingredient such as a pentaerythritol has been added, as in many typical intumescent coating formulations,¹⁷ the chemistry is likely to be further accompanied by phosphorylation and dehydration reactions similar to those which have been described in detail for ammonium polyphosphate-pentaerythritol systems.¹⁸

Comparison of Flame-Retardant Efficiency— Some Considerations in Lieu of Data

Efficacy comparisons are likely to be misleading, because relative efficacy of flame-retardants depends on the polymer matrix in which they are used and on the other ingredients present. No published comparison of the different melamine phosphates was found in our review so the best we can do is offer some "rules of thumb."

To a first approximation, the flame-retardant activity of a series of related phosphorus compounds is usually strongly correlated to the phosphorus contents. As a first approximation, the formulator might consider the cost per unit weight of phosphorus. However, structural influences can play a part in modifying this basic activity, they are: (1) possible (not assured) synergistic effects of nitrogen; (2) structural effects on thermal stability, affecting the optimum match of polymer degradation temperature to additive degradation temperature; and (3) possible special effects of the pyrophosphate linkage.

In regard to the third item, the possible special activity of pyrophosphate, there are at least two studies not dealing specifically with melamine phosphates which show instances in which the pyrophosphate group contributes more flame-retardant or enhanced char-forming efficacy than comparable phosphorus compounds without the pyrophosphate group.^{19,21}

In comparison to ammonium polyphosphate, the TGA data suggests that the melamine phosphates might provide a more thermally stable protective barrier on the burning polymer. If TGA results on the pure flame-retardants are any indication, the yield of this barrier substance would be in the order melamine pyrophosphate > melamine phosphate > dimelamine phosphate > ammonium polyphosphate.

We recognize the risk of drawing conclusions from TGA studies on the pure flame-retardant in the absence of the other ingredients of the formulation, and an experimental comparison is strongly advised.

A very important factor in the choice of melamine phosphate for a given coating formulation is the water solubility. For flame-retardant (intumescent) coatings intended to survive severe weathering, for example, the protection of offshore oil installations, the least soluble melamine phosphate, namely the pyrophosphate, would appear to be the logical choice.

Survey of Applications of Melamine Phosphates in Coatings

The best established uses of the melamine phosphates are in flame-retardant, mostly intumescent, coatings (paints and mastics). In these applications, the melamine phosphates appear to compete with melamine and ammonium polyphosphate, although combinations of a melamine phosphate with ammonium polyphosphate are also mentioned in the patent literature. The particular choice seems dependent on requirements for water resistance, flow characteristics, cost and other factors. Where the coating must endure weathering, melamine phosphates, especially the pyrophosphate, appear likely to give better durability than coatings based on ammonium polyphosphate. Comparative weathering data is, however, scarce.

The flame-retardant coatings based on melamine phosphates are often used as the base coat or primer, and often as a one-coat system. The melamine phosphates do not tend to cause corrosion or to affect corrosion resistance. In fact, coatings containing them are often applied directly to bare steel. In extreme exposure conditions, such as offshore installations, it may be advantageous to use melamine phosphates in multicoat systems. For example, melamine phosphate (or the less soluble pyrophosphate) can be formulated into an epoxy primer, which can be topcoated with a high-performance system such as a two-component urethane.

A detailed discussion of the choice of binder is outside the scope of this article and, indeed, we found little comparative information in the literature. Binders in commercial use appear to include epoxies as well as vinyl resins such as polyvinyl acetate, vinyl acrylics, and polyvinylidene chloride (itself rather fire-retardant).

Melamine phosphates provide both the catalyst feature and the blowing agent component to the intumescent coating. This combined action is often found to permit lower total solids loadings, easier application, and better coating properties.

The history of the use of melamine phosphates in fire-retardant coatings goes back to the 1940s. Useful general reviews cover the development and principles of intumescent coatings.^{17,18} A review of intumescent coatings with particular emphasis on the use of melamine phosphates was published in 1979.³ The advantages of melamine pyrophosphate in regard to low solubility and low hygroscopicity were recognized quite early. An advantageously dispersible crystal form^{7,8} provided a further impetus to use of pyrophosphate.

A broad patent in 1966 covers a wide range of binders, and carbonifics (carbonaceous char formers) and shows melamine pyrophosphate as one of the preferred spumifics (foam formers).²²

Most of the remaining references are more specific as to the principal resin (binder) used therein. In many instances, the reference states the use of melamine phosphate(s) without explicitly stating which one.

OIL-BASED COATINGS: A detailed study by the USDA led to tung-oil-based flame-retardant coatings using melamine phosphates as spumific ingredients and polyurethanes as char-forming agents.²³

CHLORINATED RUBBER-BASED COATINGS: A flexible coating on a conformable fabric sheet was developed on the basis

of a chlorinated rubber binder, glass fibers, and melamine pyrophosphate as catalyst and spumific.²⁴

WATER-BASED LATEX COATINGS: Melamine pyrophosphate in a particular crystalline form is readily dispersed in latex paint formulations, with a resultant low viscosity even at high loadings of the additive.^{4,5} Two representative formulations are the following:

Latex Intumescent Coating Formulations

Formulation Number	1	2
Grind together the following ingredients:		
Water	278.3	289.0
Potassium triphosphosphate	3.0	1.5
Ethoxylated castor oil (dispersant)	4.0	4.0
Melamine pyrophosphate	332.0	350.0
Dipentaerythritol	102.0	87.5
Fungicide	0.5	0.5
Defoamer	3.0	3.0
Titanium dioxide	60.0	60.0
70% chlorinated paraffin	40.0	40.0
Ester alcohol (Texanol)	1.1	—
Hydroxyethylcellulose (1.5% soln.)	5.2	—
Reduce with:		
Vinyl acrylic emulsion	220.0	—
Polyvinyl acetate	—	220.0
Hydroxyethylcellulose (3% soln.)	—	45.0
Defoamer	1.0	1.0
Physical Characteristics:		
Pigment volume concentration	74	
Total solids	60	
Viscosity	62 KU	
pH	4.2	
Scrub resistance (20% Lava soap)	500 strokes to 50% show	
Fire Resistance (coverage 125 sq ft/gal)		
Flame spread (2-ft tunnel)		
Before wash test	27	
After wash test	25	
Foam-char height		
Before wash test	0.6"	
After wash test	0.7"	
25-ft. E-84 tunnel rating		
At 125 sq ft/gal	—	15
At 150 sq ft/gal	—	20

These formulations were found to have good oven aging and freeze-thaw stability. As the data shows, the paint film has good scrub resistance.

In one of the few published comparisons of ammonium polyphosphate to melamine phosphate in fire-resistant coatings, an aqueous formulation was used based on pentaerythritol, dicyandiamide, carboxymethylcellulose, pigments, melamine phosphate or ammonium polyphosphate, and polyvinyl acetate latex. The temperature of the substrate surface after five minutes heating reached only 250°C whereas a similar coating with ammonium polyphosphate in place of melamine phosphate reached 570°C.²⁵

However, both melamine phosphate and ammonium polyphosphate are used together in a patented aqueous fire-retardant paint based on ethylene-vinyl acetate or acrylonitrile-vinyl acetate latices along with a thermosetting resin.²⁶

Also with regard to combinations of flame-retardants, a patent on fire-retardant coatings based on melamine-urea resins or mixture with ethylene-vinyl acetate copolymer de-

scribes the use of melamine phosphate, dipentaerythritol and Al(OH)₃.²⁷

VINYL COATINGS: Weather-resistant fire-retardant vinyl emulsion paints were disclosed utilizing a polyol (char former) such as a pentaerythritol plus melamine pyrophosphate. The use of glass fibers gave improved results.²⁸

A water-based intumescent paint was formulated by combining a copolymer or terpolymer of vinyl chloride or vinylidene chloride and a melamine phosphate.²⁹

An interesting use of melamine pyrophosphate is disclosed where it is a char "homogenizing agent" (eliminating holes and other irregularities) in the char from an intumescent coating based on vinyl chloride/vinylidene chloride copolymer as binder and p,p'-oxybisbenzenesulfonamide as intumescent agent. The improved quality of the char resulted in lower flame spread and better insulation by the intumescent foam of the underlying combustible material.³⁰

EPOXY COATINGS: Coatings (mastics, paints) for protecting, for example, structural steel girders are formulated using an epoxy resin plus a melamine phosphate.

An early example uses melamine borate and/or melamine phosphate. A formulation of 18.4 parts melamine phosphate, 51.9 parts Araldite™ MY 753 epoxy (Ciba), and 7.4 parts glass fibers coated on steel at 0.07-inch thickness gave seven inches of intumescent char.³¹

In a patent directed to protective conduits, formulations are disclosed for epoxy-based melamine phosphate-containing intumescent coatings, also containing ceramic fibers or crushed glass particles.³²

A fire-retardant intumescent coating which resists leaching is formulated from a diglycidyl bisphenol A, melamine pyrophosphate, dicyandiamide, urea, and optionally char-reinforcing ingredients, such as borax and a low-melting glass fiber or powder.³³

Present day intumescent mastics are represented by complex formulas containing, typically, chloroalkyl phosphate esters, ammonium polyphosphate and/or melamine pyrophosphate, melamine itself, a pentaerythritol, a clay gellant, zinc borate or other zinc compound, mineral fibers, and one or more binder resins, often an epoxy. The formulator has the option of using the melamine separately or as part of a salt.^{34,35} The performance advantage of the somewhat more costly melamine phosphate over ammonium polyphosphate is likely to lie in the weathering or steam resistance, and perhaps in the quality and timing of formation of the intumescent protective barrier under fire conditions.

In a patent dealing with the special situation of fire protection of insulated cable, combinations of acrylate copolymers and epoxies are shown as binders in a melamine phosphate containing intumescent coating.³⁶

Melamine pyrophosphate was specifically claimed to be advantageous in an aminoamide-cured epoxy intumescent coating for steel. The formulation is as follows: a solution of 50 parts diglycidyl ether of bisphenol A, 5 parts xylene, 5 parts MIBK, 20 parts melamine pyrophosphate, and 10 parts TiO₂ mixed with a solution of 25 parts Versamid™ 125 (Henkel), 2.5 parts toluene, and 2.5 parts butanol provides a spray-paintable hard fire-resistant coating for steel.³⁷

AMINO RESIN COATINGS: A fire-retardant intumescent coating is formulated using a melamine-formaldehyde or urea-

formaldehyde resin, sodium carbonate, alkali silicofluoride or alkali silicate, and, as carbonization-accelerating agents, a combination of a melamine phosphate and ammonium polyphosphate.³⁸

MISCELLANEOUS COATING FORMULATIONS: Intumescent coating formulations containing melamine pyrophosphate are improved in regard to viscosity stability by inclusion of a chelating agent.³⁹

Finding Clues to Better Coating Formulations in the Noncoating Literature—The Search for Synergism

The formulator of coatings should note that there are frequent reports of useful combinations of the melamine phosphates with other flame-retardants, even, somewhat surprisingly, with other phosphorus flame-retardants. Data supporting the idea of synergism has been shown in a few cases. Phosphorus-nitrogen synergism is not a general phenomenon, but real and useful instances of it are well-known.^{4,5}

Where synergism is found experimentally, the reason for it is usually not clearly understood. It might be postulated that each of the two phosphorus compounds has a different mode of action. Synergism can result from an actual chemical interaction but can also be a consequence of non linear relationships of the flame-retardant effect with respect to flame-retardant concentration.^{4,5} Regardless of its cause, synergism is an effect of practical utility to the formulator, permitting lower total additive level to reach a given target result, or a better result at a fixed total additive level. For example, Granzow⁴⁰ showed that combinations of melamine pyrophosphate with two different types of phosphonates exhibited substantially greater-than-additive (synergistic) flame-retardant effects in polybutylene terephthalate.

A few other instances of such favorable interactions are reported, which may or may not be truly synergism, but which are nonetheless obviously useful. For example, combinations of ethylenediamine phosphate (available as Albright and Wilson's Amgard™ EDAP) and melamine phosphate are claimed to have advantageous flame-retardant properties in polyolefins and copolymers. A formulation to achieve the Underwriters' Laboratory UL-94 V0 rating (rapid extinguishment, no flaming drip) in EVA wire insulation is: 27% EDAP, 3% melamine phosphate, 10% pentaerythritol.⁴¹ Similarly, combinations of ethylenediamine phosphate and melamine phosphate were shown to be useful in oil-based intumescent putties.⁴²

Combinations of ammonium polyphosphate with a melamine phosphate are said to be useful in flame retarding polypropylene. A representative formulation is: 49.9% ammonium polyphosphate, 29.5% melamine phosphate, and 23.6% pentaerythritol or dipentaerythritol, mixed and added to polypropylene at 28.9% to obtain a V0 rating at 3.2 mm thickness.⁴³ A mixture of ammonium polyphosphate and melamine phosphate is also shown to be effective in highly alumina trihydrate-filled epoxy-based intumescent compositions.⁴⁴ Combinations of melamine phosphate with melamine isocyanurate are disclosed in combination with halogen additives and antimony in complicated flame-retardant epoxy formulations.⁴⁵

Comments on Smoke and Toxic Fumes

Char-forming flame-retardant systems such as intumescent coatings tend to have low visible smoke evolution. No general statement can be made regarding smoke from melamine phosphate-containing coating formulations, since if an organic binder is present, that component is likely to have a major influence.

Recent reviews of combustion toxicity point to carbon monoxide as the chief lethal and incapacitating gas in fire atmospheres, and the yield of carbon monoxide in a full scale fire appears to be more a function of burning conditions than of the material burning.^{46,47}

CONCLUSIONS

Deciding between the melamine phosphates for a given use will require that the compounder take into account the price, the relative performance (usually found out by actual testing), the water solubility, thermal stability, and ease of dispersion. Published comparisons of performance are rare or nonexistent. The salient points are:

(1) For the highest thermal stability and the lowest water solubility, melamine pyrophosphate is the preferred compound in the group;

(2) Where release of water as well as melamine is believed to be helpful, melamine (ortho)phosphate may have a possible advantage;

(3) Where it has been found experimentally that favorable flammability results are obtained by use of a formulation containing melamine itself plus a melamine phosphate, the formulator may find it advantageous (on the basis of performance or handling convenience) to use dimelamine phosphate instead of the separately added melamine and melamine phosphate; and

(4) Advantage may be taken of possible favorable interactions with combinations of melamine phosphates with ammonium polyphosphate. Results are unpredictable, but synergism is possible.

ACKNOWLEDGMENT

The authors thank Dr. Chia-Hui (Oliver) Huang for assistance in obtaining thermogravimetric curves, and Dr. B. Singh and the Information Services of American Cyanamid Company for aiding in the literature and patent retrieval.

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Evaluation of Corrosion Behavior of Metal-Filled Polymeric Coatings

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Pretreated steel samples have been coated with a layer (~250 μm) of a metal-filled (Ni, Cu, Fe) epoxy resin (Dow 324) deposited by a spinning process. The corrosion behavior of these specimens in 3.5% NaCl has been investigated by electrochemical impedance spectroscopy, Tafel measurements, and dielectric measurements undertaken in the frequency range of 20-10⁷ Hz. Correlation between the different approaches shows that coatings of epoxy resin composites filled with iron powder possessing higher ac resistance and lower capacitance are more protective than the pure epoxy resin coatings. On the contrary, copper or nickel powder addition leads to coatings which, though still protective, exhibit lower protection than the pure epoxy.

INTRODUCTION

The corrosion resistance of a polymer coated metal surface is generally considered to depend on the metal characteristics, the metal pretreatment, and several properties of the polymer (processability, chemical, electrical, thermal, and mechanical properties).^{1,2} Epoxies represent perhaps the best combination of corrosion resistance and mechanical properties^{3,4} when they are suitably crosslinked or copolymerized with other resins, notably those of the amine or polyamide family.⁵ Coatings based on epoxy resins and aminoplast crosslinkers show exceptional corrosion resistance due to the polymer resistance to degradation by corrosion generated hydroxide.⁶

Recent increasing technical demands justify recognition of composite coatings because of their contribution to structural, optical, and electrical needs.⁷ Metal coatings reinforced with glass, polyaramide, or graphite fibres are now

used⁸ as well as particulate polymeric composites with conductive fillers which enhance their thermal and mechanical properties.^{8,9}

Coatings with polyaramide or graphite fibres are considered corrosion resistant, despite the fact that when coupled to ordinary metals in the presence of most electrolytes, the coatings act like platinum or gold and promote the galvanic corrosion of any metal higher in the electrogalvanic scale. Little is presently known about the protective action of particulate polymeric coatings except for the zinc-rich coatings which are universally accepted as protective systems.

The study of other metallic fillers in polymeric matrices presents a challenge since either the metallic powders or their corrosion products may alter the protective performance of the coatings.

For the evaluation of the performance of an organic coating/metal system, electrochemical impedance methods find increasing use, due to the advantages they have over traditional dc measurements.¹⁰⁻¹⁵ Despite the large organic coating resistance, impedance methods provide quantitative kinetic and mechanistic information, even in aggressive media of low conductivity.

In common with other electrochemical processes, the steel corrosion and the behavior of polymer coatings can be described in terms of an equivalent circuit (*Figure 1a*). In this circuit, the bulk properties of the coating are represented as a resistance of the coating, R_f , and the geometrical capacitance, C_f , which is expressed by the formula:

$$C = \epsilon \cdot \epsilon_0 \frac{S}{l} \quad (1)$$

C , ϵ , S , l are respectively the capacitance, the permittivity, the area, and the thickness of the coating, ϵ_0 is the dielectric constant of vacuum (8.85×10^{-12} F/m); and Z is the faradaic impedance of the corrosion reaction at the base of the pores, or discontinuities of the coating. C_{dl} is the double layer capacitance at the base of the pores and R_e is the external electrolyte solution resistance.

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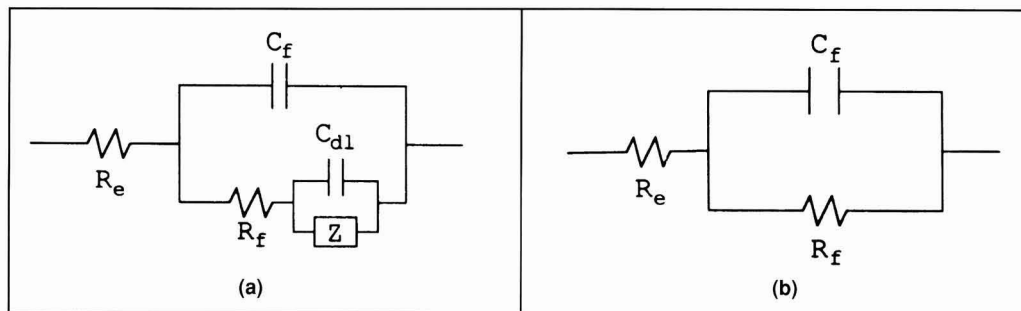


Figure 1—Electrical equivalent circuit generally accepted for a coated metal/solution interface without diffusion (a) and simplified electrical equivalent circuit in the high frequency range (b)¹⁵

If the time constant of the coating is sufficiently different from the characteristics of the electrode, the above circuit in the high frequency range becomes as shown in Figure 1b,¹⁶ which represents an intact coating or detached coating film.¹⁷ The hydration of the polymer coating is the first step in the kinetic model of corrosion or blistering of coated metals. The determination of water penetration in thin organic coatings by ac techniques has been summarized by Leidheiser,¹⁸ who later reviewed the understanding of the principles governing corrosion beneath organic coatings.¹⁹

In this work, the role of metal powders other than zinc in corrosion protective coatings was investigated. Pretreated steel specimens coated with a layer of metal-filled (Ni, Cu, Fe) epoxy resin were used. Composites of this type exhibited

increased conductivity,^{7,20} while some mechanical properties are enhanced.⁹ Thus the contemporary demands for combinations of functions were met. AC impedance and dc (Tafel) measurements were performed. An attempt was made to correlate the previous results with those of dielectric measurements undertaken also in the range of 20-10⁷ Hz, but in a test cell excluding the corrosive media.

EXPERIMENTAL

Materials

The test specimens were circular steel disks (diameter $\Phi = 6$ cm) with the following weight percent composition: C:0.12; Mn:0.5; P:0.005; S:0.05; and Fe to 100. The coating used was a commercially available bisphenol-A-type epoxy resin (DER 324, Dow Chemical Co.), with molecular weight 378, epoxide equivalent weight 197-206, and viscosity 600-800 mPa.s at 25°C. As curing agent, the product XZ87706.05 of Dow Chemical Co. was employed. The system was used either in this formulation or filled with powdered metals in a content of 15% by weight. Powdered metals were incorporated in the liquid state at 30°C. Metal powders of nickel (Merck), copper (Merck), and iron (Ferak Laborat) were used. Copper grain size was lower than 63 μm , nickel lower than 10 μm , and iron grains lower than 40 μm . The corrosion environment was a 3.5% NaCl solution prepared from analytical grade salt and deionized water.

Sample Preparation

The metallic substrate was cleaned by immersion in a strong solution of HCl with an organic corrosion inhibitor, washed with water, polished with emery paper (up to 000 grit), degreased for 10 minutes in boiling xylene,¹ and stored in a desiccator before coating. After being stirred thoroughly, each mixture was deposited on the metal surface by a spinning coater (Erichsen 334/E). Initial curing was carried out at ambient for 24 hr, followed by post-curing at 40°C for 48 hr. Then the specimens were immersed in the corrosive environment, i.e., in 3.5% NaCl solution. Uncoated specimens, as well as those coated only with epoxy resin, were used as reference specimens.

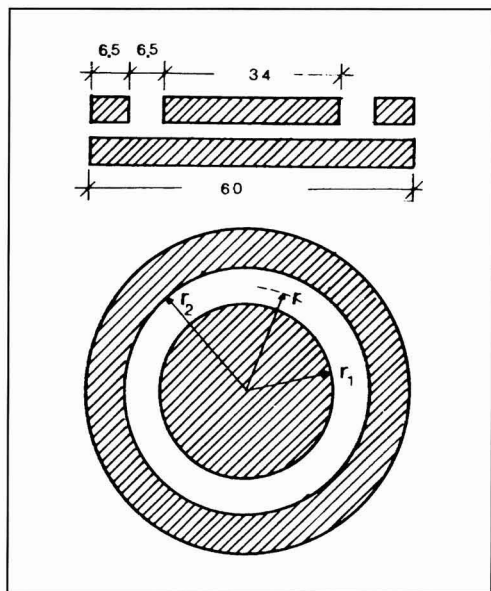


Figure 2—Electrode shape and dimensions in mm

Each type of measurement at every exposure time tested was performed on different specimens and was always duplicated. Thus 140 specimens having a dry film thickness at each surface equal to $250 \mu\text{m} \pm 20 \mu\text{m}$ were chosen from a greater production number.

Test Instrumentation and Conditions

The electrochemical cell for both ac impedance and Tafel measurements consisted of a hollow Teflon[®] cylinder clamped to the surface of the metal substrate and creating by an O-ring seal the vessel for the electrolyte (3.5% NaCl). The working electrode was the coated specimen having an exposed surface area equal to 19.63 cm^2 . The reference electrode was a saturated calomel electrode (SCE), while the auxiliary electrode was a high density graphite rod.

All measurements were carried out at ambient, with the electrolyte in contact with air. Before each measurement, the change in electrical potential was recorded until the corrosion potential, E_{cor} , was achieved. Tafel plots were performed on two separate specimens, one for the anodic and one for the cathodic polarization, using a Princeton Applied Research Model 331 potentiostat/galvanostat. The scan rate was always 1 mV/s.

The ac impedance measurements were performed using sine wave signals of 15 mV, by means of a Video bridge T-2100 of Electro-Scientific Industries Inc., in the frequency range of 20 Hz to 5 kHz, and by an impedance analyzer LF3192A of Hewlett Packard, in the frequency range 5 kHz to 13 MHz. Each value was the mean value of five measurements in a logarithmic sweep of the frequencies (20 points per logarithmic unit). Dielectric measurements were performed using the same apparatus. The test cell was a three terminal guarded system (Figure 2) constructed according to ASTM D150-83.²¹

RESULTS AND DISCUSSION

Steel Corrosion Rate Estimation

Epoxy coatings, generally crosslinked with amines or polyamines, are widely used as heavy duty moisture and chemical resistance coatings and linings in various environments, since they create a three dimensional protective network. This performance is shown in Figure 3 in which the potentiodynamic polarization plots for an uncoated specimen and the different types of coated steel specimens are given. Each plot represents a separate anodic and cathodic scan and is considered as the Tafel plot of a separate metal specimen. All types of coated specimens clearly show a better performance than that of uncoated specimens, despite the longer exposure time of the former in the corrosive environment. After 115 days the value of the corrosion current density of the specimens coated with epoxy resin is about 750 times less than that of the bare steel exposed in the corrosion environment for 35 days.

When conductive particles are dispersed in the epoxy resin, the dielectric permittivity of the composite increases; thus, the transport properties of the coating are significantly changed which also affects its protective properties. The addition of Ni, Cu, and Fe in the form of powder leads to

protective coatings (Figure 3). The composite with iron shows the best results, as the corrosion current density is reduced by 3×10^3 times compared to that of bare steel, which was exposed in the corrosive environment for a time interval three times less. Coatings of epoxy with copper and nickel powders exhibit almost similar protective behavior, which is, however, inferior to that of unfilled epoxy coatings. Based on the usual Tafel estimation of the corrosion current density, the rank order of the corrosion resistance of these specimens is the following:

Steel+Epoxy+Fe>Steel+Epoxy>Steel+Epoxy+Cu>Steel+Epoxy+Ni>Steel.

AC Impedance Measurements

Bode and phase angle plots corresponding to the circuit of Figure 1b for the coatings tested in this work are presented in Figures 4-9 versus immersion time. Representative Bode plots of all types of specimens after just a few minutes of immersion ($t = 0$) and also for 37 and 115 days of immersion are given in Figures 4-6. Initially, all specimens have almost the same impedance values, about $10^8 \Omega$, corresponding to $5 \times 10^6 \Omega/\text{cm}^2$. The resistance of the coating is a measure of its corrosion protective properties and the value lies near the suggested limit, where corrosion beneath the coating is occurring at a rate one should be concerned about ($<10^7 \Omega/\text{cm}^2$).¹⁸ After 37 days of immersion in the corrosive environment, the specimens continue to present the same behavior independent of coating type and their impedance is slightly reduced to the value of about $2 \times 10^7 \Omega$ or $9 \times 10^5 \Omega/\text{cm}^2$. At longer exposure times, e.g 115 days (Figure 6), impedance values have differentiated, depending on the coating type. The coating with iron powder shows the least decrease in impedance ($\sim 4 \times 10^5 \Omega/\text{cm}^2$), while those with nickel powder show the most ($\sim 0.6 \times 10^3 \Omega/\text{cm}^2$). A classification for the different coating types, based on the impedance value for 115 days exposure, leads to the following rank order:

$$Z_{\text{ep+Fe}} > Z_{\text{ep}} > Z_{\text{ep+Cu}} > Z_{\text{ep+Ni}}$$

The same results can be also deduced from phase angle plots (Figures 7-9). It is clear that processes occurring in the first 37 days do not affect the peaks of the plots in all cases, but after 115 days of exposure the maximum phase angles are shifted to lower frequencies. This shift is greater for

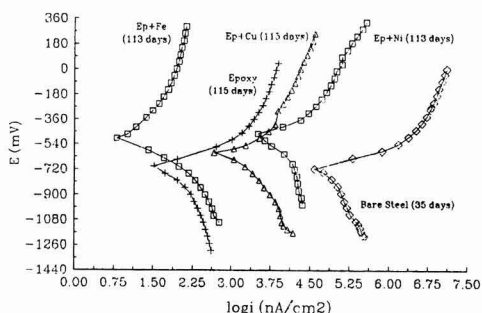


Figure 3—Potentiodynamic polarization plots for uncoated and epoxy coated steel specimens in 3.5% NaCl

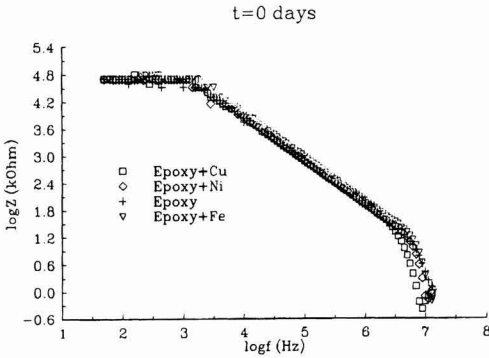


Figure 4—Bode plots for uncoated and different types of epoxy coated steel specimens just after the immersion in 3.5% NaCl solution

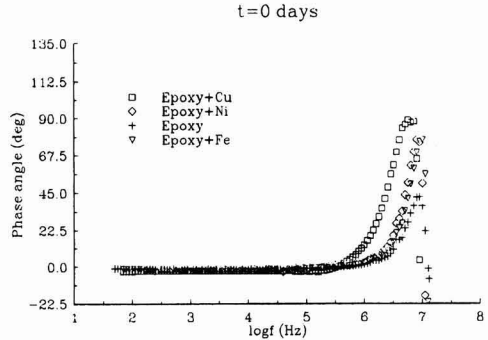


Figure 7—Phase angle plots for uncoated and different types of epoxy coated steel specimens just after the immersion in 3.5% NaCl solution

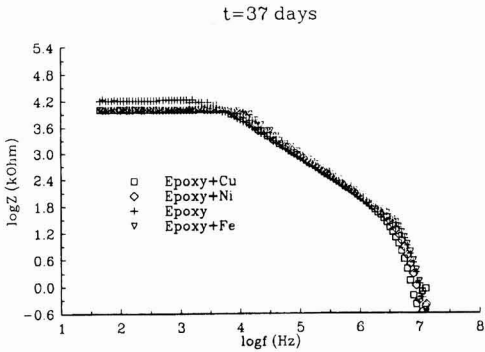


Figure 5—Bode plots for uncoated and different types of epoxy coated steel specimens exposed to 3.5% NaCl solution for 37 days

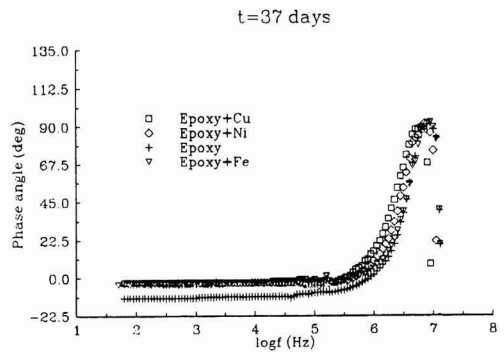


Figure 8—Phase angle plots for uncoated and different types of epoxy coated steel specimens exposed to 3.5% NaCl solution for 37 days

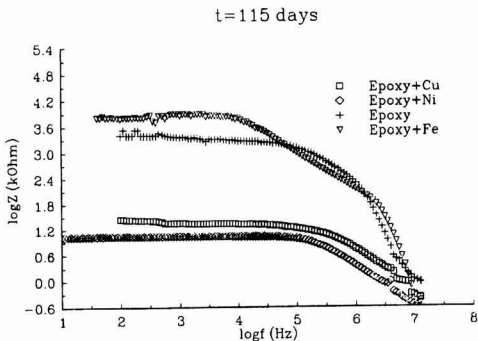


Figure 6—Bode plots for uncoated and different types of epoxy coated steel specimens exposed to 3.5% NaCl solution for 115 days

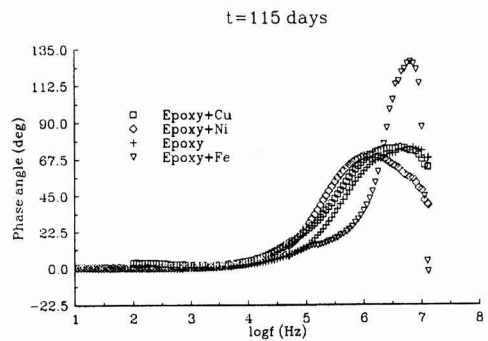


Figure 9—Phase angle plots for uncoated and different types of epoxy coated steel specimens exposed to 3.5% NaCl solution for 115 days

coatings containing nickel powder and less for those containing iron powder. This high frequency maximum phase angle shift is related to an increase in the area of the metal exposed to the corrosive environment through the defects of the coating.²² These defects are increased with the immersion time because of the polymer swelling in the electrolyte.

The addition of powders in the polymer affects its protective properties either by filling the micropores of the polymer and thus exerting a barrier effect which reduces the substrate corrosion rate, or by creating conductive paths, which, in the case of nickel or copper addition, accelerates the steel substrate corrosion rate, due to galvanic corrosion. In the case of iron powder, the absence of galvanic corrosion reveals the positive influence of micropore filling, either by the powder grains or by the bulky corrosion products. This assumption explains the behavior shown in previous plots (Figures 3-9), that is, the iron-filled coatings are the most protective, while those with nickel or copper, though still protective, exhibit lower protection than the epoxy without filler.

The mechanism is the same as one of those accepted for sacrificial coatings which contain an active pigment, such as zinc, in galvanic contact to a more noble metal. These coatings are reported²³⁻²⁵ to provide excellent barrier protection for steel due to the growth of a voluminous zinc oxide or various zinc corrosion products, such as zinc hydroxides, carbonates, and others which seal the defects in the highly porous matrix of the coating.

Assessment of Coatings Behavior

Hydration of polymer coating is the precursive step in the corrosion mechanism of coated metal, because the water uptake provides the electrolytic medium in which entities in the coating can move easier, reducing the coating resistance. Hydration also affects coating capacitance values, thus providing a comparative measure of protective behavior.

Capacitance of the different coatings were obtained in the three terminal guarded cell in the frequency range of 20-10⁷ Hz. Results related to high-, medium-frequency part of the impedance spectra of polymer coated metals (model of Figure 1b) are the values of capacitance measured at 10 kHz, which are plotted in Figure 10. In all cases, curves follow the same general trend, i.e. there is first a period of decreasing, followed by a period of increasing, and finally they reach a stable level of capacitance.

The decrease of the capacitance in the early immersion times has been observed also by other workers¹⁶ and it has been attributed either to the fact that the water is not randomly distributed in the polymer coating, or to additional internal stresses in the coating created by the water uptake and the swelling. These changes are able to lower the dielectric permittivity.²⁶ Another suggested influence is the adsorption or reaction of water which may change the dielectric behavior of the polymer coating.¹⁶

Even though the capacitance value of the coating with iron powder is greater than that of the epoxy resin, as expected²¹ before immersion in the corrosive environment (25.74 pF versus 25.04 pF), it appears during the exposure to acquire steady-state capacitance less than but near to that of the epoxy resin. Nickel and copper coatings acquire steady-state capacitance with values higher than those of the epoxy

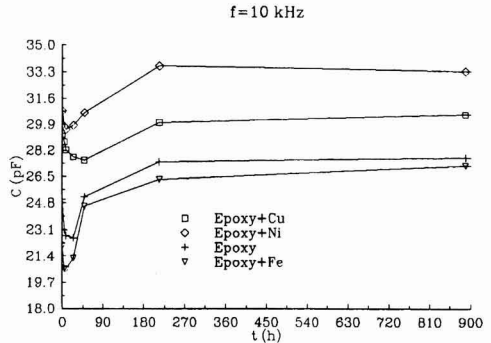


Figure 10—Capacitance versus immersion time in 3.5% NaCl solution for uncoated and different types of epoxy coated steel specimens

resin, in accordance with previous comments. The change of capacitance is affected by the dielectric permittivity increase, because of water penetration and the swelling of the coating.

In Figure 11 the corresponding percent water uptake of the coatings tested is given versus immersion time, as determined by the mathematical expression of Bracher et al.:^{27,28}

$$\frac{C_t}{C_0} = 80^x \quad (2)$$

where C_t and C_0 are respectively the capacitance at time t of immersion and the initial capacitance of the coating, x is the volume fraction of water inside the coating, and 80 is the dielectric permittivity of water.

It is clear that after a relatively short immersion time, the water uptake in all cases reaches a stable level; the value of which depends on the coating type. Generally, low values of steady-state capacitance can be attributed to low water uptake, but in Figure 11 this behavior is not followed. The coating with iron powder shows the greatest water uptake value, in spite of its low steady-state capacitance and its better corrosion protection properties. This could be attributed to the fact that iron shows good catalytic properties in

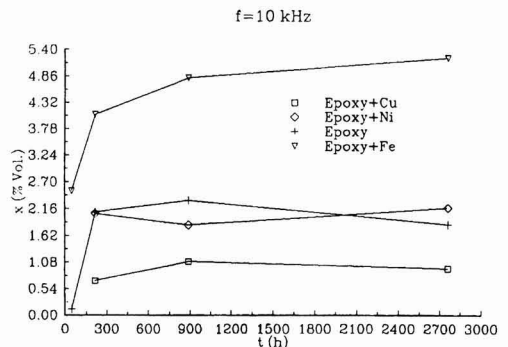


Figure 11—Water uptake versus immersion time in 3.5% NaCl solution for uncoated and different types of epoxy coated steel specimens

the cathodic oxygen reduction reaction $1/2 O_2 + H_2O + 2e \rightarrow 2OH^-$, leading to accelerated oxidation of the metal powder and thus producing bulky corrosive products, which fill the micropores of the polymer and increase the coating resistance.

Differences in the catalytic properties of metals for the cathodic reaction that occurs in corrosive environments of the type used, as well as differences in the nature of corrosive products, which might increase the coating uptake of water due to osmotic processes,²³ could explain differences in behavior shown in Figures 10 and 11. This is ascertained also by other workers,^{16,18} where it is stated that interaction between water, polymer coating, and metallic substrate (i.e., what is reflected by capacitance measurements), rather than the water concentration in the polymer, is the controlling factor in the corrosion protection performance of a coating.

Ratings of Visible Damage

Visual examination of test specimens at the end of exposure time revealed no significant damage in all cases, with respect to blistering (ASTM D 714-87) and rusting (ASTM D 610-85). Blistering ratings could be classified as 6 few for coatings containing iron and 4 few for those with nickel and copper. Corresponding rating for rusting is 8 (0.1% of surface rusted) and 7 (0.3% of surface rusted).

CONCLUSIONS

The corrosion protective behavior of coatings composed of epoxy resin and epoxy resin composites with metal powders (Cu, Ni, Fe) investigated by impedance spectroscopy, and the corrosion rate of the steel substrate measured according to the electrochemical Tafel method, lead to the same conclusions as dielectric measurements performed with a specially designed test cell which excludes the corrosive environment during measurements.

Coatings composed of epoxy resin filled with iron powder exhibit lower values of steady-state capacitance and higher impedance values, thus showing the best performance and leading to lower corrosion rates of the steel substrate. Nickel or copper powders in coatings with epoxy resin reduce corrosion protection performance of the epoxy coatings though they continue to be protective. Corrosion performance cannot be evaluated from the water uptake alone, but other factors must also be considered, e.g. the catalytic behavior of the metal powder towards the cathodic reaction and the nature of the corrosion products.

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Polymers for Water-Based Coatings— A Systematic Overview

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The various types of polymers used in waterborne coatings are reviewed systematically from the point of view of the methods of synthesis and their principal physical characteristics. The polymer types range from the two extremes of dispersions of highly insoluble polymers in water to highly water-soluble polymers, and cover a whole range of intermediate types, such as hydrophobically modified water-soluble polymers, swollen microgels, alkali soluble emulsions, alkali swellable emulsions, and water-reducible polymers. The key properties of each type are discussed with reference to the ways they are utilized in aqueous coatings and their film forming behavior.

Particular emphasis is placed on key developments over the years, and on more recent developments, such as associative thickeners, aqueous dispersions of step growth polymers (notably aqueous polyurethanes), hybrid systems in which more than one polymer type is combined in the same system, aqueous radiation curing, voided polymer particles, and sequential polymerization techniques to give control over the morphology of emulsion polymer particles. The paper ends with a discussion of some of the deficiencies of waterborne coatings which will need to be addressed in the future.

INTRODUCTION

The advent of waterborne coatings has brought challenges and opportunities to the polymer chemist and continues to do so. Many important advances have taken place in recent years in terms of polymeric binders, polymeric dispersants, polymeric thickeners, and polymeric colloid stabilizers.

Central to the utilization of polymers in aqueous media is the fact that certain polar functional groups are capable of conferring water solubility or water dispersibility to an oth-

erwise water-insoluble polymer. Best known are carboxylic acid groups, sulphonic acid groups, and tertiary amine groups. The concentration of such functional groups in the polymer is highly influential in determining the state in which the polymer will exist in an aqueous environment. Thus, at high concentrations, the polymer may be water soluble, and at lower concentrations the polymer may be water dispersible provided its molecular weight/viscosity is not excessive. At even lower concentrations, the polar group may be capable of providing charge or steric stabilization to a dispersion of the polymer in water.

Because there is a whole range of synthetic routes available for the preparation of aqueous polymers, and because the polymers can differ widely in terms of (1) the nature and concentration of the polar solubilizing group, (2) molecular weight, and (3) the hydrophobic/hydrophilic characteristics of the other units in the polymer chain, aqueous polymer systems with a wide-range of different morphological and physical characteristics can be obtained. Many such systems are utilized in surface coatings; some are well-characterized and understood while others are not. This paper attempts to discuss the various types of polymers in a logical way in terms of their methods of preparation, their physical characteristics, and some of their uses in the surface coatings industry. This attempt to classify aqueous polymers is made difficult by the fact that there is no clear cut demarcation between the various polymer types, as is discussed in the following sections.

SOLUBILIZING GROUPS

There is a very wide range of polar water solubilizing functional groups known. These functional groups can be broadly classified into the three categories of anionic, cationic, and nonionic (i.e., nonionizable). The most commonly utilized functional groups conferring water solubility include weak acids (carboxylic), strong acids (sulphonic), weak bases (amine), strong bases (tertiary and quaternary ammo-

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nium compounds), and nonionizable groups (ethylene oxide, vinyl pyrrolidone). In the cases where the functional group is ionizable, the water solubilization effect is greater when the group is in its ionized (salt) form. Therefore, many copolymers containing ionizable water solubilizing groups are water soluble in the pH region over which the group is substantially ionized, and water-insoluble in the pH region over which the group is substantially un-ionized. For example, copolymers containing weak carboxylic acid groups (e.g., from acrylic acid) are often water soluble (depending on the concentration of acrylic acid) at pH values above the pK_a of acrylic acid (~4.2) and water-insoluble below this pH value. Conversely, basic polymers containing, for example, tertiary amine groups, are soluble (assuming a sufficiently high concentration of functional groups) at low pH values (i.e., below the pK_a) and insoluble above this pH. This switch in solubility with change in pH is widely utilized as the basis of anodic and cathodic electrodeposition since large changes in pH are experienced at the anode and cathode.

Similarly, where the ionizable functional group is utilized to provide charge stabilization to a polymer colloid in water, the stabilizing effect is highly dependent upon the pH of the system. A change in pH can bring about a total loss in colloid stability; this effect is also used advantageously in electrodeposition.

CLASSIFICATION OF SYNTHETIC POLYMERS USED IN AQUEOUS MEDIA

It is useful to classify the polymers in two distinct ways: (1) based on the synthetic procedure; and (2) based on the physical state of the polymer in water, e.g., highly water-soluble, water-insoluble dispersion, etc.

In this paper both these classifications will be discussed since neither alone brings out all the important aspects.

Classification According to Synthetic Procedure

Two main categories can be defined: (1) polymer synthesized in the presence of water; and (2) polymer synthesized in the bulk or in solution in an organic solvent (usually water miscible) and subsequently added to water.

In the former category, polymerization can be either by free-radical or step-growth polymerization. Ionic polymerization procedures can be virtually ruled out as such polymerizations cannot be performed in the presence of water. An interesting recent development is the ruthenium

catalyzed ring opening metathesis polymerization which can be conducted in water¹ and can give an aqueous polymer dispersion.²

SYNTHESIS PERFORMED IN THE PRESENCE OF WATER: The main procedures falling within this category are summarized in *Table 1*.

Some of the main features of each procedure are briefly discussed in the following:

—Emulsion polymerization is the most widely practiced of the procedures and is characterized by the fact that a free radical initiator (usually water soluble) is used to polymerize free radically polymerizable monomer(s) to give a water-insoluble polymer. In general, the monomers have a low but finite water solubility, although it is common practice to also incorporate water-soluble acid co-monomers, such as acrylic acid and methacrylic acid. Emulsion polymerization differs mechanistically from the other forms of radical polymerizations and exhibits the industrially important characteristic of being able to simultaneously obtain both high molecular weight polymer and high polymerization rate. Furthermore, the viscosity of the resultant emulsion is not molecular weight dependent; hence, the ability of this procedure to prepare very high-molecular weight polymers can be fully utilized. Emulsion polymerization gives particles in the diameter range ~50-500 nm, with the ability to accurately control particle size. Particle stability is usually achieved through the use of adsorbed surfactants, often in conjunction with the stabilizing effect of charged polymer end groups (e.g., sulphate groups from persulphate polymerization initiators) and the stabilizing effect of ionic groups arising from the presence of minor proportions of ionic comonomer (e.g., carboxylate groups from acrylic acid and sulphonate groups from sulphoethyl methacrylate). Emulsion polymers are widely used in waterborne paints.

—Suspension polymerization differs from emulsion polymerization in that a monomer soluble free radical polymerization initiator is utilized to polymerize essentially water-insoluble monomers. The polymerizations can be regarded as a set of bulk polymerizations taking place in each monomer droplet, and thus molecular weight is inversely proportional to initiator concentration and polymerization rate as is typical of a bulk radical polymerization. Particle stabilization is usually through the use of adsorbed water-soluble polymers such as partially hydrolyzed polyvinyl acetate and acrylic acid copolymers, and particle size is generally in the range 0.01-1 mm. The relatively large particle size of suspension polymers facilitates the isolation of polymer particle (e.g., by centrifugation) and such "beads" are widely utilized in solvent-borne surface coatings and in photocopy toner resins. Suspension copolymers containing sufficient carboxylic acid comonomer to be alkali-soluble are utilized at alkaline pH in printing inks. As a result of the large particle size, suspension polymers are rarely directly utilized in the form of the aqueous dispersion because settlement and film forming problems would be expected.

—Free radical solution polymerization is characterized by the feature that monomer(s), initiator, and polymer are soluble in the continuous phase, which may be either water or a water/solvent mixture. Examples of appropriate monomers are acrylic acid, acrylamide, N-vinyl pyrrolidone, and

Table 1 — Synthesis Performed in the Presence of Water

- Emulsion polymerization
- Suspension polymerization
- Aqueous solution polymerization (i.e., both monomers and polymer water-soluble)
- Dispersion polymerization
- Inverse emulsion polymerization
- Polymerization in miniemulsions
- Polymerization in microemulsions
- Micellar polymerization
- Post reaction in water of a naturally occurring or synthetic water-soluble polymer

2-acrylamido-2-methyl-propane-sulphonic acid. This procedure is utilized for the preparation of dispersants and thickeners. Associative thickeners³ can be prepared by utilizing a co-monomer bearing a hydrophobic group capable of associating in water, or by introducing such a hydrophobic group by a subsequent reaction with the water-soluble polymer.

—Dispersion polymerization entails the polymerization of monomers which are soluble in a liquid medium to produce a polymer which is insoluble in the liquid medium. If the polymerization is performed in the presence of an appropriate colloid stabilizer, the polymer precipitates to produce a stable polymer dispersion. While nonaqueous dispersion polymerization is the best known example of this process,⁴ a free radically initiated dispersion process has been described in which the continuous liquid phase is a miscible water/alcohol mixture⁵ and in which a copolymerizable surfactant is utilized.

—Inverse emulsion polymerization⁶ entails the emulsification of an aqueous monomer solution in a continuous oil medium using a water-in-oil emulsifier, and polymerizing using an oil- or water-soluble polymerization initiator to give submicron water swollen polymer particles dispersed in oil. This process gives the characteristic benefits of emulsion polymerization previously mentioned, i.e., high-molecular weight polymers produced at high-polymerization rate, high-solids and low-viscosities. The most practically important feature is that addition of excess water causes inversion and rapid dissolution of the water swollen polymer particles, even when the polymer is of very high molecular weight and might otherwise be very slow to dissolve. Typical monomers which can be used in this process are acrylamide, acrylic acid, and 2-sulphoethylacrylate. This process is widely utilized for the preparation of high-molecular weight flocculants, but is rarely used for making water-soluble additives for surface coatings.

The techniques of aqueous polymerization in monomer miniemulsions,⁷ monomer microemulsions,⁸ and monomer vesicles⁹ have been extensively studied in recent years; however little, if any, practical exploitation in surface coatings has been found.

A micellar polymerization process has been described¹⁰ which utilizes a surfactant to solubilize a water-insoluble monomer to facilitate its copolymerizations with a water-soluble monomer. Valint et al.¹¹ have studied a polymerization in which sodium lauryl sulphate was used to solubilize the hydrophobic monomer N-4-butyl phenyl acrylamide in water, and in which acrylamide was dissolved in the aqueous phase. The polymerization was initiated with the water-soluble initiator potassium persulphate. The final polymer composition was found to be close to the composition of the original monomer mixtures, although polymer composition varied as a function of conversion implying that the resultant copolymer was compositionally heterogeneous. Polymers made by this micellar polymerization procedure have been studied as associative thickeners.³

PREFORMED POLYMER SUBSEQUENTLY ADDED TO WATER: The main procedures can be classified as:

(1) Free radical addition or step-growth polymerization in the bulk to give a low or medium molecular weight polymer in which the water solubilizing group is incorpo-

rated via one or more of the co-monomers, followed by addition to water (or vice versa). In some instances, chain extension is carried out during or subsequent to the addition to water.

(2) Free radical addition or step-growth polymerization in the bulk, with subsequent functionalization to introduce a water solubilizing group, followed by addition to water (or vice versa).

(3) Free radical addition or step-growth polymerization in a water-miscible cosolvent or a water/cosolvent mixture with incorporation of the water solubilizing group via one or more comonomers, followed by addition to water (or vice versa) and in some instances cosolvent removal.

(4) Free radical addition, step-growth, or ionic polymerization in a solvent, with subsequent functionalization to introduce a water-solubilizing group, followed by addition to water and in some instances cosolvent removal.

While all of these procedures are industrially practiced in the preparation of binders for surface coatings, procedures (1) and (3) are probably the most widely utilized.

An important feature of this type of approach is that the viscosity of the polymer should be sufficiently low to allow subsequent dispersion or dissolution in water. The necessary low viscosity is achieved by a number of techniques: (1) limiting the polymer molecular weight, (2) adding the polymer as a solution in solvent (which may or may not be the polymerization solvent) or (3) adding the polymer at elevated temperature to the water. Each of these three approaches to reducing viscosity is exemplified in the various routes for preparing aqueous polyurethanes as is described later.⁽¹⁾

Agitation conditions can be highly important when carrying out such processes, especially when the concentration of water solubilizing functional groups is low and the desired product is an aqueous dispersion. In general, higher viscosity/high-molecular weight polymers can be utilized when high-shear agitation conditions are employed. Both shear and the viscosity of the dispersed (polymer rich) phase are highly influential in determining the particle size of the final dispersion, as is demonstrated by the following relationship¹² for the attainable particle diameter d in a dispersion process.

$$d = \frac{G_i}{\gamma \eta_{\text{cont}}} f \left(\frac{\eta_{\text{disp}}}{\eta_{\text{cont}}} \right)$$

where G_i = polymer-water interfacial tension
 γ = shear rate
 η_{disp} = viscosity of dispersed (polymer) phase
 η_{cont} = viscosity of continuous phase

Equation (1) is useful for the current discussion. Not only is the dependence of attainable particle size on the viscosity of the dispersed (polymer) phase and the shear rate indicated, but the importance of the polymer water interfacial tension is also highlighted. As would intuitively be expected, the final attainable particle diameter decreases (an indication of increasing ease of dispersion) as the interfacial tension decreases. Such a decrease in interfacial tension can be obtained by the inclusion of water-solubilizing functional groups or by the addition of an appropriate surfactant. In many instances, it is not necessary to utilize a surfactant for this

purpose as inclusion of the water-solubilizing functional groups causes a sufficient reduction in interfacial tension to achieve the desired reduction in particle size; this situation is frequently encountered with carboxylated urethanes when very low particle sizes (typically 30-100 nm) can be achieved in the absence of surfactant and under low shear agitation conditions. It is worth pointing out that it is not only the ability to achieve low particle size, which is important, but also the ability to maintain the colloid stability of the low particle size dispersion which has been created. Thus, it is necessary to either select a water-solubilizing functional group which provides adequate colloid stability at the relevant pH and ionic strength or introduce an appropriate surfactant for this purpose.

Another important factor involved in dispersing a preformed polymer in water is the order of addition. When water is added to the polymer (or to a solution of polymer in organic solvent), an inversion process occurs at some stage during the addition; this inversion corresponds to the composition at which the continuous phase switches from being the polymer phase to being the water phase. Such inversion processes can be very critical to manage and generally involve passing through a maximum in viscosity.

Aqueous step-growth polymers made by the subsequent addition of a preformed polymer to water include polyurethanes, polyesters, alkyds, and epoxies. An example of the use of free radical polymers in this type of process is the so-called "water-reducible acrylics" in which (meth)acrylic monomers, at least one of which is acid functional, are copolymerized in water-miscible cosolvent. A solution of the neutralized polymer can be diluted by the addition of water. The diluted system is not a true solution, and upon dilution with water, the viscosity can go through a maximum. Zhey-Zhong Jin et al.¹³ showed such a viscosity maximum on addition of water to a solution in n-butanol of an acrylic polymer containing 10 wt% of copolymerized acrylic acid. In comparison, the corresponding polymer containing 26 wt% of acrylic acid behaved as a conventional solution polymer, with the viscosity progressively decreasing upon dilution with water.

Water-reducible polymers are widely used in the surface coating industry. For example, hydroxyl functional water-reducible acrylics are sold as solutions in water-miscible solvents for use as industrial coatings for metals. The purpose of the hydroxyl functionality is to give crosslinking when the systems are formulated with melamine formaldehyde (MF) resins and baked under typical MF curing conditions.

Classification According to Physical State

The precise physical nature of the aqueous polymer system obtained using the various synthetic procedures outlined in the previous section is very dependent on a number of variables, some of which relate to the polymer itself (molecular weight, concentration, and nature of the solubilizing groups, backbone hydrophobicity, crosslinking), some of which relate to the synthetic process employed (shear and surfactant content), and some of which relate to the aqueous solution/dispersion itself (pH, polymer concentration, and ionic strength).

In this section, an attempt is made to classify the types of system which can be obtained.

The two extreme ends of what can be regarded as a continuous spectrum of physical states are:

(1) Systems in which the polymer is highly water soluble over the entire pH range, e.g., polyethylene oxide homopolymer; and

(2) Systems in which the polymer is highly water-insoluble, exists as an aqueous dispersion of the polymer throughout the pH range, and has the minimum concentration of water-solubilizing groups and surfactant to ensure colloid stability of the dispersed polymer particles, e.g., emulsifier-free polystyrene latex.

Between these two extremes is a whole range of possible intermediate states, many of which are utilized in the surface coatings industry.





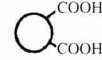
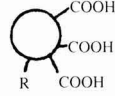
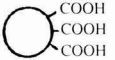
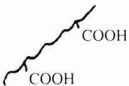
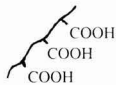
Discussion of these intermediate states is made difficult by the fact that some are not well-characterized, and the fact that there is no clear cut demarcation between the various types. Nevertheless, since it is instructive to do this, an attempt to identify various intermediate states is made in *Table 2*. In the example selected, the water-solubilizing group is carboxylic acid (from acrylic acid) because of both its practical importance and also because the group can exist in both ionized or un-ionized form, depending on pH. *Table 2* schematically illustrates the practically important situations in which free radical polymerization is conducted at an acid pH (as is the case, for example, in persulphate initiated emulsion polymerization) and in which the final aqueous polymer system is subsequently neutralized by addition of a base such as ammonia.

At one end of the spectrum lies polyacrylic acid, a polymer which in the normally encountered molecular weight range is highly water soluble over a wide pH range, even at high ionic strengths. Polyacrylic acid is used as a flocculant (high molecular weights) and as a thickener in aqueous coatings (moderate molecular weights). Solutions of polyacrylic acid in water progressively increase in viscosity as the pH is increased, an effect which at its simplest level can be explained by the progressive increase in ionization and hydration of the carboxyl group, with the mutual ionic repulsion between the ionized groups causing the molecules to adopt a more expanded conformation, with a consequent increase in intermolecular entanglement and hence in viscosity.

At the other end of the spectrum lies a polymer dispersion based on a polymer in which all the constituent co-monomers are highly water-insoluble (i.e., contains no acrylic acid or other water-soluble monomer) such as polystyrene or polybutyl methacrylate, with colloid stability being achieved by the use of an adsorbed surfactant which is effective throughout the pH range, and/or initiator derived charged polymer end groups. In such a system, the polymer molecules are likely to adopt a similar (but not identical) conformation and packing to that which they would adopt in the bulk.

Moving progressively away from this latter extreme situation, one can consider the same polymer dispersion in which a low concentration of acrylic acid (1-5%) has been incorporated by copolymerization, e.g., butyl-methacrylate-acrylic acid. Such a dispersion is typical of what is frequently used

Table 2 — Spectrum of Polymer Types Acrylic Acid (AA) Containing Polymers Prepared by Free-Radical Polymerization in Water

Schematic (of Acidic pH Form)	Description	Characteristics
	Polymer contains no deliberately introduced acid co-monomer. Polymer highly insoluble throughout pH range.	Little or no increase of particle size and viscosity on neutralization. Viscosity independent of polymer molecular weight.
	Low concentration of AA (1-2%). Hydrophobic co-monomer (e.g., styrene).	Very little increase of particle size and viscosity on neutralization. Viscosity very little dependent on polymer molecular weight.
	Low concentration of AA (1-7%). Less hydrophobic co-monomer.	Particle size and viscosity increase on neutralization due to swelling.
	Polymer crosslinked. Intermediate concentration of AA (10-25%).	Particle size and viscosity increase on neutralization, but no polymer dissolution occurs.
	Uncrosslinked polymer. Intermediate concentration of AA (10-25%).	Pronounced viscosity increase on neutralization.
	Uncrosslinked polymer. High concentration of AA (25-50%). Contains terminal hydrophobic associating groups.	Viscosity increase on neutralization. Rheological properties affected by hydrophobic associations.
	Uncrosslinked polymer. High concentration of AA (25-50%).	Very pronounced increase in viscosity on neutralization due to dissolution.
	Acrylic acid-rich copolymer which are soluble at low pH.	Viscosity increases on neutralization. Viscosity very molecular weight dependent.
	Polyacrylic acid.	Viscosity increases on neutralization. Viscosity very molecular weight dependent.

Note: Figures given for AA concentration are only indicative.

in practice in latex paints, with the acrylic acid being incorporated in order to improve adhesion, pigmentability, and colloid stability. Provided that the colloid stability of such a dispersion is not dominated by adsorbed surfactant, then the copolymerized acrylic acid contributes to the colloid stability, with the stability increasing with increasing pH due to progressively increased degree of ionization of the copolymerized acrylic acid. This effect is demonstrated in *Figure 1* which shows the increase in critical flocculation concentra-

tion (to added electrolyte) with increase in pH in a vinylidene chloride/vinyl chloride emulsion polymer containing 2% acrylic acid and only a very small concentration of adsorbed surfactant (0.1% anionic surfactant on monomers). In contrast, the corresponding latex, which contains no acrylic acid, is less stable, and the stability is pH independent.

In the system previously described in which the co-monomers (mainly vinylidene chloride and vinyl chloride) are hydrophobic, little if any viscosity increase occurred on

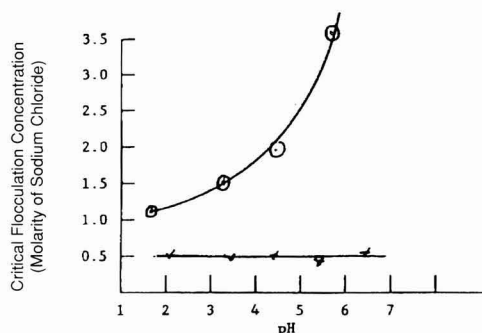


Figure 1—Effect of pH on latex stability: ○—2% acrylic acid; ×—0% acrylic acid

neutralization even at the high polymer solids content of 42% by volume. On the other hand, Quadrak and Snuparek¹⁴ have shown that less hydrophobic latexes based on ethyl acrylate and containing 1 and 2% acrylic acid and with a polymer solids content of 40% exhibited a steep rise in viscosity as the solids content increased because of the increase in volume fraction due to swelling.

High concentrations of acrylic acid can be utilized in an emulsion polymerization conducted at low pH (i.e., $< pK_a$ of the acid co-monomer). As the concentration of acid in the final polymer is progressively increased, the extent of swelling neutralization increases. Further increase in the acrylic acid concentration eventually results in a product which is highly water soluble at alkaline pH. Systems of this type are utilized as binders for printing inks, with the alkali solubility being an important characteristic as it leads to easy "clean up" of printing rollers, etc. Such systems are also utilized as alkali strippable temporary coatings. Another use is in strippable floor polishes in which the carboxylated polymer is crosslinked with divalent zinc ions to provide an abrasion resistant coating, but which can be stripped off from the substrate by the addition of aqueous ammonia which solubilizes both the zinc ions and the acrylic acid functional polymer. A very important use is as a thickener in latex paints, frequently known as alkali soluble or alkali swellable thickeners (AST). When the AST is prepared by emulsion polymerization, it is usually referred to as an alkali swellable or alkali soluble emulsion (ASE).

Emulsion polymers which have a low acid co-monomer concentration, increase progressively in viscosity on neutralization by swelling, whereas polymers which have a high acid concentration progressively increase in viscosity by swelling followed by dissolution. However, at intermediate acid concentrations, a viscosity maximum can be obtained on neutralization. Quadrak and Snuparek¹⁴ reported that ethyl acrylate/methacrylic acid emulsion polymers exhibited viscosity maxima when the methacrylic acid (MAA) concentration was in the range 20-40%, but not at low concentrations of methacrylic acid (5 and 10%) or high concentrations (55%).

In discussing these results at intermediate concentrations of methacrylic acid, Quadrak and Snuparek¹⁴ attributed the

steep decrease in viscosity for the base addition (i.e., past the viscosity maximum) to a break-up of highly water swollen particles into a system of supermolecular polymer aggregates. Thus, although the polymer clarifies on neutralization, complete dissolution does not take place, and the system contains a considerable proportion of refractive index-matched insoluble aggregates which are not visible to the naked eye.

The importance of the nature of the co-monomer is just as great for medium and high acid content polymers as for the low acid content polymers discussed previously. The extent of viscosity increase on neutralization very much depends upon the hydrophilic-hydrophobic nature of the monomer(s) copolymerized with acrylic acid. Loncar¹⁵ et al., studied the alkali swellability of carboxylated copolymer emulsion which varied in the type of hydrophobic co-monomer. A comparison of methyl methacrylate-MAA and styrene-MAA emulsions containing higher levels of acid monomer showed that the former swelled extensively on neutralization, whereas the latter showed very little change in swelling (i.e., in particle size and viscosity). Shay¹⁶ has reviewed the factors affecting the thickening, swelling, and dissolution behavior of conventional ASE polymers.

An interesting situation arises when a highly carboxylated polymer is crosslinked by the inclusion of a difunctional monomer during the polymerization because the polymer cannot be alkali soluble, and instead extensive swelling takes place which is accompanied by a major change in rheological properties. Such highly carboxylated "microgels" are discussed more extensively in the next section.

Other interesting variants of the alkali swellable and alkali soluble polymers are those in which the polymer also contains "associative" groups. The associative groups are generally incorporated by utilizing a highly hydrophobic monomer, or by post reaction of an existing alkali swellable/soluble polymer to incorporate the hydrophobic group. The association effect is responsible for enhanced thickening and unique rheological properties. A wide-range of synthetic routes to hydrophobically modified water-soluble polymers have been reported and are discussed later.

In the beforementioned discussion, the examples chosen for the various physical states of carboxylated aqueous dispersion were all products of free radical polymerization process (mainly emulsion polymerization) carried out in water using acrylic acid as co-monomer. Analogous series of polymers based on other water-solubilizing groups (sulphonic acid) can be prepared. The water-solubilizing group can be cationic (e.g., introduced by copolymerization with dimethylaminoethyl methacrylate), in which case the pH dependence is reversed. When dispersing preformed polymers in water, it is possible to achieve physical states which can be regarded as corresponding to some (if not all) of the intermediate states previously discussed and summarized in Table 2. For example, Reynolds¹⁷ prepared low molecular weight (~16,000) neutralized sulphonate functionalized aqueous polyesters based on the use of sodium sulphoisophthalic acid which were shown to be in the form of aqueous dispersions that were swollen with water. The extent of swelling depended on the concentration of sulphonate groups and on the hydrated radius of the counter ion. Addition of n-propanol to the aqueous dispersions caused particle swelling and free-

ing of individual polymer chains from the dispersed particles (detected by light scattering). Reynolds¹⁷ proposed that the dispersed polyester particles were made up of aggregates of about 100 polymer chains, each of which is coiled up and "bound" to its neighbors by hydrophobic interactions which were disrupted by the addition of *n*-propanol. These sulphonate functional aqueous polyesters were initially developed as textile coatings.

A recent¹⁸ study of aqueous polyurethane dispersions using fluorescence spectroscopy and small angle neutron scattering demonstrated that these dispersed particles were also swollen with water, as is discussed in more detail later.

CARBOXYLATED MICROGELS

The situation in which a carboxylated polymer is crosslinked by the inclusion of difunctional co-monomer during an emulsion polymerization process was mentioned in the previous section. The inclusion of crosslinking co-monomer (above a critical concentration) prevents the polymer from dissolving on neutralization, and instead extensive swelling takes place. The extent of swelling depends on the concentration of crosslinking co-monomer.

An interesting variant of a crosslinked microgel for use in aqueous metallic basecoats for OEM automotive applications has been developed.¹⁹ The polymer is made by a multi-stage acrylic emulsion polymerization process, and comprises a lightly crosslinked core of nonswelling polymer, and a grafted shell of highly carboxylated polymer which is also hydroxyl functional for melamine formaldehyde crosslinking. The function of the crosslinked core is to provide mechanical toughness and chemical resistance (e.g., resistance to "strike in" from solvent-borne topcoats) while the function of the carboxylated mantle is to provide adhesion and crosslinking characteristics, and which provides (after neutralization with amine) the special pseudo plastic rheological characteristics required for this specialized application area.²⁰ At high-shear rates typical of spray atomization, the viscosity is very low, as is required for good atomization, good metallic flake orientation, and good circulation characteristics in pipelines. However, at low shear rates, the viscosity is very high, as is required for retention of metallic flake orientation and good sag resistance during drying, and good antisetling properties in the liquid paint.

The microgel technology has been further developed, leading to the recent development of an aqueous basecoat system for refinishing cars.²¹ The successful design of this system for autofinish has posed additional challenges over those present in OEM systems since in the refinish market the baking temperature of 130-140°C conventionally required for the use of melamine formaldehyde crosslinkers are not available, and drying conditions are less well controlled. Passivated and stable dispersions of aluminum flake pigment in aqueous systems have also been achieved to provide the range of basic colors required for a mixing scheme capable of matching several thousand car colors.

DESTABILIZATION AND DEPOSITION

The ability to destabilize aqueous dispersions and insolubilize polymers in aqueous polymeric solutions has

given rise to a number of deposition processes. For example, where an ionizable functional group is utilized to provide changes in stabilization of a polymer colloid, then the stabilizing effect is highly pH sensitive and a change of pH can bring about a total loss in colloid stability. Similarly, where an ionizable functional group is utilized to provide aqueous solubility of a polymer, then the solubilizing effect is also highly pH sensitive. These effects of pH are widely utilized as the basis for electrodeposition processes.

Viewed simplistically, the main reaction at the anode is liberation of hydrogen ions from water, thus locally generating acidity. Anionic polymers, therefore, lose solubility or colloid stability in this region and are deposited on the anode. Conversely, hydroxyl ions are generated at the cathode and, hence, cause the local loss of solubility/stability of a cationic polymer, and hence deposition at the cathode.

Other colloid destabilization processes have been utilized as the basis of a deposition process. A good example is the process known as autophoresis²² which utilizes the fact that an anionic charge stabilized dispersion can be destabilized by the introduction of multivalent cations. In the autodeposition process, a ferrous substrate is immersed in a highly acidified polymer latex. Dissolution of the substrate, due to the acidity of the medium, causes the generation of ferrous ions (and in some cases ferric ions, depending on the bath conditions) which causes an abrupt loss in latex stability and gives a uniform polymer coating. A particular attribute of the autodeposition process is that there are no "throwing power" restrictions, and a uniform coating thickness is obtained over the entire substrate surface, even in constricted regions.²³

Doroszkowski²⁴ has shown that sterically stabilized polymer dispersion can also be destabilized in a controlled fashion in electrodeposition processes. Cathodic deposition was obtained by the use of polyethylene oxide stabilized emulsion and utilized the fact that the solubility of ethylene oxide in water decreases as the pH increases. Thus, cathodically generated hydroxide ions can cause destabilization and deposition of carefully designed polyethylene oxide stabilized dispersion. Anodic deposition of polyethylene oxide stabilized latexes²⁴ was achieved by utilization of the fact that at low pH un-ionized polycarboxylic acids form water-insoluble complexes with polyethylene oxide.²⁵ Thus, when polyacrylic acid was added to a sterically stabilized emulsion whose stabilizing groups were polyethylene oxide chains, a system was obtained that was colloid stable at neutral and alkaline pH (provided the polyacrylic acid molecular weight was appropriately chosen), but which was destabilized and deposited in the acidic region in the proximity of the anode.

The decrease in solubility of polyethylene oxide chains with increase in temperature has also been utilized by Doroszkowski²⁶ as the basis of a deposition process for sterically stabilized dispersions based on polyethylene oxide stabilization.

ASSOCIATIVE THICKENERS

A fundamental problem with aqueous polymer dispersions is that their rheology is less favorable for surface coatings applications than that of polymer solutions which are more Newtonian. For example, the viscosity of a collo-

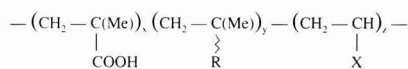
dal dispersion drops very quickly with increasing shear rate, and low shear rate viscosity tends to be too high to allow good flow and leveling. The high shear rate viscosity tends to be too low to give good brush pick-up and transfer from rollcoaters. Addition of water-soluble polymer (thickener) is generally vital to increase high shear rate viscosity to an acceptable level for application of the coating, but in so doing the low shear rate viscosity of the dispersion is raised disproportionately, with an unfavorable effect on the flow and leveling characteristics. The advent of associative thickeners has undoubtedly been a major advancement since such hydrophobically modified water-soluble polymers provide the opportunity to independently adjust the high shear rate viscosity and the low shear rate viscosity.²⁷ This control results in essence from the fact that the addition of cosolvent or low molecular weight surfactant to a system comprising polymer dispersion and hydrophobically modified water-soluble polymer can reduce the viscosity by reducing the magnitude of the hydrophobic associations between thickener hydrophobes and/or between these hydrophobes and the latex particle surface. This reduction in viscosity is far more pronounced at low shear rates than at high shear rates, because the initial hydrophobic associations present before the addition of cosolvent or surfactant have a large effect on viscosity at low shear rates, but much less effect on viscosity at high shear rates.²⁷

A wide-range of synthetic routes³ to associative thickeners has been described. The feature common to all systems is the presence of associating hydrophobic groups which are often located at the end of polyethylene oxide side groups or end groups. The associating groups are commonly C₈-C₂₄ hydrocarbon groups. The synthetic routes can be divided into the following main types:

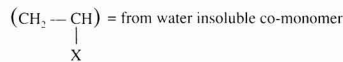
- (1) Copolymerization of a water-soluble monomer with a monomer bearing an associating hydrophobic group (free radical or step growth polymerization);
- (2) Homopolymerization of a water-soluble monomer or copolymerization of the soluble monomer with water-insoluble monomer(s), followed by post functionalization of the polymer to introduce the hydrophobic groups; and
- (3) Post functionalization of a naturally occurring water-soluble polymer.

A number of important examples are described in the following. The main free radically polymerized water-soluble monomers reported for the synthesis of associated thickeners are acrylamide, N vinyl pyrrolidone, (meth)acrylic acid, maleic anhydride, and sulphonate functional monomers such as 3-sodium 2-sulphoethyl methacrylate, 2-sodium styrene sulphonate and 5-sodium-2-acrylamido-2-methylpropane sulphonate. In some instances, copolymerization of these water-soluble monomers with one or more water-insoluble monomer yields an associative thickener. For example, random copolymers of acrylamide and N-alkyl acrylamides with hydrophobic alkyl groups have been prepared by micellar solution polymerization,¹¹ and acrylamide copolymers with lauryl methacrylate have been reported.²⁸ A commonly utilized type of co-monomer providing hydrophobic associating groups is the type in which the associating group is located at the end of a polyether (usually polyethylene oxide) chain. Such co-monomers can be prepared by reacting the

terminal hydroxyl group of a conventional ethoxylated surfactant (which will have a terminal hydroxyl group) with a compound containing a polymerizable double bond, e.g., methacryol chloride, maleic anhydride, vinyl benzyl chloride, and isocyanatoethyl methacrylate. Shay¹⁶ has comprehensively reviewed the synthesis of hydrophobically modified alkali soluble polymer emulsions (HASE) prepared by the emulsion copolymerization of such hydrophobic co-monomers with (meth)acrylic acid and a water-insoluble co-monomer. The structure of this type of polymer can be represented schematically as:

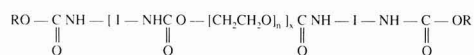


where: $\sim\sim$ = polyethylene oxide



R = associating hydrophobic group

One class of AT which is widely exploited commercially is the hydrophobically modified ethoxylated urethane thickeners (HEUR). The simplest and most widely utilized HEURs are linear polyurethanes based on polyethylene glycol and a diisocyanate and having a terminal associating hydrophobic group²⁹ can be represented as:



where R = associating hydrophobic unit

OCN—I—NCO di-isocyanate

Typical terminal hydrophobic units are C₁₂-C₁₈ alkyl groups which are introduced by capping the isocyanate terminated diblock oligomer (obtained by reaction of the calculated stoichiometric excess of diisocyanate with polyethylene glycol) with the appropriate hydrophobic alcohol. This simple diblock type of HEUR has been widely utilized commercially and variants can be readily synthesized in terms of x, n, choice of diisocyanate, and terminal hydrophobe.

As a result of the great flexibility provided by urethane chemistry, it is possible to prepare HEURs of other geometries,³⁰ e.g., molecules with three hydrophobes/molecule by the use of the isocyanurate of a diisocyanate, comb polymers with random hydrophobe placements, and comb polymers with block hydrophobe placements.

An example of the synthesis of associative thickeners by the post reaction of naturally occurring polymers is provided by the hydrophobic modification of water-soluble cellulose derivatives, such as (hydroxyethyl)cellulose and (hydroxypropyl) cellulose by the reaction with, for example,

appropriate long chain alkyl halides,³¹ acyl halides,³¹ acid anhydrides,³² and isocyanates.³¹ Not only is this class of hydrophobically modified polymer effective as rheology modifiers in latex paints, but they are claimed³³ to act as stabilizers in the suspension polymerization of vinyl and acrylic monomers and to be effective thickeners in systems containing high concentrations of surfactants such as shampoos.

It is apparent from the previous discussion that there are now a wide variety of synthetic routes to hydrophobically modified water-soluble polymeric thickeners. In all cases, the concentration and nature of the hydrophobic groups is crucial; a low concentration of hydrophobic groups is required in order to obtain intermolecular association rather than intramolecular associations which would collapse the chains. The use of fluorescence spectroscopy³⁴ and Fourier transform infrared spectroscopy³⁵ has provided important insights into the nature of the associations taking place in these systems.

EMULSION POLYMERIZATION

Emulsion polymers (latexes) are widely utilized as binders for aqueous coatings, and a very broad range of free radically polymerizable monomers are employed in their synthesis, e.g., (meth)acrylates, vinyl and vinylidene halides, styrene, vinyl esters, acrylonitrile, and ethylene. A summary of the many developments which have taken place in this area would be too lengthy for inclusion in this paper, therefore, only one interesting development is discussed in the next section.

SEQUENTIAL EMULSION POLYMERIZATION

An area of increasing importance is that of control and characterization of the morphology of the particles produced by emulsion polymerization. This is especially the case for emulsion polymers produced by sequential monomer feeding techniques. For example, in a semi-continuous emulsion polymerization, one combination of monomers is fed during the early stages of the polymerization, with a switch to a different combination of monomers for the later stages of the polymerization.

While sequential emulsion polymers have in the past been frequently described as "core-shell" polymers, there is now a general acceptance that a whole range of particle morphologies can be obtained depending on the system variables.^{39,41,42} Thus, a whole range of particle morphologies has been described in the literature, such as core-shell, inverse core shell, one phase uniform morphology, and gradient morphology. A range of phase separated morphologies has also been described,³⁶ such as uniform inclusion of one phase within another continuous phase ('currant-buns') surface concentrated separate spherical polymer phases ('raspberry structure'), and 'half moon' structures. The multi-lobe acrylic latex can be regarded as one such structure.³⁷ A large number of studies have been performed³⁸⁻⁵⁰ with the objective of defining the relationship between the detailed nature of the polymerization systems (e.g., batch versus monomer fed, monomer feed rate, monomer solubility in water, and monomer hydrophobicity) and particle morphology.

Arising from the various empirical studies on the relationship between the polymerization variables and particle morphology, it has been possible to build-up some general guidelines within certain polymer types. For example, it is generally accepted that the presence of di/trifunctional crosslinking co-monomers in at least one of the monomer combinations increases the probability of obtaining a phase separated morphology,⁴⁹ and that this morphology is more likely to tend towards the core-shell type if the polymerization is conducted in a monomer starved manner⁴⁹ so that monomer swelling of the growing polymer particles is limited, with a consequent reduction in mobility of the phases (assuming a phase separated structure is generated) during the course of the polymerization. Probably the best example of such control is in the preparation of commercial acrylic impact modifiers, some of which have been demonstrated to have clear cut core-shell morphologies,³⁸ and indeed three- and four-shell systems have been successfully prepared. Important factors to attaining such morphology are the use of difunctional crosslinking co-monomers, and also the use of a difunctional tie monomer at the change-over stage between the feeding of two monomer mixtures.³⁸

While the use of di- and trifunctional crosslinking co-monomers is a very powerful tool for exerting control of latex particle morphology, its use is somewhat limited in surface coatings applications because of the need for good latex film formation; all but the lowest level of crosslinking in a latex particle tends to impair latex film formation at room temperature, although somewhat higher levels can be tolerated if film formation is at elevated temperatures. Consequently, other techniques need to be used if the control of particle morphology is required in latexes intended for use as binders in surface coatings applications.

A step forward in the understanding of the factors controlling latex particle morphology has resulted from the application of simple surface energy expressions to allow the calculation of the total interfacial energy of the various possible alternative morphologies. Such treatments have been published by Sundberg,³⁹ Waters,⁴⁰ and Dimonie⁴¹ et al., and take as the central premise the argument that the thermodynamically preferred morphology is that with lowest total interfacial energy G :

$$G = \sum \gamma_{ij} A_{ij}$$

where A is the interfacial area and γ is the interfacial energy between the phase i and j .

For a two phase system in water (w) in which the first fed monomer is designated phase 1 and the second monomer phase 2:

$$\begin{aligned} G \text{ core-shell} &= \gamma_{12}A_{12} + \gamma_{2w}A_{2w} \\ \text{and } G \text{ inverted} &= \gamma_{12}A_{12} + \gamma_{1w}A_{1w} \end{aligned}$$

The more favored of the two morphologies considered is clearly governed by the relative magnitude of γ_{1w} and γ_{2w} (making the reasonable assumption that $A_{1w} = A_{2w}$ if only these two morphologies are being compared). Thus, core-shell morphology is preferred over inverted core-shell morphology if $\gamma_{2w} < \gamma_{1w}$, i.e., if the more hydrophilic monomer is fed second.

In practice, there are other possible morphologies and some recent treatments^{40,42,43} consider, not only the three

extreme morphologies of core-shell, inverse core-shell, and separate particles, but also an intermediate structure which both particles partially interface with the continuous phase, i.e., one particle is partially enveloping or engulfing the other.

Since this theoretical treatment assumes that the favored morphology is that with the minimum total interfacial free energy, it follows that the relative volume fraction of the two components is also important in determining morphology since this volume fraction is changing during the course of a sequential emulsion polymerization. Thus, the preferred morphology can change during the course of a polymerization.

Although useful thermodynamic equations have been published,^{40,42,43} their applicability could be extended if the various interfacial energy terms were known with some precision. This is rarely the case in practical systems. It might be expected that the next few years will see studies on the quantitative determination of various polymer-water and polymer-polymer interfacial energies, which will increase the value of the published theoretical treatments. Polymer-water interfacial tension can be determined by the drop volume method. Polymer-polymer interfacial tension is less easy to determine experimentally. Relatively subtle effects are important, e.g., the polymer-water interfacial tension of a polymer produced using a hydrophilic, charged polymerization initiator (persulphate) may be appreciably different from the corresponding polymer prepared using a non-charged polymerization initiator. Certainly it has been observed in practice⁴⁴ that the choice of polymerization initiator can have an influence on the final particle morphology. Surfactant effects can also exert an important influence on polymer-water interfacial tensions and hence on particle morphology. For example, Chen⁴⁵ et al., showed that in a polystyrene/polymethyl methacrylate system, the final particle morphology depended on the choice of surfactant.

It is clearly preferable when designing a sequential emulsion polymer if the system is designed such that the desired particle morphology is that with the lower total interfacial energy. This, however, cannot always be the case, as is exemplified in the synthesis of voided acrylic latex particles for use as opacifying pigments. One commercially important process to prepare such voided acrylic particles is described in the patent literature.⁴⁶ In this process, a highly carboxylated acrylic latex particle is prepared at low pH by emulsion polymerization; this highly carboxylated core particle is then overcoated using a much less carboxylated and less hydrophilic copolymer, and the resultant core-shell polymer swollen by the addition of base. The swelling of the polymeric core causes swelling of the overcoated particles; voids are generated when the system is dried down and loses the entrapped water. The overcoating step in the process is thermodynamically unfavorable because the core is significantly more hydrophilic than the shell. Park⁴⁷ has studied this system and his results illustrate a number of ways in which the attainment of the thermodynamically preferred structure can be restricted. The principle method entailed slowing down the kinetics of the morphology rearrangement to the thermodynamically preferred structure by arranging for the second fed more hydrophobic monomer (styrene) to produce a highly viscous polystyrene shell layer by conducting the polymerization in such a way that swelling of the polystyrene shell by

styrene monomer was minimized, that is, by maintaining the instantaneous conversion as high as possible (monomer starved) and by avoiding swelling of the core with styrene monomer. Crosslinking of the hydrophilic core with ethylene glycol dimethacrylate also helped to minimize swelling of the hydrophilic core by the second-stage monomer.

Another account of the ways in which the kinetics of morphology development can be used to encourage core-shell structure in cases which the core-shell structure is thermodynamically unfavorable has been given by Lee and Rudin.⁴⁸ They discussed the restriction of phase mobility by the use of high glass transition temperature (T_g) polymers, high molecular weight polymers, and the absence of low molecular weight species (including monomer) which may act as plasticizing agents. Rudin⁴⁹ showed, in particular, that by performing the second-stage polymerization at low temperature, the mobility could be substantially reduced and thermodynamically unfavorable core-shell structures obtained. Rudin⁴⁹ performed polymethyl methacrylate (PMMA)/polystyrene polymerizations in which the second-stage polymerization was carried out at room temperature using a redox polymerization initiator based on sodium formaldehyde sulphoxylate and ferrous sulphate. Significantly, it was found that very little migration of the more hydrophobic polystyrene phase into the PMMA core occurred even when the second-stage polymerization was performed under batch conditions.

Characterization of the morphology of composite latex particles is not always straightforward. Transmission electron microscopy can be a powerful tool in the hands of experts, especially when one phase can be preferentially stained; excellent micrographs have been produced by the Lehigh group in particular. The technique of surface-soap titration can be useful as exemplified in Okubo's work.⁵⁰ However, there are instances in real system of interest in surface coatings where these two techniques are not very useful. In such cases it may be necessary to utilize a combination of indirect techniques. Simple measurement of MFT can be instructive if the two phases have significantly different T_g 's, and dynamic mechanical analysis (DMTA) of films cast from the latex can differentiate between one- and two-phase morphology, although the same situation does not necessarily apply in the parent latex particles. More sophisticated techniques such as neutron scattering, fluorescence quenching, and atomic force microscopy have been applied in recent years, but not always with unambiguous results.

AQUEOUS DISPERSIONS OF PRE-FORMED STEP-GROWTH POLYMERS

The most important examples of this class in the coatings industry are polyurethanes, polyesters (including alkyds), and epoxies. The preparation and morphology of this type of system was discussed in general terms previously. In this section, polyurethane and polyester dispersions are considered in a little more detail.

Aqueous Polyurethane Dispersions

The technology for the preparation of aqueous polyurethane dispersions has progressed considerably over the past

30 years, and is still continuing to advance. In many respects, performance levels can now match that of solvent-borne polyurethanes. Optimized polyurethanes can offer a superior balance of properties over those products of typical emulsion polymerizations, especially in terms of the balance between mechanical properties (abrasion resistance, hardness, and tensile strength) and film forming temperature.

A recent study¹⁸ of an anionic aqueous polyurethane dispersion using luminescence spectroscopy and small angle neutron scattering has shown that the dispersed particles have an open structure and are swollen with water. This work suggested that the ability of aqueous polyurethanes to combine film formation at low temperature with the ability to give high film hardness is in part a result of this water-swollen morphology which aids film formation (i.e., water plasticization). The ability to prepare very low particle size polyurethane dispersions (20-100 nm) is also helpful in terms of film formation since it has been shown⁶⁹ that decreasing particle size aids the rate and extent of particle coalescence. The high film hardness which can be achieved with these systems arises from the presence of a hard block phase.

Techniques have been described and are used commercially for the preparation of aqueous polyurethane dispersions. These techniques have been well reviewed by Dietrich⁵¹ and by Rosthauser and Nachtkamp.⁵² The more modern processes share two common features. In all cases, the first step is the formation of a medium molecular weight isocyanate terminated prepolymer by the reaction of suitable di or polyol with a stoichiometric excess of di or polyisocyanate. However, the way in which this prepolymer is chain extended and the viscosity maintained at a manageably low level differ as outlined in the following. The polymer to be dispersed in water is functionalized with water-solubilizing/dispersing groups which are introduced either into the prepolymer prior to chain extension, or are introduced as part of the chain extension agent. Thus, small particle size stable dispersions can frequently be produced without the use of an externally added surfactant.

In the solution process, the isocyanate terminated polyurethane prepolymer is chain extended in solution in order to prevent an excessive viscosity being attained. The preferred solvent is acetone, and hence this process is frequently referred as the acetone process. The chain extender can, for example, be a sulphonate functional diamine, in which case the water-solubilizing/dispersing group is introduced at the chain extension step. The chain extended polymer is thus more properly described as a polyurethane urea. Water is then added to the polymer solution without the need for high-shear agitation, and after phase inversion a dispersion of polymer solution in water is obtained. Dietrich⁵³ has described in detail the complex events taking place during this inversion process. Removal of the solvent by distillation yields the desired aqueous polymer dispersion. While the acetone process is effective and reproducible, it is naturally limited to the requirements that the polymer is uncrosslinked and is acetone soluble, and so the resultant coatings tend not to be very solvent resistant. The need for solvent removal is another obvious process disadvantage.

In the prepolymer mixing^{51,52} process, a hydrophilically modified isocyanate terminated polyurethane prepolymer is chain extended with diamine or polyamine at the aqueous

dispersion step. This chain extension is possible because of the preferential reactivity of isocyanate groups with amine rather than with water. In order to maintain this preferential reactivity with amine, it is necessary to prevent the water temperature from exceeding the value at which significant reactions occur between water and the isocyanate. The choice of isocyanates is clearly important in this respect. The prepolymer mixing process is extremely flexible in terms of the range of aqueous polyurethane ureas which can be prepared, and has the major advantages that it avoids the use of large amounts of solvent and avoids the need for the final polymer to be solvent soluble.

The ketamine/ketazine^{54,55} process can be regarded as a variant of the prepolymer mixing process. The chain extending agent is a ketone-blocked diamine (ketamine) or ketone-blocked hydrazine (ketazine) which is mixed directly with the isocyanate terminated polyurethane prepolymer. During the subsequent water dispersion step, the ketamine or ketazine is hydrolyzed to generate free diamine or hydrazine respectively, and thus quantitative chain extension takes place. A claimed⁵² advantage of the ketamine process over the prepolymer mixing process is that it is better suited for preparing aqueous urethanes based on the more water reactive aromatic isocyanates.

The hot melt process^{52,53} involves the capping of a functionalized isocyanate terminated polyurethane prepolymer with urea at $>130^{\circ}\text{C}$ to form a biuret. This capped polyurethane (which can be solvent free) is dispersed in water at $\sim 100^{\circ}\text{C}$ to minimize viscosity, and chain extension carried out in the presence of the water by the reaction with formaldehyde which generates methylol groups, which in turn self-condense to give the desired molecular weight build-up.

Anionic, cationic, or nonionically stabilized aqueous polyurethane dispersions can be prepared.⁵² Anionic dispersions are currently the most widely utilized type and are usually either carboxylate or sulphonate functionalized co-monomers, e.g., suitably hindered dihydroxy carboxylic acids (dimethylol propionic acid) or dihydroxy sulphonic acids. Cationic systems are prepared by the incorporation of diols containing tertiary nitrogen atoms, which are converted to the quaternary ammonium ion by the addition of a suitable alkylating agent or acid. Nonionically stabilized aqueous polyurethanes can be prepared by the use of diol or diisocyanate co-monomers bearing pendant polyethylene oxide^{56,57} chains. Such polyurethane dispersions are colloidal stable over a broad pH range, but a high concentration of polyethylene oxide based co-monomer is required to achieve a low particle size dispersion. Thus, combinations of nonionic and anionic stabilizations are sometimes utilized in order to achieve a combination of small particle size and strong steric stability, without the need to utilize excessively high concentration of nonionic stabilizing co-monomer. Urethane dispersions employ this type of stabilization and can be blended with low pH, acid containing acrylic latex.

Aqueous polyurethane dispersions are being increasingly used in the surface coatings industry because of the unique property balances which can be obtained by this very flexible chemistry. Important applications include wood lacquers, leather finishing, adhesives, plastic coatings, and glass fiber sizing.

A number of recent developments in aqueous polyurethanes are worth mentioning. Precrosslinked urethanes^{58,59} can be prepared by the addition of a multifunctional co-monomer after preparation of the isocyanate terminated prepolymer and before the aqueous dispersion stage. Such precrosslinking need not deleteriously affect film formation providing that the level of crosslinking is controlled, and gives rise to an improvement in hardness and solvent resistance. Blocked polyurethanes⁵⁹ can be prepared by the reaction of an isocyanate terminated prepolymer containing acid functionality with, for example, an oxime followed by neutralization and dispersion in water. These water dispersed blocked polyurethane prepolymers can be combined with hydroxy functional acrylic or polyurethane dispersions to provide effective waterborne baking finishes. The choice of both isocyanate and blocking agent is important in controlling deblocking temperature and hydrolytic stability.

Two-pack aqueous polyurethanes based on hydrophilically modified polyisocyanates are another recent development.⁶⁰ These reactive two-pack systems comprise a hydrophilically modified polyisocyanate and a co-reactive aqueous polymer, e.g., a hydroxy functional polyurethane dispersion or a water dispersed acrylic polyol. Because of the reaction of isocyanate groups with water, the pot life of such systems is limited, although an increase in pot life to five to six hours has been obtained by the hydrophilic modification⁶¹ of the isocyanate. These systems are claimed to give very good dry film properties, but do not possess the advantages of the aqueous polyurethane dispersion previously discussed in terms of being one pack and in terms of being free of reactive polyisocyanates during application (spraying).

Polyester and Alkyd Aqueous Dispersions

As in the case for aqueous polyurethanes, there is a limit to the molecular weight of the polymer which can be utilized because of the need to have a manageable viscosity at the aqueous dispersion stage. However, polyesters do not have the advantage possessed by polyurethanes of being readily chain extended during or subsequent to the aqueous dispersion stage. Thus, many aqueous polyesters utilized for coating applications have a relatively low molecular weight and achieve acceptable film properties by virtue of subsequent crosslinking reactions, e.g., melamine formaldehyde-based baking systems. The more frequently utilized water-solubility/dispersing groups are carboxylate and sulphonate, the latter functionality often being introduced by the use of alkali metal salts of sulpho isophthalic acid which are very effective¹⁷ in imparting solubility/dispersibility with minimum agitation in the absence of added surfactants and solvents. Linear sulphonate functional polyesters have been utilized for many years in textile coatings (sizes). The use of alkali metal ions rather than a volatile amine to neutralize the sulphonate functionality is clearly an advantage in terms of the VOC of the final liquid coating,⁶² and is also an advantage in terms of being able to utilize higher polymer melt temperatures (therefore lower viscosities) at the aqueous dispersion stage without loss of volatile amine. The use of involatile base is also beneficial in processes in which the

polyester is dissolved in a volatile solvent before dispersion in water since the problem of loss of volatile base is avoided during the distillation step to remove solvent.⁶²

The problem of molecular weight build-up in an aqueous polyester is overcome in principle in the case of corresponding alkyd by the incorporation of fatty acids which contain autoxidizable double bonds; catalyzed autoxidation reactions in the final film give rise to the necessary molecular weight build-up/crosslinking. Alkyd emulsions have been developed on this principle and are being promoted for the decorative market. A number of problems were encountered during their development.⁶³ For example, the use of volatile amines to neutralize the carboxylic acid groups gave rise to a decrease in autoxidation (drying) rate and caused film yellowing. These problems were circumvented by the use of an inorganic base such as sodium hydroxide.⁶³ A further problem to be overcome was that the cobalt drier salts conventionally added to catalyze the autoxidation reaction were complexed by longer chain ethylene oxide based, surfactant as well as by many neutralizing amines, and hence, such components must be avoided. Solvent free alkyd emulsions are now commercially available, although their drying rate (autoxidation rate) does not match that of the corresponding alkyds in solvent.⁶³

An intrinsic problem with aqueous polyesters and alkyds relates to the poor hydrolytic stability of the ester linkage, especially under acid and alkaline conditions; optimum pH is the region 5-7. This is particularly a problem when carboxyl groups (for aqueous dispersibility) are introduced via the ring opening of anhydrides⁶⁴ because of the Anchimeric effect.⁶⁵ Thus, care has to be taken in the design of the polymers in order to maximize hydrolytic stability.

HYBRID SYSTEMS

Hybrid systems are being increasingly utilized in which the binder is a combination of more than one generic class of polymer, for example, urethane-acrylics and epoxy-acrylics. A large number of preparative techniques have been reported, especially in the patent literature, and a full review is beyond the scope of this paper.

Probably the most widely utilized technique is to free radically polymerize a combination of monomers in the presence of a pre-formed polymer which may or may not be intrinsically water dispersible. If the pre-formed polymer is water dispersible, it can be used directly as a seed for a subsequent free radical emulsion polymerization, whereas if the pre-formed polymer is not intrinsically water dispersible, then it can either be emulsified in water using a combination of a surfactant and high shear, or it can be dissolved (if soluble) in the monomers utilized in an emulsion polymerization. In some instances the pre-formed polymer can have pendant or terminal functional groups, which can participate in the subsequent emulsion polymerization, thus giving grafting between the two polymers.

Hybrid systems prepared by sequential polymerization can provide superior properties to those obtained from the corresponding polymer blends. This is because totally different particle (and hence film) morphology can be obtained in a sequentially polymerized system since both polymers can exist in the same particle. Furthermore, grafting can provide

superior properties (mechanical properties) compared to blends.

Arnoldus⁶⁶ and Jansse⁵⁹ have shown that urethane-acrylic aqueous dispersions prepared by performing an acrylic emulsion polymerization in the presence of an aqueous polyurethane can possess a range of advantages over the corresponding blends, e.g., reduced water sensitivity, and the ability to prepare in cosolvent-free form. Since the polyurethane is generally more hydrophilic than the acrylic copolymer, the polyurethane concentrates at the particle surface. In a well-designed system, the particles coalesce on film formation to give a film with a continuous polyurethane phase. Therefore, the resultant coating behaves more like the parent polyurethane than does the equivalent blend of acrylic latex and polyurethane dispersion.

An important example of a hybrid system is the epoxy acrylic aqueous system widely utilized for interior can coatings. One published⁶⁷ preparative technique is to graft acrylic acid and other acrylic monomers onto an epoxy resin to produce an epoxy acrylic graft polymer which, following neutralization, can be dispersed in water.

One of the important advantages of hybrid systems is that binders with new and useful property balances can be prepared without the need to use new monomers. The beforementioned type of epoxy acrylic system⁶⁷ exemplifies this advantage in that the approach allows high performance coatings to be developed while staying within the severe constraints of food contact legislation in terms of the allowable monomers.

FILM FORMATION

The process of film formation is crucial in attaining good coating properties. The film forming process for aqueous polymer dispersions is much more difficult to control and more critical than for systems which are a solution of polymer in organic solvent or in water. Aqueous dispersions form films by a coalescence process in which the individual polymer particles are forced together as the water is lost during drying, and the particles deform and eventually interdiffuse, ideally on a molecular scale. Incomplete coalescence can give rise to water sensitivity of the coating and, in the case of coatings on ferrous substrates, to a phenomenon known as "early rusting." The coalescence process is highly dependent upon a number of parameters,⁶⁸ being aided by decreasing particle size,⁶⁹ decreasing polymer T_g , increasing temperature, cosolvent additions, absence of crosslinking, and increasing contact surface energy. On the other hand, the film-forming process of polymer solutions (aqueous and nonaqueous) is much less critical, e.g., good film formation takes place at room temperature, irrespective of polymer T_g . One reason for this good film formation is that molecular interpenetration is present prior to drying the coating.

It is interesting to consider the film-forming process of intermediate polymer types discussed in the previous section. The film formation of a highly carboxylated acrylic latex of the alkali soluble type was studied at two separate pH's (pH = 3.5 and 8) by atomic force microscopy (AFM). The AFM analysis clearly showed that at pH = 3.5 the mechanism of film formation was one of particle coalescence, while at pH = 8 the film formation mechanism was

totally different in that no individual particles could be discerned, and the coating had a uniform surface profile throughout the drying process.

The coalescence process undergone by aqueous polymer dispersions has been thoroughly studied over the years. Earlier experimental work was based on electron microscopy. More recently, small angle neutron scattering⁷⁰ and luminescence spectroscopy have given further insights into the process. In an example of the latter approach, Winnik⁷¹ et al., have used energy transfer studies to measure the diffusion coefficient for polybutyl methacrylate (PBMA) during coalescence of PBMA latex with and without added cosolvent. Winnik⁷² has also estimated the proportion of the polymer molecules that undergo molecular interdiffusion during latex film formation by the use of luminescence spectroscopy.

AQUEOUS RADIATION CURING

Aqueous radiation curing systems have been discussed with increasing frequency over the past 10 years or so. However, only recently is there starting to be real signs of market acceptance for such applications as gravure and flexoprinting inks, clear overprint varnishes, wood lacquers, and screen printing inks.

Nearly all the systems described to date have been UV-curable systems making use of free radical generating photoinitiators, and involving polymers with acrylate double bonds.^{74,77-80} The polymer types reported represent many of the polymer types utilized in general for aqueous coatings. Thus, water soluble, water thinnable, water dispersible, and latex-based systems have all been reported. Polymers with widely varying molecular weights are involved. Some systems contain high levels of multifunctional acrylates (MFA) of the type used for 100% solids radiation curable systems, some contain moderate levels of MFA, while MFA-free systems have also been described. In view of this wide-range of different chemical approaches employed, it is to be expected that the main characteristics, the advantages and the disadvantages also vary widely. This area is not yet sufficiently mature for clear market preferences for particular approaches to have become evident. Nevertheless, by considering in a little more detail the chemical basis of the different approaches, it is possible to gain an appreciation of some of the strengths and weakness of each.

An early approach involved the preparation of typical 100% solids radiation curable systems (i.e., systems containing acrylated oligomers and MFAs) which could be thinned by addition of water.⁷³ This approach had the advantage of reducing the otherwise high viscosity of a conventional 100% solids system and gave the characteristic high crosslink density of this sort of system. However, the viscosity was still high by the standards of many aqueous systems, and the worker hazards associated with the use of some MFAs at high concentration were very much present.

Water-soluble systems have been considered⁷⁴ but it is likely that the inevitable high level of hydrophilic groups will lead to a final cured film which has a degree of water sensitivity even when high crosslink densities are achieved. Thus, although the systems may be suitable for certain graphic arts applications, suitability in other application areas requir-

ing greater aqueous resistance properties is more questionable.

A natural development has been in the use of water dispersible acrylated oligomers and low molecular weight polymers, both in the presence or absence of added MFA. Urethane oligomers are particularly well suited in that great synthetic flexibility⁷⁵ is possible and intrinsically good film properties achievable. Good control over the level of acrylate functionality is achievable, which in turn allows control over final crosslink density. Two such radiation curable aqueous urethanes have recently been described by Stenson.^{76,77} They are both aliphatic urethanes rendered water dispersible by the incorporation of neutralized carboxylic acid groups and sold as an aqueous dispersion. These two systems exemplify the types with and without added MFA; one system contains no MFA while the other system contains 6.7% trimethylol propane triacrylate as diluent MFA. Stenson^{76,77} has reported the dramatic improvement in mechanical properties of both systems following UV-cure. An important characteristic of such systems is that in contrast to conventional 100% solids radiation curable systems the films can be hard and tack free before UV-cure, a feature which has a number of practical advantages and which derives from the considerably higher molecular weight and lower MFA content of the aqueous polyurethanes. Stenson⁷⁶ points out that these aqueous radiation curable urethanes can be readily blended in all proportions with other conventional anionically stabilized urethanes in order to achieve desirable property balances.

Aqueous polyesters are another class of water dispersible acrylated oligomers/low molecular weight polymers and have been described by Overbeek et al.⁶² who point out that cosolvents which might be necessary for viscosity control during resin dispersion in water can be replaced by reactive oligomer diluents. Thus, the approach represents a route to zero VOC systems. In some instances the reactive diluent may not be needed. Again, control of the concentration of acrylate functionality allows control of crosslink density after UV-cure. Therefore, dispersions can be produced⁶² by this approach that have zero VOC but which after cure have excellent elevated temperature (52°C, 16 hr) block resistance with heat seal above 200°C. Garrat⁷⁸ has reported a radiation curable aqueous phthalic acid based aqueous hydroxy functional polyester containing a sodium sulphate group to provide water dispersibility. Acrylation was achieved by reaction of the hydroxy functional polyester with a diisocyanate and a hydroxy functional acrylic monomer.

Acrylic latex-based systems have also been developed. McGinnes and Seidewand⁷⁹ described an acrylic latex which was methacrylated by the reaction of glycidyl methacrylate with an amine functional acrylic latex. In contrast, Wood⁸⁰ has described a system in which an emulsified MFA, such as trimethylol propane triacrylate, is added to a nonfunctional acrylic emulsion polymer. On film formation, an intimate mix of the two components is said to be obtained, and on cure an interpenetrating network (IPN) is formed in which the crosslinked MFA forms an IPN with the acrylic polymer. Muzyczko et al.⁸¹ have disclosed a photopolymerizable system in which a high molecular weight polymer dispersed as an oil in water emulsion is combined with a water-soluble or water dispersible UV-curable polymer. The purpose of this

system was the preparation of photoresists, since on selective irradiation of a coated component, the unexposed areas could be removed by washing with aqueous base, whereas the unexposed areas were crosslinked and resistant to such washing.

An acrylate functionalized acrylic latex which forms a good film at room temperature without the need to add MFA to aid film formation, has recently been reported.⁸²

A feature of aqueous radcure systems based on polymer dispersions prepared by emulsion polymerization is that before UV-cure, the polymer has very high-molecular weight compared to all other radiation-curable systems of both the aqueous and nonaqueous types. Thus, a lower level of functionality is required to form a good crosslinked film. In consequence, lower levels of photoinitiator might be expected to be needed. Shrinkage on cure is much less than in other UV radiation curable systems. An interesting variant of a high molecular weight aqueous dispersion system has been claimed by Sutton⁸³ in which the dispersed polymer had cationic reactive functionality and the system contained a water dispersed cationic photoinitiator. The system is claimed to give the characteristic advantage of cationically initiated UV polymerization in conventional 100% solids systems, e.g., insensitivity to oxygen and continued curing after the source of light has been removed. It is perhaps surprising that cationic polymerization occurs in water. The cationic functionality claimed is epoxy (from glycidyl methacrylate), cyclic ketal, cyclic ether, and lactones.

The advantage of aqueous radiation curing over 100% solids radcure can be summarized as follows:

- Lower viscosity systems can be formulated, and rheology can be controlled by means of the addition of water or of conventional thickeners for aqueous-based systems.
- Because of the potential to operate at lower viscosity, other application techniques (spraying, roller coating, curtain coating) can be utilized and much thinner films can be applied.
- Because of the greatly reduced need for acrylate diluent monomers, it is possible to formulate systems with lower toxicity, lower odor, and reduced skin irritancy. It is possible to design systems which contain no acrylic diluents as previously mentioned.
- Shrinkage on cure is less, especially in the case of systems based on medium molecular weight and high molecular weight polymer dispersions; improved adhesion to nonabsorbent substrates can result from the decreased shrinkage.
- Equipment spillages can be cleaned up with water.
- Even prior to radiation, the coatings can be physically dry to the touch, especially in the case of systems based on medium molecular weight and (especially) high molecular weight polymer dispersions. In contrast, 100% solids systems are very sticky before cure.

The main disadvantages of aqueous radiation curable systems compared to 100% solids radiation curable systems should also be pointed out. These are:

- Most of the water must be removed prior to UV-cure. This is not a disadvantage with thin films on absorbent substrates such as paper or wood. However, on nonabsorbent

substrates there is the need for a separate drying (water removal) step.

- Because of the need for water removal as a separate step, overall cure schedules are longer with waterborne systems.

Inspection of the advantages and disadvantages of aqueous radiation curable systems reveal that there are many potential application areas where the attributes can be exploited to advantage. There is little doubt that the commercial usage of such systems will grow and broaden. A range of different chemistries are possible as outlined, and it is likely that several of these will be needed to provide the cost/performance balance demanded by the different potential application areas.

DIFFICULTIES ASSOCIATED WITH CURRENT AQUEOUS COATINGS

While the advantages of aqueous coatings are well-recognized, it is worth summarizing some of the difficulties associated with the formulation and use of aqueous coatings, because by doing so, many of the targets for future research are highlighted. It is useful to separate these disadvantages into the following two classes: (1) disadvantages of water compared to organic solvent; and (2) disadvantages of current polymers designed for use in aqueous media.

The former type of disadvantage is clearly intrinsic to aqueous coatings, and the role of the various additives used in aqueous coating formulations is frequently to alleviate such disadvantages. The latter type of disadvantage can be addressed by polymer design and steady progress has continued to be made in this area.

A well-recognized disadvantage is that water has a high latent heat of evaporation (~540 cal/g); hence at high temperature, a high energy input is required to facilitate drying, while at ambient temperature and/or high relative humidities drying is slow. In practical terms this slow loss of water gives rise to a number of important disadvantages, such as long drying times. These effects can be alleviated by the use of selected volatile cosolvents. Cosolvents are also widely utilized at present to assist in the coalescence process in high T_g latex-based systems. As the principal driving force towards the use of aqueous coatings is an environmental one, there are strong pressures to either remove the cosolvent altogether or in some instances to move to more environmentally acceptable cosolvents, and both of these approaches are the basis of current work. Reduction of cosolvent concentration is a non-trivial problem because of the range of functions performed by the cosolvent in a typical aqueous formulation. Total elimination of cosolvent is in turn an even more demanding target. In emulsion polymer based systems, one of the challenges is to develop latexes which coalesce at lower temperatures yet which do not give coatings with a sticky surface. One approach⁸⁴ is to blend a high T_g latex polymer with an excess of low T_g latex polymer which forms the continuous phase and therefore determines film forming temperature.

The surface tension of water (~72 dynes/cm²) is very high, leading to a range of difficulties, e.g., wetting of most surfaces (especially low energy surfaces) crawling, cratering,

and pigment wetting. While the surface tension can be readily reduced by the addition of cosolvents and surfactants, the addition of the former has unfavorable VOC implications as previously discussed. The addition of surfactants to aid surface wetting and/or to help stabilize the dispersed component in an aqueous formulation (polymer and pigments) can itself cause practical difficulties because such additives are, by necessity, surface active and can cause foam and pinhole formation by stabilizing the water-air interface of entrained air bubbles by increasing surface elasticity and/or surface viscosity.

The attainment of good pigment dispersion is in general more difficult to achieve in an aqueous system than in the case of the corresponding solvent-borne system. The attainment of a state of good pigment dispersion is important for a number of reasons, e.g., achieving good gloss, achieving good opacity and hiding power, and obtaining good barrier properties when pigmented barrier polymers. Soluble polymers (thickeners) can act as flocculants for the dispersed pigment particles and, in some instances, for latex particles. Ionic impurities also act as flocculants for aqueous dispersions, such impurities frequently arising from the finite solubility of pigments which are present in the formulation. For example, most anticorrosive pigments rely on slight dissolution to provide anticorrosive anions (phosphate or chromate), but in so doing generate soluble counter ions (cations) which are frequently multivalent (zinc, molybdenum, calcium, and barium) and, which, therefore act as powerful flocculating species. Even when the pigments in the wet paint are not flocculated, it is a common experience that flocculation occurs during the paint drying down process on the substrate due to the progressive increase in concentration of both the dispersed particles and of the flocculating species during drying, and hence the pigments become flocculated in the final dry paint. Even in the absence of flocculating species, flocculation would occur during drying at some critical volume fraction. One claimed advantage of associative thickeners is that they have less tendency to flocculate the pigments than have conventional water-soluble polymers of the cellulosic type.

In aqueous coating formulations based on a polymeric binder which comprises dispersed polymer particles (e.g., a latex), purely statistical and geometric factors provide another reason why attainment of good pigment dispersion is more difficult than in a solvent-borne (soluble polymer) formulation.

The high conductivity of water can cause difficulties. More difficulties can arise when using aqueous coatings directly on ferrous substrates when drying takes place under ambient conditions because the slow evaporation of the high conductivity aqueous coating encourages the initiation of corrosion reactions at this very early stage of the life of the coating systems. Once such corrosion reactions are initiated, it is to be expected (and indeed it is frequently observed) that long-term anticorrosive performance is impaired since key components for subsequent corrosion have been introduced (Fe^{2+}). One obvious manifestation of such early corrosion is known as flash rusting, in which brown rust spots can appear in a matter of hours on the top surface of an aqueous coating directly applied to steel. This process has been studied in detail⁸⁵ and has been shown to be attributable to dissolution

of iron at the substrate to give soluble ferrous ions which convectively diffuse to the top surface of the film where they are oxidized to Fe^{3+} . Reducing agents such as sodium nitrite are frequently added to water-based paints to reduce the tendency to give flash rusting, presumably by reducing the tendency of the Fe^{2+} produced by substrate dissolution to be oxidized to the visible form Fe^{3+} .

The freezing point of water is high compared to most organic solvents; therefore, it is frequently necessary to add freezing point depressants or protect the formulations from freezing. Such protection is by no means always easy to achieve during transportation and storage. Strongly sterically stabilized dispersions can remain colloid stable during several freeze-thaw cycles, but achieving such colloid stability for all the dispersed components in a fully formulated paint is again by no means easy.

Bacterial growth requires an aqueous environment. It is frequently necessary to add a preservative in an aqueous coating formulation to prevent bacterial growth in the wet formulation, thus further increasing the number of formulation components.

It is clear from the foregoing discussion that the formulation of aqueous coatings is in general far more complex than is the case for solvent-borne systems; this very complexity and the need for more formulation additives can itself be regarded as a disadvantage. Additives introduced to achieve one effect can be damaging in other respects (e.g., wetting versus foaming). Developments which allow formulation simplification (e.g., low foaming dispersions, latexes with intrinsically good wetting ability, and film forming characteristics) would be beneficial.

CONCLUSIONS

Many advances in the synthesis of polymers for aqueous coatings have been made over the past 40 years. However, the level of research activity has probably never been so high as at the present time, and a range of new developments can be confidently expected.

ACKNOWLEDGMENTS

The author would like to acknowledge useful discussions with colleagues during the preparation of this paper, and especially R. Satguru, A. Overbeek, R. Seidewand (Zeneca Resins), and S. Downing (ICI Paints). The author is grateful to Zeneca Resins for permission to publish this paper.

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Annual Index



Volume 66
Numbers 828-839
January—December, 1994

Journal of Coatings Technology 1994 Annual Index

Keyword Subject Index

Additives

Defoamer Feb., p. 47
 Dispersants Sept., p. 93; Sept., p. 99
 Driers July, p. 63
 Fouling (Anti-) July, p. 63
 Hindered Amine Light Stabilizers (HALS) Aug., p. 57
 Silicones Feb., p. 47; Sept., p. 107
 Surfactants Jan., p. 99; Feb., p. 47; Aug., p. 67; Sept., p. 99
 Thickener Sept., p. 99

Analysis

Accelerated Tests Aug., p. 85; Oct., p. 49
 Atomic Force Microscopy Nov., p. 19
 Chemical Oct., p. 27
 Coating Hardness Feb., p. 55
 Conductive Energy Apr., p. 23
 Convective Energy Apr., p. 23
 Convocal Laser Microscopy Nov., p. 19
 Corrosion Resistance Oct., p. 49
 Curing Apr., p. 23
 Differential Scanning Calorimetry Apr., p. 23; Apr., p. 39; June, p. 59
 Dynamic Contact Angle May, p. 55
 Dynamic Mechanical Analysis May, p. 27
 Electric IR Curing Apr., p. 23
 Electrochemical Impedance Spectroscopy July, p. 59
 Failure Analysis Feb., p. 23
 Fourier Transform Infrared Spectroscopy Feb., p. 39; Apr., p. 39; July, p. 39
 Glass Transition Temperature June, p. 83
 Image July, p. 51
 Impedance Aug., p. 85; Dec., p. 81
 Indentation Hardness Feb., p. 55
 Internal Reflection Spectroscopy July, p. 39
 Kinetic Study June, p. 59
 Luminescence Spectroscopy Mar., p. 47
 Outdoor Exposure Aug., p. 85; Oct., p. 49
 Penetration Hardness Feb., p. 55
 Pfund Hardness Feb., p. 55
 Photoacoustic FTIR Apr., p. 23; Dec., p. 59
 Scanning Acoustic Microscopy Nov., p. 19
 Small Angle Neutron Scattering Mar., p. 47
 Small Angle X-Ray Scattering Mar., p. 47
 Surface July, p. 51
 Sward Rocker Feb., p. 54
 Tensile Tests May, p. 27
 Thermal Desorption-Gas Chromatography/
 Mass Spectrometry Oct., p. 27
 Thermal Radiation Heat Transfer Apr., p. 23
 Thermally Stimulated Current Aug., p. 79

Urethane Curing Dec., p. 59
 UV/VIS Spectroscopy Feb., p. 39
 Weathering Jan., p. 109

Biologicals

Fouling Oct., p. 21
 Microorganisms Oct., p. 21

Chemical Compounds

Copper Complex July, p. 63
 Triazoles July, p. 63

Chemical Process

Aging June, p. 83
 Corrosion Apr., p. 47; July, p. 28; July, p. 59; July, p. 63; Aug., p. 85; Oct., p. 39; Dec., p. 81
 Degradation July, p. 51
 Deposition Dec., p. 89
 Weathering June, p. 83; July, p. 28; Oct., p. 49

Coatings Components

Acrylic Jan., p. 99; June, p. 83
 Acrylic Emulsion Mar., p. 47
 Alkyd Apr., p. 47; May, p. 37; Oct., p. 39; Nov., p. 37
 Dispersant Sept., p. 93
 Emulsifier May, p. 37
 Epoxidized Polybutadiene Nov., p. 27
 Epoxy Oct., p. 21
 Isocyanate (Poly) Dec., p. 67
 Latex Jan., p. 99; Aug., p. 67; Sept., p. 99
 Melamine June, p. 75; June, p. 83; Dec., p. 73
 Naphthenic Acid Ester Sept., p. 93
 Sulphur Dioxide Apr., p. 39; Oct., p. 39
 Urethane (Poly) June, p. 83; Dec., p. 89
 Vinyl Acrylic Jan., p. 99
 Vinyl Ether Nov., p. 19

Coatings

Acrylics Jan., p. 99
 Adhesion Jan., p. 109; Aug., p. 79; Aug., p. 85; Nov., p. 43; Dec., p. 59
 Appearance Jan., p. 93
 Aqueous Sept., p. 93; Nov., p. 43
 Automotive Aug., p. 57; Sept., p. 93; Oct., p. 27

Barrier	Apr., p. 47
Basecoat/Clearcoat	Aug., p. 57
Bond Strength	Jan., p. 109
Characterization	May, p. 27
Clearcoat	June, p. 83
Container	Mar., p. 41
Core	Jan., p. 99
Corrosion (Anti-)	Apr., p. 47; July, p. 28; July, p. 59; July, p. 63; Aug., p. 85; Oct., p. 49; Nov., p. 43; Dec., p. 81
Cost	Apr., p. 47
Critical Pigment Volume Concentration	Aug., p. 79
Crosslink Density	Nov., p. 19
Crosslinking	June, p. 63
Defects, Defect Characterization	Feb., p. 23; Sept., p. 107; Nov., p. 19
Degradation	July, p. 51; Oct., p. 27
Design of Experiments	Mar., p. 65; Apr., p. 55
Durability	Jan., p. 109; July, p. 28; Aug., p. 57
Epoxy	July, p. 59
Finish	Sept., p. 107
Flame Retardant	Dec., p. 73
Flexibility	Mar., p. 41
Foaming	Feb., p. 47; Mar., p. 57
Formability	Mar., p. 41
Fouling (Anti-)	July, p. 63
Gloss	Jan., p. 93; May, p. 47; Sept., p. 99
Hardness	Feb., p. 54; Feb., p. 55
High Solids	June, p. 75; Sept., p. 107; Dec., p. 67
Intumescent	Dec., p. 73
Latex	June, p. 63
Marine	July, p. 63; Oct., p. 21
Mechanical Stability	May, p. 37
Oxidation (Auto-)	Oct., p. 39
Performance	July, p. 28
Permeability	Aug., p. 85
Photooxidation	July, p. 28
Powder	Apr., p. 23
Primers	Apr., p. 47
Protection	Oct., p. 21; Dec., p. 81
Reflectivity	Feb., p. 39
Rheology	May, p. 27; Sept., p. 99
Sample Preparation	Feb., p. 23
Stability	Mar., p. 57; June, p. 75; Aug., p. 57; Sept., p. 93; Nov., p. 37
Stress	June, p. 83
Topcoat	Aug., p. 57
Traffic	July, p. 51
UV Cured	Feb., p. 39; Nov., p. 27
UV Transparency	Feb., p. 39
Volatile Organic Compounds	May, p. 47
Water	July, p. 39
Waterborne	Mar., p. 41; May, p. 37; Aug., p. 67; Oct., p. 21; Nov., p. 37; Dec., p. 89
Weathering	June, p. 83; July, p. 28; Oct., p. 49
Zinc Oxide	Apr., p. 47

Computer Applications

Design of Experiments	Mar., p. 65; Apr., p. 55
Relative Statistical Error	July, p. 59
Scattergram	July, p. 59
Statistical Design	May, p. 27

Films

Cratering	Feb., p. 23
Cross-Sectioning	Feb., p. 23
Crosslink Density	Nov., p. 19

Curing	Apr., p. 23
Diffusion	May, p. 55
Formation	Mar., p. 47; Apr., p. 23; June, p. 63; Dec., p. 89
Galvanized Gassing	Feb., p. 23
Interfacial Interaction	Aug., p. 79
Nubbing	Feb., p. 23
Particulate Contamination	Feb., p. 23
Pinholing	Feb., p. 23
Surface	Jan., p. 93

Formulation

Foam	Feb., p. 47; Mar., p. 57
Modeling	Apr., p. 23; July, p. 28; July, p. 39; Aug., p. 67
Statistical Design	May, p. 27

Optics, Color

Distinctness of Image	May, p. 47
Gloss	Jan., p. 93; May, p. 47; Sept., p. 99

Pigments

1,4-Diketo-3,6-diarylpyrrolopyrroles	May, p. 47
Aluminum Trihydroxide	Feb., p. 39
Dispersion	May, p. 47
Extenders	Feb., p. 39
Fillers	Feb., p. 39
Flattening Agent	Jan., p. 93
Flocculation Resistance	Sept., p. 93
Particles	Jan., p. 93
Quinacridones	May, p. 47
Size	Jan., p. 93

Pollution/Health

Hazards	July, p. 69
Lead	July, p. 69
Lead Abatement	July, p. 69
Poisons	July, p. 69
Sulphur Dioxide	Apr., p. 39

Polymeric Components

Acrylic	Jan., p. 99; June, p. 83
Acrylic Emulsion	Mar., p. 47
Amine Blocked Sulfonic Acid	June, p. 75
Epoxidized Polybutadiene	Nov., p. 27
Epoxy	Oct., p. 21
Hexamethoxymethylmelamine	June, p. 75
Isocyanate (Poly)	Dec., p. 67
Melamine	June, p. 75; June, p. 83; Dec., p. 73
Urethane (Poly)	Mar., p. 47
Water Reducible Acrylic	Mar., p. 57

Polymers

Adsorption	Aug., p. 67; Sept., p. 99
Colloidal Stability	Mar., p. 47
Curing	Nov., p. 27
Dispersants	May, p. 47
Emulsion	June, p. 63
Foam Fractionation	Mar., p. 57
Foam Stability	Mar., p. 57
Hydrophobically Modified	Dec., p. 89
Particle Morphology	Mar., p. 47

Polymerization	Nov., p. 27
UV Curable Polymers	Feb., p. 39
Water Soluble	Dec., p. 89

Solvents

Coalescing Aids	Aug. p. 67
Diluents	Dec., p. 59

Substrates

Coatings Interface	July, p. 39
Plastic	Sept., p. 93
Roughness	Jan. p. 109
Thermoplastic	Oct., p. 27; Nov., p. 43
Steel ... Apr., p. 47; July, p. 59; July, p. 63; Nov., p. 43; Dec., p. 81	
Wood	May, p. 55; Oct., p. 21



Alphabetical Listing of Papers

A

- Adsorption in Latex Paints in Relation to Some of the Properties of the Mill Base and the Final Coating—M. Huldén, E. Sjöblom, and A. Saarnak, Sept., p. 99.
- Aluminum Trihydroxide (ATH): A UV Transparent Filler for UV-Curable Coatings—A.A. Parker, E.S. Martin, and T.R. Clever, Feb., p. 39.
- Aqueous Polyurethanes—Polymer Colloids with Unusual Colloidal, Morphological, and Application Characteristics—R. Satguru, J. McMahon, J.C. Padgett, and R.G. Coogan, Mar., p. 47.

C

- Chemical Analysis of Painted Thermoplastics by Thermal Degradation GC/MS—W.R. Rodgers, T.S. Ellis, G.D. Cheever, R. Louis-Ferdinand, D.P. Thorton, and N. Somers, Oct., p. 27.
- Chemical Criteria for Durable Automotive Topcoats—D.R. Bauer, Aug., p. 57.
- Chemical Origins of Paint Performance—R.A. Dickie, July, p. 28.
- Chemical Reaction Kinetics of Sulfur Dioxide and Oxygen with Unsaturated Drying Oils—W.H. Simendinger and C.M. Balik, Oct., p. 39.
- Chemical Reactivity of Sulphur Dioxide with Unsaturated Drying Oils—W.H. Simendinger and C.M. Balik, Apr., p. 39.
- Coatings Characterization Using Multiple Techniques and Statistically Designed Experiments—M. Neag, P. Wilson, and G. Skerl, May, p. 27.
- Comparison of the Effectiveness of Electric IR and Other Energy Sources to Cure Powder Coatings—R.J. Dick, K.J. Heater, V.D. McGinniss, W.F. McDonald, and R.E. Russell, Apr., p. 23.
- Coping with Errors in Electrochemical Impedance Spectroscopy Data from Coated Metals—W.S. Tait, July, p. 59.
- Correlation of Accelerated Exposure Testing and Exterior Exposure Sites—Cleveland Society for Coatings Technology, Oct., p. 49.
- Cost-Effective Pigmentation in Alkyd Primers for Steel: Barrier Anti-Corrosion Mechanism—W.C. Johnson, Apr., p. 47.
- A Critique of the Taguchi Approach—Part I: A Presentation of Some Deficiencies and How These Limit Its Efficiency and Validity—J.L. McGovern, Mar., p. 65.
- A Critique of the Taguchi Approach—Part II: An Alternative that is More Efficient—J.L. McGovern, Apr., p. 55.

D

- Defects in Solvent-Free Organic Coatings Studied by Atomic Force Microscopy, Scanning Acoustic Microscopy, and Confocal Laser Microscopy—J. Lange, J.-A.E. Månson, and A. Hult, Nov., p. 19.
- Developments of Marine Paint Formulations Based on Thiotriazole Compounds—A.B. Tadros, July, p. 63.
- The Dynamic Contact Angle—A Characteristic to Predict the Lifetime of a Wood Topcoat—G. Hora, May, p. 55.

E

- Effect of Polyurethane Curing Conditions on the Delamination of Pressure Sensitive Films—B.W. Ludwig and M.W. Urban, Dec., p. 59.
- Epoxidized Polybutadiene: A Novel Prepolymer for Cationically UV-Curable Coatings—F. Cazaux, X. Coqueret, B. Lignot, C. Loucheux, P. Rousseau, J.J. Flat, S. Leroux, and C. Verge, Nov., p. 27.
- Effect of Prewetting, Surface Roughness, and Wood Species on the Performance of Paint Stains—R.S. Williams and W.C. Feist, Jan., p. 109.
- Evaluating Traffic Paint Degradation Using Image Analysis—B. Pourdeyhimi and A. Nayernouri, July, p. 51.
- Evaluation of Corrosion Behavior of Metal-Filled Polymeric Coatings—N. Kouloumbi, G.M. Tsangaris, and S.T. Kyvelidis, Dec., p. 83.

F

- Film Formation from Conventional and Miniemulsion Latex Systems Containing Dimethyl Meta-Isopropenyl Benzyl Isocyanate (TMI®)—A Functional Monomer/Crosslinking Agent—Y. Inaba, E.S. Daniels, and M.S. El-Aasser, June, p. 63.
- Foam Stability and Foam Fractionation of Water-Reducible Acrylic Polymer Systems—R. Twite, J. Zhu, and G.P. Bierwagen, Mar., p. 57.

G

- Gloss of Paint Films: II. Effects of Pigment Size—J.H. Braun and D.P. Fields, Jan., p. 93.

H

- High Performance Polyurethane Coating Systems Utilizing Oxazolidine-Based Reactive Diluents—G.N. Robinson, T.L. Johnson, and M.D. Hoffman, Dec., p. 67.
- High-Solids Coatings Using Benzylalanilinium Sulfonates—T. Morimoto and S. Nakano, June, p. 75.
- High-Solids Nonaqueous Dispersion Coatings Based on Crystalline Oligoesters—G. Teng and F.N. Jones, Feb., p. 31.
- Hygrothermal Stress Evolution During Weathering in Organic Coatings—D.Y. Perera and M. Oosterbroek, June, p. 83.

I

- Influence of Defoamers on the Efficiency of Waterborne Coating Systems—W. Heilen, O. Klocker, and J. Adams, Feb., p. 47.
- Interfaces of Polyphenyletheretherketone (PEEK) and Polyphenylene Sulfide (PPS) Coated Zinc Phosphated Steels after Heating-Cooling Cycles in a Wet, Harsh Environment—T. Sugama and N. Carciello, Nov., p. 24.

K

- A Kinetic Study of the Reaction of Epoxidized Rubber and Carboxylic Acids—J.K. Copeland and S.F. Thames, June, p. 59.

M

- Mechanical Stability of Alkyd Emulsions—Part 1: Influence of Emulsion Droplet Size and the Emulsifier—G. Östberg, B. Bergenstähl, and M. Huldén, May, p. 37.
- Mechanical Stability of Alkyd Emulsions—Part 2: Influence of Alkyd Properties—G. Östberg and Björn Bergenstähl, Nov., p. 37.
- Melamine Phosphates and Pyrophosphates in Flame-Retardant Coatings: Old Products with New Potential—E. Weil and B. McSwigan, Dec., p. 75.
- Mixed Adsorption of Anionic and Nonionic Surfactants on Latex Particles—M. Huldén and B. Kronberg, Aug., p. 67.

N

- A New Sample Preparation Technique for the Examination and Analysis of Paint Film Defects—T.J. Veneri and J.A. Kramer, Feb., p. 23.
- Novel Composite Latex Particles for Use in Coatings—G.A. Vandezande and A. Rudin, Jan., p. 99.
- Novel Epoxy Resins for Container Waterborne Coatings with Improved Flexibility—D.S. Treybig and D.P. Sheih, Mar., p. 41.

P

- Polymers for Water-Based Coatings—A Systematic Overview—J.C. Padgett, Dec., p. 89

R

- Reduction of Air Bubbles in Spray-Applied Coatings—M.S. Gebhard and L.E. Sciven, Mar., p. 27.
- Rheologically Effective Organic Pigments—E.E. Jaffe, C.D. Campbell, S.B. Hendi, and F. Bähler, May, p. 47.

S

- Selection of Corrosion Test Methods Based on Mechanism Principles—Northwestern Society for Coatings Technology, Aug., p. 85.
- Silicone Additives for High-Solids Polyester-Melamine Coatings—New York Society for Coatings Technology, Sept., p. 107.
- A Study of Water at the Organic Coating/Substrate Interface—T. Nguyen, D. Bentz, and E. Byrd, July, p. 39.

U

- Use of Naphthenic Acid Ester as a Dispersing Agent in Aqueous Conductive Primers—J.L. Carmine and R.A. Ryntz, Sept., p. 93
- Use of Thermally Stimulated Current to Measure Properties of Coatings—C.A. Kumins, C.J. Knauss, and R.J. Ruch, Aug., p. 79.

W

- A Waterborne and Environmentally Benign, Marine Timber Coating—B.G. Dixon and W. Gomes, Oct., p. 21.

Open Forum

- Indentation/Penetration Hardness Testing—The Future—M.R. Euverard, Feb., p. 55.
- Lead-Based Paint and the Lead Abatement Issue in the United States—Northwestern Society for Coatings Technology, July, p. 69.



Author Index

- A**
- ADAMS, J.—See Heilen, W.
- B**
- BÄBLER, F.—See Jaffe, E.E.
BALIK, C.M.—See Simendinger, W.H.
BALIK, C.M.—See Simendinger, W.H.
BAUER, D.R.—Chemical Criteria for Durable Automotive Topcoats, Aug., p. 57.
BENTZ, D.—See Nguyen, T.
BERGENSTÄHL, B.—See Östberg, G.
BERGENSTÄHL, B.—See Östberg, G.
BIERWAGEN, G.P.—See Twite, R.
BRAUN, J.H. and FIELDS, D.P.—Gloss of Paint Films: II. Effects of Pigment Size, Jan., p. 93.
BYRD, E.—See Nguyen, T.
- C**
- CAMPBELL, C.D.—See Jaffe, E.E.
CARCIELLO, N.—See Sugama, T.
CARMINE, J.L. and RYNTZ, R.A.—The Use of Naphthenic Acid Ester As a Dispersing Agent in Aqueous Conductive Primers, Sept., p. 93.
CAZAUX, F., COQUERET, X., LIGNOT, B., LOUCHEUX, C., ROUSSEAU, P., FLAT, J.J., LEROUX, S., and VERGE, C.—Epoxidized Polybutadiene: A Novel Prepolymer for Cationically UV-Curable Coatings, Nov., p. 27.
CHEEVER, G.D.—See Rodgers, W.R.
CLEVER, T.R.—See Parker, A.A.
COOGAN, R.G.—See Satguru, R.
COPELAND, J.K. and THAMES, S.F.—A Kinetic Study of the Reaction of Epoxidized Rubber and Carboxylic Acid, June, p. 59.
COQUERET, X.—See Cazaux, F.
- D**
- DANIELS, E.S.—See Inaba, Y.
DICK, R.J., HEATER, K.J., MCGINNIS, V.D., McDONALD, W.F., and RUSSELL, R.E.—Comparison of the Effectiveness of Electric IR and Other Energy Sources to Cure Powder Coatings, Apr., p. 23
DICKIE, R.A.—Chemical Origins of Paint Performance, July, p. 29.
DIXON, B.G. and GOMES, W.—A Waterborne and Environmentally Benign, Marine Timber Coating, Oct., p. 21.
- E**
- EL-AASSER, M.S.—See Inaba, Y.
ELLIS, T.S.—See Rodgers, W.R.
EUVERARD, M.R.—Indentation/Penetration Hardness Testing—The Future, Feb., p. 55.
- F**
- FEIST, W.C.—See Williams, R.S.
FERLAUTO, E.C.—Lead-Based Paint and the Lead Abatement Issue in the United States, July, p. 69.
FIELDS, D.P.—See Braun, J.H.
FLAT, J.J.—See Cazaux, F.
- G**
- GEBHARD, M.S. and SCRIVEN, L.E.—Reduction of Air Bubbles in Spray-Applied Coatings, Mar., p. 27.
- GOMES, W.—See Dixon, B.G.
- H**
- HEATER, K.J.—See Dick, R.J.
HEILEN, W., KLOCKER, O., and ADAMS, J.—Influence of Defoamers on the Efficiency of Waterborne Coating Systems, Feb., p. 47.
HENDI, S.B.—See Jaffe, E.E.
HOFFMAN, M.D.—See Robinson, G.N.
HORA, G.—The Dynamic Contact Angle—A Characteristic to Predict the Lifetime of a Wood Topcoat, May, p. 55.
HULDÉN, M. and KRONBERG, B.—Mixed Adsorption of Anionic and Nonionic Surfactants on Latex Particles, Aug., p. 67.
HULDÉN, M., SJÖBLOM, E., and SAARNAK, A.—Adsorption in Latex Paints in Relation to Some of the Properties of the Mill Base and the Final Coating, Sept., p. 99.
HULDÉN, M.—See Östberg, G.
HULT, A.—See Lange, J.
- I**
- INABA, Y., DANIELS, E.S., and EL-AASSER, M.S.—Film Formation from Conventional and Miniemulsion Latex Systems Containing Dimethyl Meta-Isopropenyl Benzyl Isocyanate (TMI[®])—A Functional Monomer/Crosslinking Agent, June, p. 63.
- J**
- JAFFE, E.E., CAMPBELL, C.D., HENDI, S.B., and BÄBLER, F.—Rheologically Effective Organic Pigments, May, p. 47.
JOHNSON, W.C.—Cost-Effective Pigmentation in Alkyd Primers for Steel: Barrier Anti-Corrosion Mechanism, Apr., p. 47.
JOHNSON, T.L.—See Robinson, G.N.
JONES, F.N.—See Teng, G.
- K**
- KLOCKER, O.—See Heilen, W.
KNAUSS, C.J.—See Kumins, C.A.
KOULOUMBI, K., TSANGARIS, G.M., and KYVELIDIS, S.T.—Evaluation of Corrosion Behavior of Metal-Filled Polymeric Coatings, Dec., p. 83.
KRAMER, J.A.—See Veneri, T.J.
KRONBERG, B.—See Huldén, M.
KUMINS, C.A., KNAUSS, C.J., and RUCH, R.J.—Use of Thermally Stimulated Current to Measure Properties of Coatings, Aug., p. 79.
KYVELIDIS, S.T.—See Kouloumbi, N.
- L**
- LANGE, J., MANSON, J-A.E., and HULT, A.—Defects in Solvent-Free Organic Coatings Studied by Atomic Force Microscopy, Scanning Acoustic Microscopy, and Confocal Laser Microscopy, Nov., p. 19.
LEROUX, S.—See Cazaux, F.
LIGNOT, B.—See Cazaux, F.
LOUCHEUX, C.—See Cazaux, F.
LOUIS-FERDINAND, R.—See Rodgers, W.R.
LUDWIG, B.W. and URBAN, M.W.—The Effect of Polyurethane Curing Conditions on the Delamination of Pressure Sensitive Films, Dec., p. 59.
- M**
- MARTIN, E.S.—See Parker, A.A.

MANSON, J.-A.E.—See Lange, J.
MCDONALD, W.F.—See Dick, R.J.
MCGINNISS, V.D.—See Dick, R.J.
MCGOVERN, J.L.—A Critique of the Taguchi Approach—Part I: A Presentation of Some Deficiencies and How These Limit Its Efficiency and Validity, *Mar.*, p. 65.
MCGOVERN, J.L.—A Critique of the Taguchi Approach—Part II: An Alternative that is More Efficient, *Apr.*, p. 55.
McMAHON, J.—See Satguru, R.
McSWIGAN, B.—See Weil, E.
MORIMOTO, T. and NAKANO, S.—High-Solids Coatings Using Benzylanilinium Sulfonates, *June*, p. 75.

N

NAKANO, S.—See Morimoto, T.
NAYERNOURI, A.—See Pourdeyghi, B.
NEAG, M., WILSON, P., and SKERL, G.—Coatings Characterization Using Multiple Techniques and Statistically Designed Experiments, *May*, p. 27.
NGUYEN, T., BENTZ, D., and BYRD, E.—A Study of Water at the Organic Coating/Substrate Interface, *July*, p. 39.

O

OOSTERBROEK, M.—See Perera, D.Y.
ÖSTBERG, G. and BERGENSTÄHL, B.—Mechanical Stability of Alkyd Emulsions—Part 2: Influence of Alkyd Properties, *Nov.*, p. 37.
ÖSTBERG, G., BERGENSTÄHL, B., and HULDÉN, M.—Mechanical Stability of Alkyd Emulsions—Part 1: Influence of Emulsion Drop-let Size and the Emulsifier, *May*, p. 37.

P

PADGET, J.C.—Polymers for Water-Based Coatings—A Systematic Overview, *Dec.*, p. 89
PADGET, J.C.—See Satguru, R.
PARKER, A.A., MARTIN, E.S., and CLEVER, T.R.—Aluminum Trihydroxide (ATH): A UV Transparent Filler for UV-Curable Coatings, *Feb.*, p. 39.
PERERA, D.Y. and OOSTERBROEK, M.—Hygrothermal Stress Evolution During Weathering in Organic Coatings, *June*, p. 83.
POURDEYHI, B. and NAYERNOURI, A.—Evaluating Traffic Paint Degradation Using Image Analysis, *July*, p. 51.

R

ROBINSON, G.N., JOHNSON, T.L., and HOFFMAN, M.D.—High Performance Polyurethane Coating Systems Utilizing Oxazolidine-Based Reactive Diluents, *Dec.*, p. 67.
RODGERS, W.R., ELLIS, T.S., CHEEVER, G.D., LOUIS-FERDINAND, R., THORNTON, D.P., and SOMERS, N.—Chemical Analysis of Painted Thermoplastics by Thermal Degradation GC/MS, *Oct.*, p. 27.
ROUSSEAU, P.—See Cazaux, F.
RUCH, R.J.—See Kumins, C.A.
RUDIN, A.—See Vandezande, G.A.
RUSSELL, R.E.—See Dick, R.J.
RYNTZ, R.A.—See Carmine, J.L.

S

Saarnak, A.—See Huldén, M.
Satguru, R., McMAHON, J., PADGET, J.C., and COOGAN, R.G.—Aqueous Polyurethanes—Polymer Colloids with Unusual Colloidal, Morphological, and Application Characteristics, *Mar.*, p. 47.
SCRIVEN, L.E.—See Gebhard, M.S.
SHEIH, D.P.—See Treybig, D.S.
SIMENDINGER, W.H. and BALIK, C.M.—Chemical Reaction Kinetics

of Sulfur Dioxide and Oxygen with Unsaturated Drying Oils, *Oct.*, p. 39.

SIMENDINGER, W.H. and BALIK, C.M.—Chemical Reactivity of Sulfur Dioxide with Unsaturated Drying Oils, *Apr.*, p. 39.
SJOBLOM, E.—See Huldén, M.
SKERL, G.—See Neag, M.
SOMERS, N.—See Rodgers, W.R.
SUGAMA, T. and CARCIELLO, N.—Interfaces of Polyphenyletheretherketone (PEEK) and Polyphenylene Sulfide (PPS) Coated Zinc Phosphated Steels after Heating-Cooling Cycles in a Wet, Harsh Environment, *Nov.*, p. 43.

T

TADROS, A.B.—Developments of Marine Paint Formulations Based on Thio-triazole Compounds, *July*, p. 63.
TAIT, W.S.—Coping with Errors in Electrochemical Impedance Spectroscopy Data from Coated Metals, *July*, p. 59.
TENG, G. and JONES, F.N.—High-Solids Nonaqueous Dispersion Coatings Based on Crystalline Oligoesters, *Feb.*, p. 31.
THAMES, S.F.—See Copeland, J.K.
THORNTON, D.P., See Rodgers, W.R.
TREYBIG, D.S. and SHEIH, D.P.—Novel Epoxy Resins for Container Waterborne Coatings with Improved Flexibility, *Mar.*, p. 41.
TSANGARIS, G.M.—See Kouloumbi, N.
TWITE, R., ZHU, J., and BIERWAGEN, G.P.—Foam Stability and Foam Fractionation of Water-Reducible Acrylic Polymer Systems, *Mar.*, p. 57.

U

URBAN, M.W.—See Ludwig, B.W.

V

VANDEZANDE, G.A. and RUDIN, A.—Novel Composite Latex Particles for Use in Coatings, *Jan.*, p. 99.
VENERI, T.J. and KRAMER, J.A.—A New Sample Preparation Technique for the Examination and Analysis of Paint Film Defects, *Feb.*, p. 23.
VERGE, C.—See Cazaux, F.

W

WEIL, E. and McSWIGAN, B.—Melamine Phosphates and Pyrophosphates in Flame-Retardant Coatings: Old Products with New Potential, *Dec.*, p. 75.
WILLIAMS, R.S. and FEIST, W.C.—Effect of Preweathering, Surface Roughness, and Wood Species on the Performance of Paint and Stains, *Jan.*, p. 109.
WILSON, P.—See Neag, M.

Z

ZHU, J.—See Twite, R.

Constituent Society Papers

Correlation of Accelerated Exposure Testing and Exterior Exposure Sites—Cleveland Society for Coatings Technology, *Oct.*, p. 49.
Lead-Based Paint and the Lead Abatement Issue in the United States—Northwestern Society for Coatings Technology, *July*, p. 69.
Selection of Corrosion Test Methods Based on Mechanism Principles—Northwestern Society for Coatings Technology, *Aug.*, p. 85.
Silicone Additives for High-Solids Polyester-Melamine Coatings—New York Society for Coatings Technology, *Sept.*, p. 107.

Society Meetings

BIRMINGHAM OCT.

"Intumescent Coatings"

This month marked the 500th technical meeting of the club.

A moment of silence was observed for the passing of Terry Tye, of PPG Industries (UK) Ltd. and Victor Yarsley.

Jeff Pimm and Brian Huxteth, of Nullifire Ltd., delivered an audio visual presentation on "INTUMESCENT COATINGS FOR THE CONSTRUCTION INDUSTRY."

The importance of fire protection and the Building Regulations Document B was illustrated with slides depicting what happens to wood/metal structures that have been protected by intumescent coatings and those not protected.

The technical aspects of basic intumescent paints were explored. According to the speakers, every intumescent paint should have the following: (1) a carbonific polyol, such as pentaerythritol; (2) a catalyst, such as ammonia polyphosphate; and (3) a blowing agent, such as melamine or urea.

After explaining the weakness, buckling, and support losses on unprotected steel, the speakers demonstrated the value of protecting steel with thin film intumescent paints with tests.

Tests on coated beams were conducted on a variety of tests and standards, such as BS.476 and Part 7. These tests included placing steel work into huge furnaces on both horizontal and vertical planes.

In addition, experiments on BS.8202 Part 2 were performed. Tests included heat ex-

posure, freeze thaw, sulphurdioxide resistance, humidity, salt spray, acid and solvent exposure, plus weathering and BS.476 tests.

Messrs. Pimm and Huxteth concluded with the recommendation of materials for specific end uses.

DAVID C. MORRIS, *Secretary*

CDIC OCT.

"Surface Treated Pigments"

Scholarship Chairman, Andrew Nogueira, of Hunting Industrial Coatings, noted that scholarship applications are due on January 1, 1995.

The meeting's speaker was Romesh Kumar, of Hoechst Celanese, and he discussed "SURFACE TREATED PIGMENTS—A 90'S SOLUTION TO COATINGS PROBLEMS."

Dr. Kumar began by giving background information on the role of pigments in coatings formulation. The four phases in the life of a coating are manufacture, shelf time, application, and durability; pigment dispersion and stability are crucial to all of these.

The speaker stated that coatings are comprised of pigments, resins, and solvents. Poor dispersion causes coatings deficiencies, such as rheological problems, surface problems, and color problems. To obtain stability of dispersion, steric agents or coulombic agents must be used. New technologies depend on both of these dispersants, which are added during the premix step of dispersion.

According to Dr. Kumar, incorporating pigment surface treatments during the pigment manufacturing process does not make predispersed dry pigments, but does yield a

nonflocculating grade of pigment. Therefore, the pigments still must be dispersed, but dispersion is easier.

WILLIAM E. JELF, III, *Secretary*

LOS ANGELES SEPT.

"Corrosion Inhibitors"

The Society Officers for 1994-95 were announced as follows: President—Philip C. Bremenstuh, of Zeneca Resins; Vice President—John C. Kulnane, of Ameritone Paint Corp.; Treasurer—Robert C. Skarvan, of Engineered Polymer Solutions, Inc.; and Secretary—Joseph B. Evans, of Trail Chemical Corp. John A. Gordon, of Pacific Technical Consultants will continue to serve as the Society Representative.

Robert Backlin, of Hüls America Inc., presented the traditional gavel to Philip C. Bremenstuh.

V.C. "Bud" Jenkins, Consultant, received the Society's Past-President Award from Mr. Bremenstuh.

The following Society Committee Chairmen for 1994-95 were introduced: Manufacturing—Francisco Stitt, of Sinclair Paint Co.; Educational—Edward Barrie Jr., of Sinclair Paint Co.; Environmental Affairs—Dave Muggee, of E.T. Horn Co.; Membership—Glen Wool, of John K. Bice Co.; Technical—V.C. Bud Jenkins; Scholarship—John A. Gordon; Good Fellowship, Photography, and Publicity—Lambert "Bert" Olsen, of Guardsman Products; Awards and Employment—Sandra L. Dickinson, of Fine Line Paint; Library—Carl V. Thompson, Consultant; Constitution and By-Laws—James D. Hall, of Sinclair Paint Co.; Entertainment—Scott Hoffer, of Ashland Chemical; Budget and Audit—Maurice Sampson, Retired; Career Development—Dan Gilbert, of Hills Brothers Chemical; Computers and Program Chairman—John C. Kulnane, of Ameritone Paint Corp.; Meetings—Richard T. Hayes, of E.T. Horn Co.; and Yearbook—Brian H. Turk, of Union Carbide Corp.

Frank Peters, of Dunn Edwards, reported that 15 people were graduated from the "Paint Technology" course during 1993-94. The Outstanding Student Award was presented to Gordon Zabrecky, of Pacific Coast Chemicals.

Dave Muggee, Environmental Affairs Committee Chairman, reported on the following:



Members of the Birmingham Club's Executive Committee for 1994-95 include (from left): Brian Fowler, Resiblend Services; Club Representative—Gerry J. Gough, ICI Packaging Coatings; D. Tony Wallington; Graham Jones, Kemira Coatings Ltd.; President—Roland L. Staples, Nortax; Joe Brown; and Secretary—David C. Jones, PPG Industries (UK) Ltd.

DOT Standard 17E Drums—After October 1996, only properly marked UN containers are to be used. Mr. Muggee noted that reconditioning drums will become more difficult and only drums embossed with the thickness and millimeters, concerning the heads and the sides, can be recycled easily. Drums with a thickness of 0.8 mm body and 1.1 heads are authorized. Violations could result in large fines. Users should read CFR 49-173.28.

SARA Title III Reporting for Toxics Reporting Inventory—EPA is proposing that any manufacturer who emits less than 100 pounds per year of hazardous chemicals should be exempt from reporting; however, back-up records for three years should be kept.

California Proposition 65—The U.S. District Court found that the Federal Food, Drug, and Cosmetic Act and regulations pre-empt state law. The case, which concerns mercury and dental amalgam and Proposition 65, found the State of California in error and the U.S. Government ruling did prevail. However, not enough evidence was presented to declare that Proposition 65 violates the U.S. Consumer Clause in the Constitution.

The evening's speaker was Charles H. Simpson, of Sherwin-Williams Chemicals, who spoke on "CORROSION INHIBITORS FOR ENVIRONMENTAL COMPLIANCE."

Mr. Simpson defined corrosion inhibitors as any materials that slow down or reduce the corrosion rate of metals. In coatings, they are typically in the form of anticorrosive pigments, such as zinc chromate, strontium chromate, red lead, and basic lead chromate. However, their use has declined due to environmental concerns.

According to the speaker, in many industrialized nations, corrosion and corrosion control contribute to approximately four percent of the Gross National Product. Corrosion of organic polymer-coated iron or steel is an electrochemical process, which includes the formation of a corrosion cell consisting of the metal substrate, water, oxygen, and a layer of conducting electrolyte in contact with both reaction sites.

Protective coatings reduce corrosion by providing a physical barrier between the metal and corrosive agents, mainly moisture and corrosive salts. A number of environmentally acceptable pigments have been developed that do not contain chromium or lead. Mr. Simpson stated that the three most important types are borate, phosphate, and molybdate, zinc molybdate for solvent systems, and calcium molybdate for water systems.

The speaker discussed various aspects of accelerated and outdoor durability testing of anticorrosive pigments in latex, epoxy, and alkyd coatings as well. The correlation between outdoor and accelerated rat-



The Executive Committee of the Chicago Society for 1994-95 includes (seated from left): Society Representative—Evans Angelos, OMYA, Inc.; Secretary—Marcella G. Nichols, Tru-Test Manufacturing Co.; Past-President—Gregory E. McWright, ANGUS Chemical Co.; President—Natu Patel, Ace Hardware Corp., Paint Div.; and Alison M. Azar, Votech, Inc. Standing: Vice President—C. David Stromberg, United Coatings; Educational Chairman—A. Frank Leo, Henkel Corp.; William W. Fotis, The Valspar Corp.; and Treasurer—Gerry K. Noren, DSM-Desotech, Inc.

ings was confirmed and evaluated statistically.

JOSEPH B. EVANS, *Secretary*

LOUISVILLE SEPT.

"Additive Usage in Environmentally Friendly Coatings"

Society President Mike Moilanen, of Süd Chemie Rheologicals, accepted the gavel from outgoing President, Tim Fortney, of American Dispersions, Inc. Following this ceremony, Rich Powell, of Argus Co., presented Mr. Moilanen with a plaque.

FSCT President John Lanning, of Courtaulds Coatings, Inc., was in attendance and introduced the 1994-95 Louisville Society Executive Committee: President—Mike Moilanen; President—Elect and Program Chairman—Bill Leightner, of C.L. McGuire, Co.; Treasurer—Andy Traister, of Courtaulds Coatings, Inc.; Secretary—Dan Fortney, of American Dispersions, Inc.; Society Representative—Larry Pitchford, of Reynolds Metal Co.; Membership Chairman—Chris Lockhart, of Reynolds Metal Co.; Technical Chairman—Iлона Nemeth, of Red Spot Paint & Varnish Co.; Educational Chairman—Paul Baukema, of Akzo Nobel Coatings, Inc.; and Environmental Chairman—Roy Funkhouser, of Law Environmental.

Mr. Lanning thanked the Executive Committee and the General Assembly for all the support he received from the Louisville Society during his term of office.

New York Society member, Edward W. Orr, of BYK-Chemie, was the meeting's speaker. Mr. Orr spoke on "ADDITIVE USAGE

IN ENVIRONMENTALLY FRIENDLY COATINGS."

Mr. Orr began his presentation by stating that improvements in raw materials have made environmentally friendly coatings possible. New additives have evolved to meet the challenge and special needs regarding rheology, film performance, and surface tension.

He outlined the following areas of discussion: (1) unique wetting and dispersing agents for environmentally friendly coatings; (2) flow and surface control additives for environmentally friendly coatings; and (3) defoamers in the coatings industry: theory and application.

Mr. Orr continued by stating that in other high-solids coatings, interfacially active silicones and defoamers may be necessary to maximize properties. Other new technologies (water-soluble, latex, powder, etc.) pose similar challenges. The speaker noted that proper use of silicone additives can help avoid a variety of surface defects, such as orange peel, craters, fisheyes, crawling, foam, and floating.

According to the speaker, to match the performance of comparable low-solids, a high-solids coating may require special wetting and dispersing additives. Mr. Orr mentioned that differences in shade, sagging, flooding, floating, formulation of Benard cells, and settling are all problems connected with wetting and dispersing. To better classify solvent systems, the speaker recommended differentiating between defloc-culating and controlled flocculating.

Mr. Orr concluded that environmentally acceptable coatings demand higher performance, so new additive structures have evolved to meet the new demands of advanced coatings components and application technologies.

DAN FORTNEY, *Secretary*



The 1994-95 Executive Committee of the Cleveland Society consists of the following: Society Representative—Brenda Carr, Coatings Development Co.; Secretary—Richard A. Mikol, Tremco Inc.; President—Constance F. Williams, Lubrizol Corp.; Treasurer—James Currie, Jamestown Paint Co.; Jennifer Rumberg, The Mahoning Paint Corp.; and Vice President—Michael A. Wolfe, Seegott Inc.

MONTREALOCT.

"Wollastonite-Calcium Metasilicate"

The technical speaker for this meeting was Sara Robinson, of NYCO Minerals.

Ms. Robinson gave an overview of Wollastonite, a pure white extender, acicular in shape. Derived from China, India, Mexico, and upstate New York, this product reportedly provides cohesive strength to the coating film and in turn mechanical strength, durability, and weathering.

According to Ms. Robinson, Wollastonite's alkaline pH of 9.9 acts as a buffer and is also being used for viscosity maintenance, bridge paints, and as a mineral reinforcement for roof coatings.

LUC MILLETTE, *Secretary*

NEW ENGLAND SEPT.

"Aqueous Polyurethanes"

The evening's program was a presentation by John C. Padgett, of Zeneca Resins, on "AQUEOUS POLYURETHANES—POLYMER COLLOIDS WITH UNUSUAL COLLOIDAL, MORPHOLOGICAL, AND APPLICATION CHARACTERISTICS."

Mr. Padgett discussed two classes of waterborne polymers: aqueous polymer dispersions prepared by emulsion polymerization and dispersions of preformed polymers in water. He also presented four benefits of using polyurethane dispersions instead of conventional acrylic and/or rubber systems:

- (1) Environmental advantages over their solvent-based counterparts;
- (2) Increased abrasion resistance which are film forming at room temperature;
- (3) Excellent stability with acid containing acrylics; and
- (4) Ability to combine characteristics of low MFFT and high film hardness.

The speaker concluded with slides showing specific polyurethane and acrylic latices, their swelling characteristics, DMTA and SAXS data, and film formation.

GENE C. ANDERSON, *Secretary*

NEW YORKOCT.

25-Year Members

The following members were recognized for their 25 years of service to the New York Society: Richard O. Innes, James A. O'Neill, Norman M. Russo, Ronald G. Spitzer, Joseph A. Vona, Edward Wanderman, and William P. Weber.

Technical Committee Chairman, Sheila Westerveld, of Standard Coating Corp., reported on the progress of three committees. The Zero Volatility Latex Committee will poll architectural coatings manufacturers and results will be reported at the next Technical Committee meeting.

More video tapes are being planned. A new proposal must be prepared by the Committee for the next series on laboratory procedures.

The Society Symposium, "Recent Advances in Additives and Modifiers for Coatings" is scheduled for May 3-4, 1995. Symposium Chairman Larry Waelde, of Troy Corp., is seeking volunteers for various duties.

Mike Frantz, Society Representative, reported on the highlights of the FSCT Board of Directors meeting on October 11, 1994, in New Orleans, LA. Mr. Frantz informed the members of the JCT redesign. In addition, he stated that Panorama™ Coatings Material Safety Data Sheet CD Retrieval System contains a majority of all raw materials used in the coatings industry.

The By-Laws Committee has proposed

two amendments: (1) a dues increase to \$25 for each active and associate member; and (2) under special circumstances, small Societies may have an Associate member serve as Society Representative should no Active member be available.

Cary Grobstein, of LBL Sales, presented the Mattiello Scholarship to Myongsoo Kim, of the Polytechnic University.

The meeting's technical presentation was delivered by Andrea Metz, of Rohm and Haas Co. Ms. Metz began with some of the issues that affect the global coatings industry, such as health/safety of the applicator and environmental impact. Meanwhile, coatings consumers are also asking for low odor coatings, and various regulations seek to lower both emissions and hazards.

The speaker compared solvent-free formulations to conventional latex technology for application, stability, and coating film properties. The new technology, which is based on heterogeneous polymer networks, eliminates the need for coalescent solvents and makes low MFFT with high film hardness possible.

Formulation techniques for improving scrub resistance, freeze thaw stability, and increasing gloss were also discussed by Ms. Metz.

JOHN W. DU, *Secretary*

NEW YORK NOV.

Federation Committee Update

Technical Committee Chairman Sheila Westerveld, of Standard Coating Corp., reported on the following committees:

—Symposium Committee has announced that approximately 15 papers will be presented at the spring symposium on May 3-4, 1995.

—The Zero VOC Architectural Coatings Committee conducted a survey and determined that many large paint companies do not have a perfected no VOC commercially available product. Furthermore, these companies will not market these products until forced by regulations. Next, the committee will look into a paper on "Formulation Principles for No VOC Coatings."

—A meeting is scheduled for November 22 of the Rheological Committee to evaluate paints.

Society Representative Mike Frantz, of Daniel Products Co., reported on several Federation committee activities. The Educational Coordinating Committee is working on a high school science kit that will enable Society members to demonstrate paint technology to high schools and community groups.

The Technical Advisory Committee continues to work with ASTM on lead abatement.

They are planning a series of practical articles on architectural coatings. The Joint Coatings/Forest Products Committee has been elevated to full committee status by the Planning Committee.

The Corrosion Committee presented the symposium "Innovations in the Development of VOC Compliant Corrosion-Resistant Coatings: Testing and Technology" at the Annual Meeting. They are planning a panel discussion for the 1995 Annual Meeting. Also, a monograph on "Methodology for Assessing Corrosion Inhibiting Performance in Coatings" is being developed.

Mr. Frantz announced the formation of the joint FSCT/NPCA Manufacturing Management Committee.

The Professional Development Committee has modified the seminar "Formulating for the New Clean Air Act," and seminars are planned for Cleveland and Denver in 1995. In addition, "Polymer Chemistry for the Coatings Formulator" is planned for Chicago in June.

George Amrich read a Metropolitan New York Paint and Coatings Association notice to membership describing an amendment to Part 205 of the NYSRR "Architectural Surface Coatings" that would include VOC limits for architectural and industrial maintenance coatings.

JOHN W. DU, *Secretary*

PACIFIC NORTHWEST (VANCOUVER) SEPT.

"Anti-Corrosive Molybdate for Protective Coatings"

A moment of silence was observed for the passing of Society Honorary Member John Filchak.

Manufacturing Committee Chairman Valerie Braund, of General Paint Ltd., reported on the Technical Advisory Committee meeting in Chicago. Federation President-Elect Joe Walton informed the attendees that progress for the 1994 Annual Meeting and Paint Show is going well.

The Federation's Executive Committee has been investigating introducing a Professional Certification Program for qualified paint technologists.

A survey may be conducted in order to gather information on getting manufacturers back into membership.

Ed Linton, of Cloverdale Paint Co., announced that Yoichi Seo has accepted chairmanship of the Technical Committee.

John Burghuis reported on the developments in hazardous waste recycling: (1) Waste Management Act passed, regulations are in place; (2) Davis & Co. retained to fight government on behalf of paint manufacturers; (3) B.C. Paint Care Association

formed. It will administer the post consumer paint stewardship program. One goal is to educate the general public on paint use and disposal; and (4) Manufacturers have established an Industry Funding Organization to fund an account to finance cost of recycling post consumer paint.

Charles Simpson, of The Sherwin-Williams Co., delivered the evening's presentation titled "ANTICORROSIVE MOLYBDATE FOR PROTECTIVE COATINGS."

KELVIN J. HUGET, *Secretary*

PACIFIC NORTHWEST (VANCOUVER) OCT.

"High-Solids, Low VOC Compliant Coatings"

Ed Linton, of Cloverdale Paint Co., reported that a plan to initiate a small circuit of manufacturers' lectures between the three chapters has been revealed.

Technical Committee Chairman Yoichi Seo, of Flecto Coatings, Ltd., will survey all members for input on how to structure and develop the technical program.

According to Dick Stewart, of Firestop Systems, Inc., the Society's introductory course will be ready for final editing soon. The course has been departmentalized into latex, alkyds, water-reducible, and industrial paints. The course will be held at Kwantlen College.

Dick Stewart volunteered to produce a booklet on the past 50 years of the Pacific Northwest Society and is asking members to forward any pertinent material.

The meeting's speaker was Mehrdad Emani, of McWhorter Technologies, Inc., whose topic was "High-Solids, Low VOC Compliant Coatings."

KELVIN J. HUGET, *Secretary*

PITTSBURGH SEPT.

1994-95 Committee Chairmen

A moment of silence was observed for Edward T. Ryan, of PPG Industries, Inc.

Mark Zoller, of A.C. Zoller Co., passed the Hüls gavel to President Mark A. Harley, of PPG Industries, Inc.

The Past-President's Pin was presented to Timothy Zeffiro, of J.M. Gillen/Van Horn Metz.

The following Committee Chairmen were announced: Educational Committee—Timothy Zeffiro; Manufacturing Committee—Thomas R. Sullivan, of J.M. Gillen; and Technical Advisory—Clifford K. Schoff, of PPG Industries, Inc.

The Pittsburgh Society will conduct a joint technical seminar with the Cleveland Society in 1995.

JIM REDISKE, *Secretary*

SOUTHERN (ATLANTA) SEPT,

"Formulating for the Nineties"

The Officers of the Atlanta Section of the Southern Society for 1994-95 were announced as follows: Chairman—Al Crego, of The Glidden Co.; Vice Chairman—Eve DeLaVega-Irvine, of J.M. Huber Corp.; Treasurer—Richard S. Brown, of MVA, Inc.; and Secretary—Thomas E. Godfrey, of Kohl Marketing, Inc.

George W. Buttrick, of Union Carbide Corp., UCAR Emulsion Systems gave the evening's presentation. His topic was "FORMULATING FOR THE NINETIES."

AL CREGO, *Chairman*



The 1994-95 Executive Committee of the Detroit Society consists of the following (from left): President—Ron Andrus, United Paint & Chemical; Vice President—Jane Allen, EPS; Treasurer—Tedd Strobehn, Boehl Chemicals; and Secretary—Jan Hammond, BASF.

Elections

CDIC

Active

Holzrichter, Norman A.—M Grumbacker (Consultant), Dublin, OH.
Miller, Laura S.—Perry & Derrick Co., Cincinnati, OH.

Associate

Flanagan, Michael—Flanagan Associates, Inc., Cincinnati, OH.
Joyce, James L.—Colgon Corp., Westerville, OH.
Spranger, Tilo H.—Netzsch Inc., Cincinnati.

CHICAGO

Active

Campbell, Dale R.—The Sherwin-Williams Co., Chicago, IL.
Girard, Greg B.—Armitage Industries, Inc., Elk Grove Village, IL.
Harloff, Michael L.—Rust-Oleum Corp., Pleasant Prairie, WI.
Jondahl, Thor P.—Coates Coatings Inc., Carol Stream, IL.
Kontor, Caroline J.—Halox Pigments, Hammond, IN.
Moore, James H.—The Valspar Corp., Wheeling, IL.
O'Brien, Kevin P.—Morton International, Batavia, IL.
Shulman, Peter—Zeneca Resins, Naperville, IL.
Tropsic, Christina A.—Halox Pigments, Hammond.

Associate

Balcerski, James S.—TAB Chemicals, Chicago, IL.
Palagi, Greg—Morton International, Chicago.
Reetz, Helen A.—Rust-Oleum Corp., Vernon Hills, IL.
White, James W.—White Chemical Equipment, Geneva, IL.

CLEVELAND

Active

Carpenter, Eftithia I.—PPG Industries, Inc., Cleveland, OH.
Gerow, Daniel M.—Aexcel Corp., Mentor, OH.
Hinman, Michael E.—PPG Industries, Inc., Cleveland.
Lanier, Tina R.—BFGoodrich, Brecksville, OH.
Matheis, Penny A.—Glidden Co., Strongsville, OH.
Patel, Prashant—BFGoodrich, Brecksville.
Snow, George E.—BFGoodrich, Brecksville.

Associate

Cornett, Arlen C.—CR Minerals Corp., Golden, CO.
Peoples, Renee—ECC International, Brecksville, OH.
Toney, Shawn—GE Silicones, Seven Hills, OH.
Woodworth, James P.—Davies Can Co., Solon, OH.

DETROIT

Active

Houvras, Yveara—Toledo Floor Resurface, Toledo, OH.
Plant, Adam—Akzo Nobel Coatings, Inc., Roseville, MI.
Prakapas, John P.—Mercury Paints, Detroit, MI.
Ricafraanca, Rene M.—The Sherwin-Williams Co., Troy, MI.
Ticu, Adriana E.—BASF Corp., Southfield, MI.
Verona, John A.—Tremco Autobody Tech., Brighton, MI.

LOUISVILLE

Active

Becker, Bonni L.—Akzo Nobel Coatings, Louisville, KY.
Davies, Martha A.—Reynolds Metals Co., Louisville, KY.
Scott, Alfred T.—The Sherwin-Williams Co., Richmond, KY.

Associate

Barbosa, Bob—E.P.S., Plano, TX.
Long, Kenneth D.—Reynolds Metals Co., Louisville, KY.

MONTREAL

Active

Caro, Judith E.—Adamin Industries Ltee., Chateauguay, Que.
Richard, Michel—Sico Inc., Longueuil, Que.

Associate

Wilson, Allan J.—Cabot Canada Ltd., Sarnia, Ont.

NEW ENGLAND

Active

Atkinson, Angela M.—Key Polymer Corp., Lawrence, MA.

Bieler, Yan P.—Raffi & Swanson, Wilmington, MA.

Henry, Jerry L.—Imtec Inc., Bellows Falls, VT.
Jameson, Benjamin J.—C F Jameson & Co., Inc., Bradford, MA.

Kadel, Susan S.—E.I. Dupont, Ballston Lake, NY.

McGregor, Robert G.—Brookfield Engineering, Stoughton, MA.

Veiga, Manuel J.—Bradford Industries, Lowell, MA.

Warren, Ronald D.—Zeneca Resins, Wilmington, MA.

Associate

Murphy, Garry J.—M-Coat, Lynn, MA.
Turpin, Robert H.—Quin-T Corp., Tilton, NH.
Wojewoda, Charles M.—Monsanto Co., Springfield, MA.

NEW YORK

Active

Asif, Mohammad—Benjamin Moore & Co., Flanders, NJ.
Courter, Jeanne L.—CYTEC Industries Inc., Stamford, CT.
Eskay, Robert R.—Darworth Co., Simsbury, CT.
Latif, Hamdi A.—Flexabar Corp., Lakewood, NJ.
Manz, Mark C.—Panelgraphic Corp., West Caldwell, NJ.
Mazzariello, Rick G.—Werner-Gershon Associates, Sandy Hook, CT.
Minchow, Carl B.—Benjamin Moore & Co., Flanders.
Tavaska, Robert S.—Panelgraphic Corp., West Caldwell.
Tubbs, Forrest W.—Por-15 Corp., Whippany, NJ.
Zukowski, Karrie L.—Union Carbide Corp., Samerser, NJ.

Associate

Baldassari, Janis A.—BFGoorich, Mountainhome, PA.
Cappabianca, Carl J.—Drew Industrial Div., Boonton, NJ.
Marshall, Gerard M.—Omya, Inc., Proctor, VT.

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Melikyan, M. Rebecca—ARC Industries LLC, Paterson, NJ.
O'Connor, J. Brian—McWhorter Technologies, Cape May, NJ.
Percy, Eric J.—Percy International Ltd., Averill Parks, NY.
Schimmel, Bruce S.—Ultra Additives, Paterson.

Retired

Chamberlin, R.E.—Belle Mead, NJ.
Forsyth, Robert—Riveredge, NJ.
Kovach, George A.—Union, NJ.
Nortman, Arthur I.—Brooklyn, NY.

NORTHWESTERN

Active

Figlioti, Peter A.—McWhorter Technologies, Minneapolis, MN.
Morgan, Sandra D.—Andersen Windows, Bayport, MN.
Sohoni, Milind B.—McWhorter Technologies, Minneapolis.

PIEDMONT

Active

Catena, Daniel W.—Syntech, Inc., Easley, SC.
Jovanovich, Nada—Akzo Nobel, High Point, NC.

Pittman, Dale E.—Standard Products, Rocky Mount, NC.
Watts, Gary W.—Alchemy-South, Blountville, TN.

SOUTHERN

Active

Granito, Richard—Coatings Consultants, Marathon Shores, FL.
Katres, Todd—Hüls America, Atlanta, GA.

Associate

Blackford, Robert W.—Ribelin Sales Inc., Garland, TX.
Gander, Aaron D.—Whittaker, Clark & Daniels, Cordova, TN.
Hall, James A.—Mayo Chemical Co., Smyra, GA.
Hyde, Jeffrey R.—Kemira Pigments Inc., Savannah, GA.
Nesom, Wilson F.—SC Johnson Polymer, Oviedo, FL.
Poe, Thomas R.—Seegott, Inc., Florence, KY.
Rhodes, Louis C.—Kemira, Florence.
Walter, Anita—Monsanto Co., Atlanta, GA.

Educator/Student

Poole, Payton W.—University of Southern Mississippi, Hattiesburg, MS.

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TORONTO

Active

Goode, Kenneth W.—Office Specialty, Holland Landing, Ont.
Ionescu, Corina C.—Tristar Coatings, Brampton, Ont.
Marinucci, Sam—Para Inc., Brampton.
Troncoso, Enrique R.—Lorama Chemicals Inc., Milton, Ont.

Associate

Chamberlain, Mike—Stanchem, Etobicoke, Ont.
Marshall, Griff M.—Dow Chemical Canada Inc., Etobicoke.
McGowan, Herbert C.—Dow Chemical Canada Inc., Etobicoke.
Painshaud, Marcel J.—Reichhold Ltd., Brampton, Ont.
Stevenson, Arnold—Debro Chemicals, Mississauga, Ont.

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Cervantes Convention Center

St. Louis, Missouri

Future Society Meetings

CDIC

(Jan. 9)—“ACRYLIC-POLYURETHANE HYBRID DISPERSIONS AND THEIR USE IN WATERBORNE COATINGS”—Charles R. Hegedus, Air Products and Chemicals.

(Mar. 13)—Manufacturing Program.

(Apr. 10)—CDIC 75th Anniversary.

(May 8)—“EVALUATION OF NEW GENERATION COALESCING AGENTS FOR INDUSTRIAL ACRYLIC LATEXES”—Thomas M. Larson, Exxon Chemical Co.

Chicago

(Jan. 9)—“REACTIVE OXAZOLIDINE MOISTURE CONTROL ADDITIVES FOR POLYURETHANE COATINGS”—Thomas L. Johnson, ANGUS Chemical Co.

(Feb. 6)—“DESIGNING FOR QUALITY”—Laura J. Hansen, Orr & Boss.

(Mar. 6)—“SOLVING PRACTICAL ADHESION PROBLEMS IN COATINGS WITH FUNDAMENTAL STUDIES IN SURFACE AND BULK EFFECTS OF ADHESION”—Krishan C. Sehgal, Union Carbide Chemical & Plastics Co., Inc.

(Apr. 4)—“NEW TECHNOLOGY IN SMALL MEDIA MILLING”—Harry Way, Netzsch, Inc.

(May 12)—Annual Awards Banquet.

Cleveland

(Jan. 17)—Joint Meeting with CPCA, State of the Industry—John Danziesen, Glidden/ICI America.

(Feb. 21)—“FOAM & FOAM CONTROL AGENTS”—Andrew Romano, Drew Division/ Ashland Chemical.

(Mar. 21)—“USING KAOLIN PIGMENTS TO REPLACE CRYSTALLINE SILICA”—Thad T. Broome, J.M. Huber Corp.

(Apr. 11)—Manufacturing Symposium.

(Apr. 18)—Annual Meeting. “UNIQUE WETTING & DISPERSING ADDITIVES”—Edward Orr, BYK-Chemie.

(May 4-5)—Educational Symposium.

(May 16)—Awards/Past-Presidents'/ Spouses' Night.

Golden Gate

(Jan. 16)—“UTILIZATION OF A NEW REACTIVE DILUENT TO FORMULATE LOW VOC COATINGS”—Dharma Kodali, Cargill Technical Oils.

(Mar. 13)—“USE OF SMECTITE CLAY MINERALS IN WATERBORNE SYSTEMS”—Dwayne Siptak and Bob Briell, Southern Clay Products.

(Apr. 17)—“EASILY DISPERSIBLE, LOW OIL ABSORPTION, OPACIFYING ORGANIC PIGMENTS ENCAPSULATING TITANATED LITHOPONE”—Michael Issel, Sino American Pigments.

(May 15)—“HIGH-SPEED DISPERSION TECHNIQUES”—Rocky Courtain, Morehouse Industries, Inc.

(June 19)—Manufacturing Committee Seminar.

Los Angeles

(Jan. 11)—Federation Officers Visit. “UTILIZATION OF A NEW REACTIVE DILUENT TO FORMULATE LOW VOC COATINGS”—Dharma Kodali, Cargill Technical Oils.

(Feb. 20-22)—Western Coatings Societies' Symposium and Show, San Francisco, CA.

(Mar. 8)—Past Presidents' Night. “USE OF SMECTITE CLAY MINERALS IN WATERBORNE COATINGS”—Dwayne Siptak and Bob Briell, Southern Clay Products.

(Apr. 12)—Bosses' Night. “EASILY DISPERSIBLE, LOW OIL ABSORPTION OPACIFYING ORGANIC PIGMENTS ENCAPSULATING TITANATED LITHOPONE”—Mike Issel, Sino American Pigments.

(May 10)—Awards Night. “HIGH-SPEED DISPERSION TECHNIQUES UPDATE”—Rocky Courtain, Morehouse Industries, Inc.

(June 14)—Annual Meeting.

Montreal

(Jan. 11)—“ZERO VOC COLORANTS”—Eliot Burrows, Engelhard Corp.

(Feb. 2)—Mini Symposium.

(Mar. 1)—“ACCELERATED TESTING”—Dwight Weldon, KTA-Tator.

(Apr. 5)—“RHEOLOGY MODIFIERS”—Bob Briell, Southern Clay Products.

(May 3)—“EPOXY TECHNOLOGY”—Elizabeth Wrobel, Air Products/Pacific Anchor.

New England

(Jan. 19)—“ECONOMIC UPDATE”—Arthur Werts III, Eastman Chemical.

(Feb. 16)—“THE EFFECT OF ASSOCIATIVE THICKENERS ON THE PROPERTIES OF WATER-BASED COATINGS”—David Bryant, Rheox.

(Mar. 16)—Past-Presidents' Night. “NEW LATEX TECHNOLOGY FOR SEMI-TRANSPARENT STAINS”—Arthur Leman, Rohm and Haas Co.

(Apr. 20)—Joint Meeting with New England Paint and Coatings Association. “NEW COALESCING SOLVENTS FOR WATERBORNE COATINGS”—Peter Doty, Dow Chemical Co.; and “COATINGS IN FORENSICS”—James Corby, FBI.

(May 25)—“NEW CHEMISTRIES IN DEFOAMERS AND WETTING AGENTS”—Fred Lewchik, BYK-Chemie.

New York

(Feb.)—Joint Legislative Update with New York Paint and Coatings Association.

Pacific Northwest (Puget Sound Section)

(Jan. 18)—“UTILIZATION OF NEW REACTIVE DILUENT IN FORMULATING LOW VOC COATINGS”—Dharma Kodali, Cargill Technical Oils.

(Mar. 15)—“USE OF SMECTITE CLAY MINERALS IN WATERBORNE COATINGS”—Dwayne Siptak and Bob Briell, Southern Clay Products.

(Apr. 19)—“EASILY DISPERSIBLE, LOW OIL ABSORPTION OPACIFYING ORGANIC PIGMENTS ENCAPSULATING TITANATED LITHOPONE”—Mike Issel, Sino American Pigments.

(May 4-6)—48th Annual Spring Symposium, Portland, OR.

(May 17)—Joint Meeting with Puget Sound Paint and Coatings Association. “HIGH-SPEED DISPERSION TECHNIQUES UPDATE”—Rocky Courtain, Morehouse Industries, Inc.

Piedmont

(Jan. 18)—“REACTIVE DILUENTS”—Tom Johnson, ANGUS Chemical Co.

(Feb. 15)—“ADDITIVES FOR COATINGS”—Chuck D'Amico, Ultra Additives Corp.

Pittsburgh

(Jan. 9)—“COMPLIANT COATINGS/PROBLEMATIC PAINTS”—Clifford Schoff, PPG Industries, Inc.

(Feb. 13)—“NATURAL VS ARTIFICIAL WEATHERING AND THE EQUIPMENT AVAILABLE”—Atlas Electric Corp.

(Apr. 10)—Joint Meeting with SSPC, PDCA, NACE, and PSCT.

(May 8)—“COLOR TRENDS FOR THE COMING YEAR”—PPG Industries, Inc. Past-Presidents' and Spouses' Night.

Toronto

(Feb. 13)—“POWDER COATINGS—YESTERDAY, TODAY, AND TOMORROW”—David Barlow, The Valspar Corp.

(Mar. 6)—“RADIATION CURING TECHNOLOGY FOR THE 90s AND BEYOND”—Robert A. Lie Berman, Henkel Corp.

(Apr. 10)—Technical Symposium.

(May 8)—“Non-Toxic Anticorrosive Pigments in Aqueous Media”—Robert E. Snyder, A.R. Monteith (77) Ltd. (Toronto Society Technical Committee Presentation)

People



E.A. Wroble

SC Johnson Polymer, Racine, WI, has named **Elizabeth Anne Wroble** District Accounts Manager. Ms. Wroble will handle the company's line of Joncryl® water-based acrylic and styrenated acrylic polymers and solvent-borne oligomers for the architectural and industrial coatings markets. Based in Chicago, she will provide technical sales coverage throughout the Midwest. Ms. Wroble is a member of the Chicago Society.

Van Waters & Rogers Inc., Kirkland, WA, has reorganized the company into five process-based business teams—Industrial Chemicals, Pest Control Supplies, Waste Management, Procurement, and Logistics.

Heading each of the core business processes is a member of the company's senior leadership teams: **Rodney S. Nugent**, Vice President, Industrial Chemicals; **Bevan A. Cates**, Vice President, Pest Control Supplies; **Michael E. Efting**, Vice President, Waste Management; **Bruce D. Heckenberg**, Vice President, Procurement; and **Darwin H. Simpson**, Vice President, Logistics. The remaining members of the senior leadership team are: **Linda C. Larrabee**, Vice President, Information Systems; **Ted A. Leech**, Vice President, Controller; **H. Drew MacAfee**, Vice President, Human Resources; and **James P. Alampi**, President.

Sandra Beach Lin has been appointed Director, Asia/Pacific for the Performance Additives business unit of AlliedSignal Inc., Morristown, NJ. Based in Singapore, Ms. Beach Lin will direct the sales and technical teams throughout the Asian geographical territories for the company's polyethylene derivatives.

Also, **Alisa J. Winsauer** was named Research Chemist. Ms. Winsauer will be responsible for new product characterization and application development projects for performance additives.

Performance Coatings Inc., Ukiah, CA, has announced two appointments in the Customer Service Department. **Beverly Del Grosso** has joined the company to spearhead the customer service department, and **Roberta Ollenberger** was named Customer Service Assistant.

Thomas K. Schwartzbeck has been promoted to Chief Operating Officer and Executive Vice President of Duron, Inc., Beltsville, MD. Mr. Schwartzbeck has been with the company for 20 years.

Two other appointments have also been announced: **Scott Wilson** was named Vice President of Operations and **Richard Vain** accepted the position of Vice President of Marketing and Product Services.

Carl Cappabianca has accepted the position of Marketing Manager, Chemical Additives for Ashland Chemical Company's Drew Industrial Division, Boonton, NJ. Mr. Cappabianca will provide marketing and product development support for foam control agents, biocides, and specialty surfactants for paints/coatings, inks, adhesives, and other aqueous systems. He is a member of the New York Society.



B. Seeber

Hüls America Inc., Piscataway, NJ, has announced the promotion of **Bruce Seeber** to National Accounts Manager within its Coatings Raw Materials business group. Mr. Seeber is charged with creating strategic supplier alliances for national accounts. He is a member of the Detroit Society.

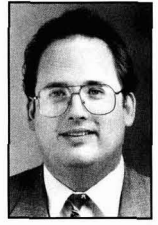
In other news, **Richard C. Diener** has accepted the promotion to the position of National Sales Manager. Mr. Diener will manage all sales-related activities of the Coatings Raw Materials group within North America.

Ed Craft has relinquished his position as Executive Director of the Wallcoverings Association, New York, NY. Mr. Craft was promoted to Vice President of a management firm. **Ron Pietrzak** replaces Mr. Craft.

Joel Oatten has accepted the position of Sales Representative for Mercury Paints, Saginaw, MI. In this position, Mr. Oatten will obtain and service professional, commercial, and industrial accounts.

Katherine A. Peterson has been named National Sales Manager, Coatings Performance Materials, for Monsanto Co., St. Louis, MO. Ms. Peterson joined the company in 1985 as a Sales Representative.

The recent addition of **Mark Drukenbrod** as Marketing Director has been announced by CB Mills, Buffalo Grove, IL. Mr. Drukenbrod will develop and implement customer and representative databases and training and sales seminars, and long-term marketing/advertising planning. He is a member of the Los Angeles Society.



M. Drukenbrod

Steven A. Reber was promoted to President of Macbeth, a Division of Kollmorgen Instruments Corp., New Windsor, NY. Mr. Reber will be responsible for the worldwide operation of the entire organization.

Akzo Nobel Coatings Inc., Troy, MI, has appointed **Rad Darby** to Vice President and General Manager, Industrial Wood Coatings. Mr. Darby will be responsible for the overall management and development of the company's Industrial Wood Coatings business based in High Point, NC, and its eight manufacturing locations across North America and Asia.

Edward Pollak has been named Vice President, International for OSi Specialties, Danbury, CT. Prior to joining the company, Mr. Pollak was a Senior Vice President of Olin Corp.

PPG Industries, Pittsburgh, PA, has announced the appointment of **L. Blaine Boswell** to Vice President of Public Affairs. Mr. Boswell will be responsible for government relations, corporate communications, and PPG Industries Foundation activities.

Also, **Arend W.D. (Ad) Vos** was named Vice President, Coatings and Resins. Mr. Vos will relocate to Tokyo, Japan.

John C. Sowizal has been named Vice President and General Manager of Custodis-Cottrell, Inc., a Research-Cottrell Company, Branchburg, NJ. Mr. Sowizal will oversee the firm's move to Itasca, IL.

Landers-Segal Color Co., Inc., Passaic, NJ, has appointed **Rick Campbell** to the position of President—Sales and Marketing. Mr. Campbell will be responsible for the further development and marketing of an extended line of organic pigments.



U. Salzer



A. Metauro

The position of Vice President and Chief Financial Officer for Degussa Corp., Ridgefield Park, NJ, has been accepted by **Uwe Salzer**. Most recently, Dr. Salzer served as Vice President and Controller for Degussa AG.

Also, **Dennis J. Taylor** has assumed the title and responsibilities of Vice President and General Counsel. Mr. Taylor will oversee all corporate legal matters.

In other news, **Albin Metauro** was named Product Manager within the Silica Division of the company's Pigment Group. In his new position, Mr. Metauro is responsible for Degussa's Aerosil® fumed silica product line.

Dexter Chemical Corp., Bronx, NY, has elected **Leo Goldberg** to the position of Chief Executive Officer. Mr. Goldberg has been with the firm since 1945 and most recently served as President and Chief Operating Officer.

Leonard Sitver succeeds Mr. Goldberg as President and Chief Operating Officer. Mr. Sitver has been with the company since 1973.

ICI Surfactants, Wilmington, DE, has named **Peter N. Saitis** as Controller. Mr. Saitis is responsible for all financial and information technology activities for the surfactants business in North America.

Vanja King has accepted the position of Group Leader for the newly created Discovery Group at Buckman Laboratories, Memphis, TN. Dr. King will guide the group in facilitating the development of new activities.

Keith Wilkinson has accepted the promotion to Products Manager, Industrial Chemicals Department for Aceto Corp., Lake Success, NY.

Frank W. Harris has been named Director of the Maurice Morton Institute of Polymer Science at The University of Akron (UA), Akron, OH. A Professor of both Polymer Science and Biomedical Engineering, Dr. Harris has been at UA since 1983. He is the fourth director to head the institute since it was founded in 1956.

Witco Corp., Greenwich, CT, has formed a new worldwide resins group overseeing the marketing of polyurethane intermediates, epoxy resins, and hardeners. Based in Frankfurt, Germany, **Peter Loewrigkeit** will spearhead the new unit as Resins Group Vice President. Mr. Loewrigkeit's most recent position was Vice President and Business Manager of Polyurethane Specialties.

The Mearl Corp., Briarcliff Manor, NY, has appointed **Paul J. Nowak** to Technical Manager, Industrial Products—Global Sales and Marketing. In addition to serving the Western Hemisphere, Mr. Nowak will conduct seminars and dispense technical assistance to European and Far East coating, paint, and plastic manufacturers primarily in the automotive industry.

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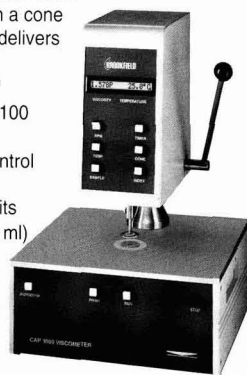
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22nd Waterborne, High-Solids, and Powder Coatings Symposium Scheduled for February 22-24, 1995

The 22nd Annual Waterborne, High-Solids, and Powder Coatings Symposium, co-sponsored by the Southern Society for Coatings Technology and the Department of Polymer Science of the University of Southern Mississippi (USM), Hattiesburg, MS, is slated for February 22-24, 1995, at the Hyatt Regency Hotel, New Orleans, LA.

The symposium will focus on the chemistry, formulation, and new developments in waterborne, high-solids, and powder coatings. Topics scheduled for presentation include the following:

Plenary Lecture—"Powder Coatings: Current Developments, Future Trends"—Douglas S. Richart, of D.S.R. Associates;

"New Blocked Polyisocyanates for Powder Coating Applications"—F.M. Witte, G. Kieft, W.H.A. van den Elshout, R. Bajjards, M. Houweling, of DSM Resins BV;

"Novel Hardeners for Polyurethane Powder Coatings"—J.V. Weiss and R.M. Guida, of Hüls America Inc.;

"Determination of Cure Profiles in Powder Coatings"—D.A. Hammerton, J.S. Dick, of UCB Chemicals Corp. and Monsanto Chemical Co.;

"Factors Affecting the Gloss Reducing Efficiency of Ionomeric Flattening Agents for Powder Coatings"—D.F. Loar, of Allied-Signal, Inc.;

"Method to Measure Inhomogeneities in Resin Polymers for Powder Coating"—R. Popli, of SC Johnson Polymer;

"A New, Self-Emulsifying Curing Agent Technology for Two-Component, Waterborne Epoxy Formulations"—F.H. Walker, K.E. Everett, S. Kamat, of Air Products and Chemicals, Inc.;

"Waterborne Epoxy Resins for Ambient Temperature Cure—Optimizing a Modular Resin/Hardener Base for Specific Demands"—B. Stengel-Rufkowsky, C. Godau, A. Pfeil, P. Becker, of Hoechst AG and Hoechst Celanese Corp., USA;

"The Chemistry and Properties of Unique Curing Agents in Two-Component Waterborne Epoxy Coatings"—B.A. Naderhoff and T.P. Takas, of Reichhold Chemicals, Inc.;

"Formulating High Performance, Rapid-Dry Waterborne Epoxy Primers"—D.J. Weinmann and E.C. Galgocsi, of Shell Development Co.;

"Structure-Property Relationship of Waterborne Epoxy Coatings Based on Novel Self-Dispersible Epoxy Resins"—K.S.

Arora, J.L. Chou, D.I. Devore, and J. Papalos, of Henkel Corp.;

"Formulation of Ultra Low VOC Waterborne Inside Spray Coatings for Beer and Beverage Cans"—G.G. Parekh, L.J. Sharp, and K.R. Thompson, of The Dexter Corp.;

"Enhanced Performance and Improved Economics of Supercritical Fluid Applied Coatings"—J.N. Argyropoulos, D.C. Busby, D.J. Dickson, C.S. Lee, and K.A. Nielsen, of Union Carbide Corp.;

"An Experimental Study of the Structure of Supercritical Fluid and Conventional Air Paint Sprays"—D.W. Sencer and J.C. Colwell, of University of Wyoming and Purdue University;

"Aliphatic Dibasic Acid-Modified Polyester Thermoset Industrial Coatings"—P.C. Heidt and M.L. Elliott, of Eastman Chemical Co.;

"Improved High-Solids, Low VOC Alkyd Coatings from 5-Tert-Butyl Isophthalic Acid"—H.B. Yokelson, K.R. Lane, L.C. Satek, R.T. Behrends, P.A. Shope, and M.A. Wilhemi, of Amoco Chemical Co.;

"Vinyl Ester Modification of 250 gm/Liter Alkyds for Faster Dry"—R.F. Eaton, K.T. Lamb, and M.P. Farr, of Union Carbide Chemicals and Plastics Co., Inc.;

"Polyester Primers Containing Cycloaliphatic Intermediates for Low VOC and Improved Flexibility"—K.M. Moody and C.A. Sykes, of Eastman Chemical Co.;

"Low VOC Fast Air-Drying Alkyd Coatings II. Allylic Reactive Diluents"—S. Dirlikov, I. Badou, and Z. Chen, of MEZA Polymers, Inc., Paint Research Associates, and Coatings Research Institute, EMU;

"Microphase Structure and Mechanical Properties of the Acrylic-Polyurethane Aqueous Dispersions: Effects of Acrylate Polymerization Processes"—Y.H. Jan, Y.T. Hwang, and C.Y. Shih, of Union Chemical Laboratories;

"Structure-Property Relationships of Aqueous Polyurethane Dispersions"—H.T. Lee, Y-T. Hwang, N-S. Chang, and C.C.T. Huang, of Union Chemical Laboratories;

"Waterborne Polyurethane Dispersion Adhesives for High Performance Film Laminating Applications"—P.A. Voss and T.E. Rolando, of H.B. Fuller Co.;

"Novel Waterborne Polyurethane Dispersions: Advances in Ambient Crosslinking with Polyisocyanates"—V.J. Tramontano and W.J. Blank, of King Industries, Inc.;

"Use of Dispersions in Urethane Aqueous Coatings"—B.R.C. Langlois, of Rhône-Poulenc-C.R.A.;

"Two-Component Water-Reducible Polyurethane Coatings"—D.E. Fiori and R. Quinn, of Cytec Industries, Inc.;

"Fast Drying, Ultra Low VOC, Two-Component Waterborne Polyurethane Coatings for the Wood Industry"—C.A. Renk and A.J. Swartz, of Miles, Inc. and Rohm and Haas Co.;

"Organic Modified Silicone Resins for Coatings"—A. Be and G.L. Witucki, of Dow Corning Corp.;

"Viscosity Reduction via Monomer Selection in Solvent-Borne High-Solids Styrene/Acrylic Coating Resins"—C.A. Zezza and K.D. Talmo, of Rhône-Poulenc, Inc.;

"The Use of Ultrafine Microporous Polyamide Powders as Reinforcement and

(Continued on next page.)

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USM to Conduct Three Short Courses Prior to 1995 Waterborne, High-Solids, Powder Coatings Symposium on February 20-21

(Continued from previous page.)

Matting Agent for UV-Cure Systems"—M. Bernard, F. Galloudec, E. Valot, of Cray Valley, Elf Atochem N.A., and Elf Atochem S.A.;

"Optimization of Type and Amount of Diluents and Flexibilizer for Solventless Epoxy Coatings"—J.H. Jagannath, of Naval R & D, New Delhi;

"Physical Chemistry of Acrylic Powder Coatings"—T. Annable, B.J. Denton, D. Perito, and S.G. Yeates, of Zeneca Resins;

"Correlation of Thermal History and Performance in Thermoplastic Powder Coatings"—S.F. Thames, K.G. Panjani, and S.D. Pace, of University of Southern Mississippi (USM), Dept. of Polymer Science;

"Environmentally Compliant Thermoplastic Powder Coatings"—D.H. Neale and D. Ellicks, of Science Applications International Corp. and U.S. Air Force Corrosion Program Office;

"Recent Developments in the Chemistry, Formulation, and Testing of Waterborne, Thin-Film Intumescent Coatings for the Fire Protection of Structural Steel"—L. O'Keefe, of Nullfire Limited;

"Novel Flame-Retardant Dibromostyrene-Based Latices: Synthesis, Characterization, and Applications"—J.L. Wang and N.A. Favstritsky, Great Lakes Chemical Corp.;

"Synthesis, Characterization, and Application of Lesquerella Oil Product in Water-Reducible Coatings"—S.F. Thames and H. Yu, of USM;

"Surface Defect Control in Waterborne Coatings"—M.A. Grolitzer, M. Ojunga-Andrew, and D.E. Erickson, of Monsanto Chemical Co.;

"Consolidation of Coating Structure: Effect of Pigment Type, Binder Level, and Dewatering Conditions"—A. Stanislawski and P. Lepoutre, of the University of Maine, Chemical Engineering Dept.;

"A Statistical Study of Hydrolytic Stability in Amine Neutralized Waterborne Polyester Resins as a Function of Monomer

Composition"—T.E. Jones and J.M. McCarthy, of Eastman Chemical Co.;

"Organic Pigments for Waterborne Industrial Coatings"—R. Kumar, of Hoechst Celanese Corp.;

"Surface Control Additives for Radiation-Curing Systems"—J. Adams, S. Struck, and K. Bowling, of Tego Chemie Service GmbH and Tego Chemie Service, USA;

"Microhardness in UV-Cured Abrasion Resistant Coatings"—J.D. Blizzard, J. S. Tonge, and T.R. Washer, of Dow Corning Corp.;

"Aluminum Trihydroxide (ATH) as a Filler for 100% Solids, UV-Cure Coatings: Effects of Filler Loading on UV Transparency and Cure Kinetics"—T.R. Clever, N.R. Dando, P.L. Kolek, and E.S. Martin, of Alcoa Industrial Chemicals;

"Aldimine-Isocyanate Chemistry: Application in High-Solids Coatings"—M.J. Dvorchak, S.D. Hicks, T.D. Wayt, and D.A. Wicks, of Miles, Inc.;

"Aldimine-Isocyanate Chemistry: A Foundation for High-Solids Coatings"—M. Lee, A.D. Meltzer, L.D. Venham, D.A. Wicks, and P.E. Yeske, of Miles, Inc.;

"Urethane Coatings Formulated with Blends of Polyisophorone Diisocyanate and Polyhexamethylene Diisocyanate"—R.T. Wojcik, R.S. Blackwell, J.W. Reisch, and J.M. O'Connor, of Olin Corp.;

"High-Solids Coatings Based on a Novel Triisocyanate"—M. Ojunga-Andrew, H.P. Higginbottom and L.W. Hill, of Monsanto Co.;

"Automotive Clearcoats Incorporating Silane Functionality and Auxiliary Crosslinkers"—J.D. Nordstrom, of DuPont Corp.;

"Aqueous Polyurethane Coating Systems for Plastics"—J. Petzoldt and M. Bock, of LS-Marketing/AL, Bayer AG;

"The Effects of Solvent and Thermal History on the Adhesion of Coatings to Thermoplastic Olefins (TPOs)"—R.A. Ryzntz, of Ford Motor Co.;

"Competitive Adsorption of Polymers and Surfactants at the Solid/Liquid Inter-

face"—I.D. Robb and P. Williams, of North East Wales Institute;

"Chlorinated and Chlorosulfonated Copolymers as Coatings Additives"—J.F. Kolc and D.F. Loar, of AlliedSignal Inc.;

"Chemistry of *In-Situ* Metal Surface Phosphating in Air-Dry Paint System"—Y. Y. Chuang and C-T. Lin, of Northern Illinois University, Dept. of Chemistry; and

"Life Cycle Assessment of Industrial Coatings"—I.S. Biggin, of BP Chemicals.

The sessions conclude with the presentation of the Elias Singer Best Paper Award.

In addition, three short courses that cover polymer science essential to surface coatings science and technology will be offered prior to the symposium at the Hyatt Regency Hotel on February 20-21, 1995.

The "Modern Coatings Technology" course is designed for individuals responsible for coatings formulation, development, and research and offers information on contemporary coatings design, formulation, and testing. It focuses on conversion from solvent to waterborne formulations and development and testing of solvent-based, waterborne, high-solids, and powder coatings. The lectures will delineate formulation/performance relationships and convey appropriate methods for technological development of superior yet cost-effective coatings.

The second short course offered is "Water-Soluble/Waterborne Polymers." Geared toward industrial chemists, this course emphasizes synthesis, characterization, kinetics, solution properties, and rheological behavior. Lectures will outline structure/property/performance relationships.

"Reformulating to Waterborne Coatings" offers practical "how to" information for implementing a variety of waterborne coating processes. Resin design and paint formulation considerations during conversion from a conventional solvent-borne coating to a waterborne coating will be discussed. This course will benefit all segments of the industry, including raw materials manufacturers, paint formulators, and end-users.

The advance registration fee for the symposium is \$495 and includes admission to the technical sessions, a copy of the *Proceedings*, refreshments, and invitations to the reception and breakfast buffet.

The advance registration fee for the short courses is \$795 each, which includes admission to the instructional sessions, pre-printed notes, and continental breakfasts and refreshments.

For those attending both a short course and the symposium, a reduction of \$100 in the short course is offered.

Advance registration must be postmarked by February 1, 1995. To obtain more information on the symposium and short courses, contact USM, Dept. of Polymer Science, Box 10063, Hattiesburg, MS 39406.

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Congratulations!

**To The
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On Their 75th Anniversary**

December 10, 1994

Chicago SCT and PCA Sponsor Coatings Course

The Joint Educational Committee of the Chicago Society for Coatings Technology and Chicago Paint and Coatings Association will conduct a "Course in Coatings Technology" on Tuesday evenings from January 10 to May 16, 1995. Held at the Lincoln Park campus of DePaul University, the course is designed to provide information on the fundamental tools needed in the coatings industry.

"A Course in Coatings Technology" serves as an introduction to the important concepts of coatings technology for chemists, technicians, sales people, and those seeking a basic understanding of coatings. Weekly modules will feature guest lecturers who will discuss the following topics:

INTRODUCTORY CONCEPTS

"Introduction to Coatings," "Introduction to Polymers," "Film Formation and Solvent Functionality: Viscoelastic Properties and Rheology Measurement."

POLYMER TECHNOLOGIES

"Polyurethanes," "Aminoplasts," "Epoxy Resins and Curing Agents," and "Oils, Alkyds, Varnishes, Driers, Antioxidants, and Antiskins."

COATINGS TECHNOLOGIES

"Conventional Technologies: Formulating Trade Sales Coatings and Formulating Industrial Coatings," "Emerging Technologies: Powder and High-Solids Coatings," and "Radiation Cured Materials."

ADDITIVES

"Defoamers," "Rheology Modifiers," and "Dispersants and Surfactants."

PIGMENTS

"White Hiding, Extender, and Color Pigments," "Color Theory, Shading and Color Measurement," and "Dispersion of Pigments."

APPLICATION TECHNIQUES AND TESTING

"Application of Industrial Coatings," "Application of Trade Sales and Maintenance Coatings," "Testing Techniques," and "Accelerated Weathering."

QUALITY CONTROL AND GOVERNMENTAL REGULATIONS

"Quality Assurance and ISO 9000" and "Environmental Considerations and Governmental Regulations"

The course concludes with a banquet on May 16, 1995.

The cost of the complete course is \$475 and includes the text and banquet. For additional information, contact Alison Azar, Seegott, Inc., 1675D Holmes Rd., Elgin, IL 60123; or Kevin Murray, Applied Polymer Systems, 1208 Remington Rd., Schaumburg, IL 60173.

"Advances in Emulsion Polymerization" Short Course Scheduled for June 5-9, 1995

The 26th annual one-week short course "Advances in Emulsion Polymerization and Latex Technology," will be offered at Lehigh University, Bethlehem, PA, during the week of June 5-9, 1995.

This course, which is designed for engineers, chemists, other scientists and managers who are actively involved in emulsion work and for those who wish to develop expertise in the area, provides an in-depth

study of the synthesis and properties of high polymer latexes. The course covers theory and applications as well as a balance between chemical and physical problems.

The course fee is \$900 for the entire week or \$300 per day for any part. Further information can be obtained from Dr. Mohamed S. El-Aasser, Emulsion Polymers Institute, Lehigh University, 111 Research Dr., Bethlehem, PA 18015.



The *Baby Tigers* were back again in the **Consolidated Research** Booth at the Paint Industries' Show. But more important, attendees learned of the wealth of talent offered by our 75 experts in coatings problem solving, market research, litigation support, expert witness, reformulations, seminars, FDA compliance, plant audits, turn-key start up and paint productions, and so forth.

Dr. Juergen H. Braun (left) and Alan Brandau, are two of the Consolidated Research experts that are up to the most exotic challenges in our coatings industry.



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Spring Week 1995

Technical Seminar

**“Coatings in the Americas:
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Issues”**



Wednesday - Thursday

May 17-18, 1995

**Fiesta Americana Coral Beach
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**** Seminar information available February 1995 ****

**FSCT, 492 Norristown Rd., Blue Bell, PA 19422
Phone - (610) 940-0777 FAX - (610) 940-0292**

Polyurethane Topcoats

A line of polyurethane topcoats designed to be chemical and solvent resistant has been detailed in technical literature. These topcoats, used to protect exterior surfaces of military aircraft and ground support equipment, have been approved by the Department of the Navy for use in the Defense Department. Contact Spraylat Corp., Aerospace Coatings Div., 1701 E. 122nd St., Chicago, IL 60633, for more information on the Eco-Thane™ line.

Circle No. 30 on Reader Service Card

Cleaning System

The introduction of a high-pressure cleaning system has been made through technical literature. This system pneumatically evacuates all solvent lines after each washing cycle to decrease VOCs. For complete technical details on the SP50/SP80 Tote Tank, write Disti-Kleen, Inc., 22 Hudson Pl., Hoboken, NJ 07030-5512.

Circle No. 31 on Reader Service Card

Coating Inspection

A logbook for coatings inspectors, paint foremen, and project managers has been published. The book contains record sheets and sections on general project data, project record and reports, and an inspector's daily log reference data. Information on the *NACE Coating Inspector's Logbook* is available from NACE International, P.O. Box 218340, Houston, TX 77218-8340.

Circle No. 32 on Reader Service Card

Test Chamber

Literature introduces a xenon-arc lamp tabletop weathering chamber with micro-processor controls. Built-in sensors for irradiance, black standard, and test chamber temperature are included on this instrument. For more details on the Suntest CPS+, write Heraeus DSET Laboratories, 45601 N. 47th Ave., Phoenix, AZ 85027-7042.

Circle No. 33 on Reader Service Card

Capillary Column

An application note highlights capillary GC columns guaranteed to provide column-to-column reproducibility and retention indexes for natural essential oil analysis. To receive a free copy of the *Essential Oils Analysis Application Note* (#FF3), contact J&W Scientific, 91 Blue Ravine Rd., Folsom, CA 95630.

Circle No. 34 on Reader Service Card

Environmental Guide

An environmental guide highlights regulation issues and compliance for furniture manufacturers. The guide covers topics such as environmental compliance, hazardous waste, underground storage tanks, wastewater, and spill prevention control. Contact AFMA, P.O. Box HP-7, High Point, NC 27261, for the "Environmental Guide for the Furniture Industry" or the "Wood Industry Waste Reduction Opportunities" workbook.

Circle No. 35 on Reader Service Card

Glycols

A publication describes a branched aliphatic diol with two primary hydroxyls. This glycol is intended for use in the production of urethanes, polyester coatings, unsaturated polyester resins, polymeric plasticizers, and diverse solvent applications. A copy of "MPDiol Glycol: Coatings/Solvents/Urethanes/Plasticizers" is available from ARCO Chemical Co., 3801 West Chester Pike, Newtown Square, PA 19073.

Circle No. 36 on Reader Service Card

Particle Sizing

A photo-sedimentometer, which measures particle size distribution of a powder by determining the light extinction of the suspended powder while it is sedimenting in a cuvette, is introduced through literature. For additional information on the Lumosed, write Paar Physica USA, Inc., 1090 King Georges Post Rd., Ste. 401, Edison, NJ 08837.

Circle No. 37 on Reader Service Card

Liquids/Solids Level Switch

Literature highlights on/off R.F. switches for monitoring tank levels of both liquids and solids. These switches are designed to measure changes in dielectric capacitance. For additional details on series 7000 level switches, contact Bernhard, Inc., 508 Center St., Kennett Square, PA 19348.

Circle No. 38 on Reader Service Card

Potentiostat

A press release highlights a potentiostat/galvanostat for basic research or electroanalytical and electrochemical corrosion measurements. Details on the Model 263A potentiostat/galvanostat are available from EG&G Instruments, Princeton Applied Research, P.O. Box 2565, Princeton, NJ 08543.

Circle No. 39 on Reader Service Card

FTIR Accessory

An FTIR microsampling accessory is detailed in a product release. The single reflection ATR optic permits direct viewing and analysis of samples such as polymers, coatings, fibers, semi-solid materials, micro-quantities of a liquid, and contaminants. Information on the ATR Objective for Spectra-Tech FTIR microscopes is available from Spectra-Tech Inc., 2 Research Dr., P.O. Box 869, Shelton, CT 06484-0869.

Circle No. 40 on Reader Service Card

Emissions Monitoring

A document describes emission monitoring gases and other gas blends. Among the topics this brochure describes are preparation and supply of emission monitoring gases and EPA protocol gases. Copies of the brochure are available by requesting Form #6931 from Liquid Carbonic, Corporate Communications Dept., 810 Jorie Blvd., Oak Brook, IL 60521-2216.

Circle No. 41 on Reader Service Card

Management Strategies

A 242-page handbook examines the technological and business needs of paint shop managers. Among the topics included are management tips, cost control, communication skills, supplier relationships, and paint shop math and accounting. The Society of Manufacturing Engineers, One SME Dr., P.O. Box 930, Dearborn, MI 48121-0930, can provide further details on *Managing a Paint Shop*.

Circle No. 42 on Reader Service Card

Epoxy Resin

Technical literature introduces a new low VOC solid epoxy resin in a solution compliant with the Hazardous Air Pollutant provisions of the 1990 Clean Air Act. The Dow Chemical Co., Customer Information Group, P.O. Box 1206, Midland, MI 48641-1206, can be contacted for further information on D.E.R.™ 660-PA80 epoxy resin.

Circle No. 43 on Reader Service Card

Water-based Primer

Literature introduces a new fast-dry water-based primer designed to impart a block-free, medium gloss surface when applied over lithographic inks. For additional details on Laticote™ B7400A, write Pierce & Stevens Corp., 710 Ohio St., Buffalo, NY 14203.

Circle No. 44 on Reader Service Card

Color Measurement

A multipurpose portable spectrophotometer is detailed in a press release. This instrument, which allows for both color and gloss measurements simultaneously, is designed with on-board software to measure color, gloss, and density for color matching and quality control applications. ColorTec™, P.O. Box 386, 74 Main St., Lebanon, NJ 08833, can be contacted for further details on the ColorTec-SCM™ spectrophotometer.

Circle No. 45 on Reader Service Card

Aqueous Dispersions

A company announces the addition of four new colors to a line of dispersions in a product release. The new products are high strength aqueous dispersions formulated without glycols, designed to be easily poured and stirred into water-based ink formulations. Engelhard Corp., Specialty Minerals & Colors Group, 101 Wood Ave., Iselin, NJ 08830, can be contacted for additional information on the new Omnicyl™ dispersions.

Circle No. 46 on Reader Service Card

Spectrophotometer

A benchtop spectrophotometer designed to measure substrates containing optical brighteners and fluorescent whitening agents is available. The instrument features a high-intensity pulsed xenon light source with an adjustable UV filter mechanism. For further information on the Color-Eye® 3100, contact Macbeth, 405 Little Britain Rd., New Windsor, NY 12553-6148.

Circle No. 47 on Reader Service Card

Multi-Dosing Dispensing System

The introduction of a multi-dosing dispensing system has been made through a technical brochure. The system, applicable for such materials as liquids, pastes, powders, and granules, includes a metering valve which combines gravimetric and volumetric dispensing. For complete technical details or a copy of the brochure on the CYDEC Multi-Dosing System, write CYDEC, Inc., 45 Great Hill Rd., Naugatuck, CT 06770.

Circle No. 48 on Reader Service Card

Used Equipment

Used laboratory and product plant equipment from the coatings and ink industries is the topic of literature. Physical test instruments, ovens, balances, lab hoods, high-speed dispersers, horizontal or vertical media mills, mixing tanks, and other equipment are available. For a list of available items, or to buy, sell, or trade equipment, contact Western Equipment, 975 66th Ave., Oakland, CA 94621.

Circle No. 49 on Reader Service Card

Design of Experiments

A booklet describes design of experiments (DOE) methodology. This publication provides answers to the 12 most commonly asked questions about DOE, and covers topics such as when and how to use DOE and DOEs links with quality. Requests for a free copy of the brochure on DOE can be directed to DuPont Quality Management and Technology Center, Nemours Bldg., Room 6502, 1007 Market St., Wilmington, DE 19898.

Circle No. 50 on Reader Service Card

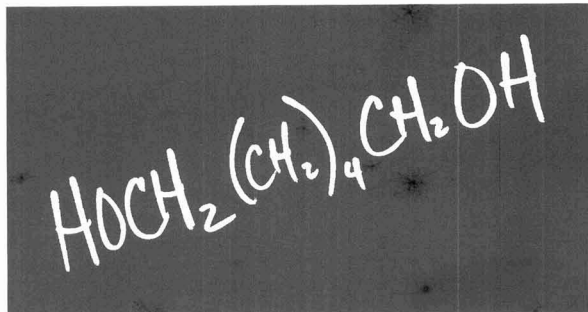
Liquid Filters

The introduction of two new filters for removing suspended solids from paints, inks, adhesives, and high-viscosity fluids in clean-in-place filtration systems has been made in a press release. These filters are designed for consistency of solids removal and fluid throughput while concentrating and reducing the volume of the captured solids. For further details on the DCF-400 and DCF-800 liquid filters, write Ronningen-Petter Engineered Filter Systems, 9151 Shaver Rd., P.O. Box 188, Portage, MI 49081-0188.

Circle No. 51 on Reader Service Card

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Performance Additives

Technical literature describes a new additives system for the production of foamed PVC materials. Reported benefits include improved dynamic thermal stability characteristics, melt and melt strength, PVC metal release, and foaming agent dispersion. Additional information on the ACX 872 additives package can be obtained from AlliedSignal Inc., Performance Additives, 101 Columbia Rd., Morristown, NJ 07962-1039.

Circle No. 52 on Reader Service Card

Wax Emulsions

A product release introduces four new low-viscosity wax emulsions. These emulsions are designed to have an extra-small particle size so as not to affect gloss or clarity in thin film waterborne coatings and inks. Additional details on Slip-Ayd® wax emulsions are obtainable from Daniel Products Co., Inc., 400 Claremont Ave., Jersey City, NJ 07304.

Circle No. 53 on Reader Service Card

Stain Blocker

An alkyd base stain blocker and spot sealer is the topic of literature. This product is designed to cover stains, including fire, water, and smoke damage, on oil or latex-based interior walls. Information on the lead and mercury free Stop-Z® sealer products is available from Mercury Paint, 14300 Schaefer Hwy., Detroit, MI 48227.

Circle No. 54 on Reader Service Card

Glycoprotein Carbohydrate Kits

A product release introduces three kits for the analysis of glycoprotein-derived oligosaccharides. These kits reportedly offer high resolution of analytes, short analysis times, and high reproducibility. More information on the N-Linked Oligosaccharide Release and Labeling Kit—PMP, the Oligosaccharide HPLC Kit—PMP, and the Oligosaccharide Capillary Electrophoresis Kit—PMP is available from The Perkin-Elmer Corp., 761 Main Ave., Norwalk, CT 06859-0012.

Circle No. 55 on Reader Service Card

UV/EB-Cured Products

A company highlights its UV/EB-cured product identification system in a press release. By using the logo on products and packaging, the environmental and quality benefits of UV/EB curing are advertised. Information on the UV/EB process mark program is available from RadTech International, 60 Revere Dr., Ste. 500, Northbrook, IL 60062.

Circle No. 56 on Reader Service Card

Reactive Diluent

A data sheet highlights a low-viscosity, oxazolidine chemistry-based additive designed to replace higher-viscosity polyols in high-solids polyurethane coatings. Reported benefits include lower VOC levels, weathering performance, and system and film performance. Request information on Zoldine® RD-20 from ANGUS Chemical Co., 1500 E. Lake Cook Rd., Buffalo Grove, IL 60089.

Circle No. 57 on Reader Service Card

Fluid Mixers

A series of technical papers defining the application of fluid mixers in the paint and coatings industries has been printed. Topics include optimum tank geometry, mixer positioning, impeller aspect ratios, and baffle design's effect on mixing, powder draws, and viscosity. Additional information on these technical papers can be obtained from EMI Inc., P.O. Box 912, Clinton, CT 06413.

Circle No. 58 on Reader Service Card

Sanding Sponges

Sponges designed for sanding, denibbing, scuffing, or defuzzing contoured surfaces and moldings are detailed in literature. These sponges are offered in three grades, and are designed to conform to contours without requiring adjustments of the product. Further details on softback sanding sponges are obtainable from 3M Abrasive Systems Div., 3M Center Bldg. 223-6N-01, St. Paul, MN 55144-1000.

Circle No. 59 on Reader Service Card

Curing Agent

Literature introduces a phenolic resol curing agent which permits the formulation of both conventional and high-solids epoxy phenolic coatings. Reported benefits include flexibility, reproducibility, performance stability, and storage stability. More information on Epikure™ DX-200-N-60 is available from Shell Chemical Co., Manager, Resins Communication, One Shell Plaza, P.O. Box 2463, Houston, TX 77252-2463.

Circle No. 60 on Reader Service Card

Filter Presses

A series of filter presses used for dewatering applications in the industrial waste industry is detailed in literature. The filter presses are designed to produce higher-solids cake and clearer filtrate than other liquid/solids separation systems. Information on series 800 through 1500 high- and low-pressure filter presses is available from Netzsch Inc., Filter Press Div., 119 Pickering Way, Exton, PA 19341-1393.

Circle No. 61 on Reader Service Card

ISO 9000 Training

A videotape provides ISO 9000 employee training and stresses the importance of registration. The video explains ISO 9000, its standards, how it affects the employee and the company, and the employee's role in working with auditors. For more information on "Employee Intro to ISO 9000," contact The Media Group, Inc., 18 Blair Park Rd., Ste. 100, Williston, VT 05495.

Circle No. 62 on Reader Service Card

Interior Paint

An interior architectural alkyd enamel meeting VOC requirements is described in a product release. Reported features of the paint, which is available in white, four off-whites, and three tinting bases, include hiding, flow and leveling, and durability. Inquiries about Craft-Kote alkyd semi-gloss are being addressed by Duron Paints & Wallcoverings, 10406 Tucker St., Beltsville, MD 20705-2297.

Circle No. 63 on Reader Service Card

Flowmeter

A press release describes a single loop flowmeter which uses the coriolis force principle to measure mass flow directly. The flowmeter, which has no flow splitter and only one tube, is designed to be fully self-draining. Additional information on the Mass 2100 coriolis flowmeter can be provided by EMCO Flowmeters, 600 Diagonal Hwy., Longmont, CO 80501.

Circle No. 64 on Reader Service Card

Dispersant

A dispersant for waterborne industrial coatings and inks is highlighted in a data sheet. Reported features include reduced grind viscosity and particle size, viscosity/dispersion stability, and low process/application foam. Air Products and Chemicals, Inc., 7201 Hamilton Blvd., Allentown, PA 18195-1501, can be contacted for a copy of Publication No. 120-9430, "Surfynol® CT-151 Dispersant."

Circle No. 65 on Reader Service Card

Monitoring System

Information on an *in-situ* monitoring system for isocyanate formation and urethane polymerization reactions has been released. Based on FTIR spectroscopy, this system provides real-time data on reaction kinetics, concentration of critical reaction species, percent conversion, and information on reaction pathways. Contact Applied Systems, Inc., 200 Harry S. Truman Pkwy., Annapolis, MD 21401, for more information on the ReactIR system.

Circle No. 66 on Reader Service Card

Coming Events

FEDERATION MEETINGS

For information on FSCT meetings, contact Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422 (610) 940-0777, FAX: (610) 940-0292.

1995

(May 17-21)—FSCT Spring Week. Spring Seminar on the 17th and 18th; Board of Directors Meeting on the 20th; Incoming Society Officers Meeting on the 21st. Fiesta Americana, Cancun, Mexico.

(Oct. 9-11)—73rd Annual Meeting and 60th Paint Industries' Show. Cervantes Convention Center, St. Louis, MO.

1996

(Oct. 23-25)—74th Annual Meeting and 61st Paint Industries' Show. McCormick Place North, Chicago, IL.

1997

(Nov. 5-7)—75th Annual Meeting and 62nd Paint Industries' Show. Georgia World Congress Center, Atlanta, GA.

SPECIAL SOCIETY MEETINGS

1995

(Jan.10-May 16)—"A Course in Coatings Technology." Sponsored by the Chicago Society and Chicago Paint and Coatings Association. Course held every Tuesday evening at DePaul University. (Alison Azar, Seegott, Inc. (708) 468-0400; or Kevin Murray, Applied Polymer Systems, (708) 882-3194).

(Feb. 2)—"Chemistry for the Changing Times." Mini-symposium sponsored by the Montreal Society. (Alain Charbonneau, Miles Canada Inc., 7600 Trans-Canada Hwy., Pointe-Claire, Que., Canada H9R 1C8).

(Feb. 20-22)—Western Coatings Societies' 22nd Biennial Symposium and Show. Sponsored by the Golden Gate, Los Angeles, Pacific Northwest, and Rocky Mountain Societies. Hilton Hotel and Towers, San Francisco, CA. (Gordon Ploch, WCSSS Chairman, Eureka Chemical Co., P.O. Box 2205, S. San Francisco, CA 94083; (415) 761-3536).

(Feb. 22-24)—22nd Annual Waterborne, High-Solids, and Powder Coatings Symposium. Sponsored by the Southern Society and The University of Southern Mississippi (USM). New Orleans, LA. (Robson F. Storey or Shelby Thames, Co-Organizers, WBHS&PC Symposium, Dept. of Polymer Science, USM, P.O. Box 10076, Hattiesburg, MS 39406-0076).

(Mar. 15)—"Clean Air & Technology." Mini-Trade Show and Symposium sponsored by the Piedmont Society. Showcase on the Park, High Point, NC. (Richard Chodnicki, Van Horn, Metz & Co., 320 Townsontown Blvd., Ste. 205, Baltimore, MD 21204).

(Mar. 29-31)—Southwestern Paint Convention. Sponsored by Houston and Dallas Societies. Airport Hyatt Regency, Dallas, TX. (Benny Puckett, Kelly-Moore Paint Co., Inc., 301 W. Hurst Blvd., Hurst, TX 76053; (817) 268-3131).

(Apr. 4)—"Compliant Coatings for 2000 and Beyond." Sponsored by the Detroit Society. Michigan State University Management Center, Troy, MI. (Joe Lesnek, DSCT, P.O. Box 2454, Riverview, MI 48192; (313) 255-2210).

(Apr. 19-21)—Southern Society Annual Meeting. Hyatt Regency, Savannah, GA. (Wayne West, Thompson & Formby, Inc., 10136 Magnolia Dr., Olive Branch, MS 38654).

(May 3-4)—"Recent Advances in Modifiers for Modern Coatings." Symposium sponsored by the New York Society. Holiday Inn North, Newark Airport, Newark, NJ. (Larry Waelde, Troy Chemical Corp., c/o NYSCT Office, 520 Westfield Ave., Elizabeth, NJ 07208; (908) 354-3200).

(May 4-5)—"Focus on the Future." 38th Annual Technical Symposium sponsored by the Cleveland Society. Quaker Square Hilton, Akron, OH. (Sharie Moskaluk, The Sherwin-Williams Co., 601 Canal Rd., Cleveland, OH 44113-2498; (216) 566-3661).

(May 4-6)—48th Annual Spring Symposium. Sponsored by the Pacific Northwest Society. Red Lion Lloyd Center, Portland, OR. (Ken Wenzel, Chemical Distributors, Inc., P.O. Box 10763, Portland, OR 97210; (503) 243-1082).

OTHER ORGANIZATIONS

1995

North America

(Jan. 15-17)—RCMA 1995 Annual Conference & EXPO. Sponsored by the Roof Coatings Manufacturers Association (RCMA). Naples, FL. (Sally Choquette, RCMA Meetings Coordinator, RCMA, 6000 Executive Blvd., Ste. 201, Rockville, MD 20852-3803).

(Jan. 20)—"Engineered Polymer Blends V: Theory and Practice." Symposium sponsored by Polytechnic University, Brooklyn, NY. (Eli M. Pearce, Polymer Research Institute, Polytechnic University, 6 Metrotech Center, Brooklyn, NY 11201).

(Jan. 22-25)—Meeting of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications. Hyatt Regency Hotel, San Antonio, TX. (ASTM, 1916 Race St., Philadelphia, PA 19103-1187).

(Feb. 1-3)—"Bridging the Environment." The Fourth World Congress on Coating Systems for Bridges and Steel Structures. Sponsored by the University of Missouri—Rolla (UMR). Marriott Airport Hotel, St. Louis, MO. (Michael R. Van De Mark or Norma Fleming, 119 ME Annex, UMR, Rolla, MO 65401).

(Feb. 19-22)—18th Annual Meeting of The Adhesion Society. Crystal Sands Resort, Hilton Head, SC. (Joseph W. Holubka, Ford Motor Co., MD 3198, P.O. Box 2053, Dearborn, MI 48121).

(Feb. 20-22)—"Basic Coatings for Sales, Marketing, and General Personnel." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(Feb. 24-26)—"Spring Decor 1995." Sponsored by the National Decorating Products Association (NDPA). Georgia International Convention Center, Atlanta, GA. (Teri Flotron, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Mar. 5-8)—"Pigment Dispersions: Science and Technology." Orlando, FL. (A.V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Mar. 6-8)—"Advances in Polymer Colloids/Emulsion Polymers." Orlando, FL. (A.V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Mar. 6-8)—"Fundamentals of Adhesion." Orlando, FL. (A.V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Mar. 6-8)—"Introduction to Polymer Colloids/Emulsion Polymers." Grosvenor Resorts, Orlando, FL. (A.V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Mar. 8-10)—"Computer Modeling of Polymer and Solid Interfaces." Orlando, FL. (A.V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Mar. 8-10)—"Polymer Blends and Alloys: Phase Behavior, Characterization, Morphology, and Alloying Technology." Orlando, FL. (A.V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Mar. 13-15)—"Second North American Research Conference on Stabilization and Degradation of Polymers." Hilton Head, SC. Sponsored by the American Chemical Society, Polymeric Materials: Science and Engineering (A.V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

Europe

(Mar. 20-24)—"Basic Composition of Coatings." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(Mar. 26-31)—"Corrosion '95." Annual conference sponsored by National Association of Corrosion Engineers (NACE) International, Orlando, FL. (NACE International, P.O. Box 218340, Houston, TX 77218-8340).

(Apr. 2-7)—38th Annual Technical Conference sponsored by Society of Vacuum Coaters (SVC), Chicago Marriott Downtown, Chicago, IL. (SVC, 440 Live Oak Loop NE, Albuquerque, NM 87122-1407).

(Apr. 5-7)—10th Annual Conference sponsored by Architectural Spray Coaters Association (ASCA), Doral Ocean Beach Resort, Miami, FL. (ASCA, 230 W. Wells St., Ste. 311, Milwaukee, WI 53203).

(Apr. 24-28)—"Applied Rheology for Industrial Chemists." Short course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Director, Professional Development Institute, P.O. Box 1792, Kent, OH 44240).

(Apr. 24-28)—"Paint Formulation." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(May 8-12)—"Dispersion of Pigments and Resins in Fluid Media." Short course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Director, Professional Development Institute, P.O. Box 1792, Kent, OH 44240).

(May 15-19)—"Paint Formulation." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(May 22-24)—Eighth International Symposium on Polymer Analysis and Characterization (ISPAC-8). Sanibel Island, FL. (ISPAC Registration, 815 Don Gaspar, Sante Fe, NM 87501).

(May 22-26)—"Adhesion Principles and Practice for Coatings and Polymer Scientists." Short course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Director, Professional Development Institute, P.O. Box 1792, Kent, OH 44240).

(June 5-9)—"Advances in Emulsion Polymerization and Latex Technology." Short course sponsored by Lehigh University, Bethlehem, PA. (Mohamed S. El-Aasser, Emulsion Polymers Institute, Lehigh University, 111 Research Dr., Bethlehem, PA 18015).

(June 25-29)—"Coating Work in Nuclear Facilities." Symposium sponsored by The National Board of Registration for Nuclear Safety Related Coating Engineers and Specialists. Marriott Hotel, Philadelphia, PA. (Dean M. Berger, Executive Secretary, NBR, P.O. Box 56, Leola, PA 17540).

(July 17-19)—"Basic Coatings for Sales, Marketing, and General Personnel." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(Sept. 11-15)—"Basic Composition of Coatings." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(Sept. 20-22)—"Accelerated and Natural Weathering Techniques for Coatings and Polymers." Short course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Director, Professional Development Institute, P.O. Box 1792, Kent, OH 44240).

(Sept. 25-29)—"Paint Formulation." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(Sept. 26-29)—"Introduction to Coatings Technology." Short course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Director, Professional Development Institute, P.O. Box 1792, Kent, OH 44240).

(Sept. 29-Oct. 1)—"Fall Decor 1995." Sponsored by the National Decorating Products Association (NDPA). Atlanta, GA. (Teri Flotron, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

Asia

(Jan. 16-18)—"PaintIndia '95." Nehru Centre, Bombay, India. (R. Rajagopal, Colour Publications Pvt. Ltd., 126-A, Dhuruwadi, A.V. Nagwekar Marg, Prabhadevi, Bombay 400 025 India).

(Jan. 2-6)—"Organic Coatings." 53rd International Meeting of Physical Chemistry. Sponsored by the Division de Chimie Physique of Soc. Française de Chimie, Ministry of Research, Paris, France. (Dr. Troyanowsky, Div. de Chimie Physique, Laboratoire de Chimie Physique, 11, rue Pierre et Marie Curie, 75005, Paris, France).

(Mar. 14-16)—"European Coatings Show '95." Congress and Exhibition. Exhibition Centre, Nuremberg, Germany. (Vincentz Verlag, Postfach 62 47, D-30062, Hannover, Germany).

(May 15-18)—"Recycle '95." Forum and Exposition. Sponsored by Maack Business Services, Swissôtel, Zürich, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH-8804 AU/Zürich, Switzerland).

(May 23-24)—First Pacific Coating Forum. Sponsored by the Japan Coating Technology Association. Shonan Kokusai Village, Kanagawa, Japan. (Secretariat, Japan Coating Technology Association, Daiichi Naka-Bldg. 4F, 3-4 Nihombashi-Kobunacho, Chuo-ku, Tokyo 103, Japan).

(June 12-14)—"17th Annual International Conference on Advances in the Stabilization and Degradation of Polymers." Luzern, Switzerland. (A.V. Patsis, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

Advertisers Index

<i>Air Products and Chemicals, Inc.</i>	Cover 2
<i>BASF Corp.</i>	130
<i>Brookfield Engineering Labs., Inc.</i>	124
<i>Consolidated Research Inc.</i>	127
<i>CYTEC Industries</i>	9
<i>Degussa Corp.</i>	38
<i>Dow Corning Corp.</i>	11
<i>Federation of Societies for Coatings Technology</i>	4-5
<i>William Harrison Corp.</i>	12
<i>Hüls America Inc.</i>	2, 15
<i>ICI Polyurethanes</i>	14
<i>Kerr-McGee Chemical Corp.</i>	13
<i>Perstorp Polylols</i>	17
<i>Pioneer Packaging Machinery, Inc.</i>	1
<i>Shamrock Technologies</i>	Cover 4
<i>Süddeutsches Lackwerk Zelle GmbH</i>	124
<i>Troy Corp.</i>	Cover 3

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'Humbug' from Hillman

A long, long time ago old, old friend Max Saltzman sent me a compendium of "Logical Laws, Accurate Axioms, Profound Principles, Trusty Truisms, Homey Homilies, Colorful Corollaries, Quotable Quotes & Rambunctious Ruminations" published by the Logical Machine Corp. Some have found their way to the column in the past but many have remained unquoted. Anyhow, here's a goodly dose. Maybe it will remind Max to write again, at long last.

Clarke's Third Law:

Any sufficiently advanced technology is indistinguishable from magic.

Ginsberg's Theorem:

- 1) You can't win.
- 2) You can't break even.
- 3) You can't even quit the game.

Gilb's Laws of Unreliability:

1) Computers are unreliable, but humans are even more unreliable. Corollary: At the source of every error which is blamed on the computer you will find at least two human errors, including the error of blaming it on the computer.

2) Any system which relies on human reliability is unreliable.

7) Undetectable errors are infinite in variety, in contrast to detectable errors which by definition are limited.

9) Investment in reliability will increase until it exceeds the probable cost of errors, or until someone insists on getting some useful work done.

Laws of Computer Programming:

- 1) Any given program, when running, is obsolete.
- 2) Any given program costs more and takes longer.
- 3) If a program is useful, it will have to be changed.
- 4) If a program is useless, it will have to be documented.
- 5) Any given program will expand to fill all available memory.
- 6) Program complexity grows until it exceeds the capability of the programmer who must maintain it.
- 7) Make it possible for programmers to write programs in English, and you will find that programmers cannot write in English.

Law of Selective Gravity (The Buttered Side Down Law):

An object will fall so as to do the most damage.

Snafu Equations:

- 1) Given any problem containing "n" equations, there will be "n+1" unknowns.
- 2) Interchangeable devices won't.
- 3) In any human endeavor, once you have exhausted all possibilities and fail, there will be one solution, simple and obvious, highly visible to everyone else.

Steele's Plagiarism of Somebody's Philosophy:

Everyone should believe in something—believe I'll have another drink.

Weinberg's Law:

If builders built buildings the way programmers wrote programs, then the first woodpecker that came along would destroy civilization.

Weinberg's Corollary:

An expert is a person who avoids the small errors while sweeping on to the grand fallacy.

Zymurgy's First Law of Evolving System Dynamics:

Once you open a can of worms, the only way to recan them is to use a larger can. (Old worms never die, they just worm their way into a larger can.)



Speaking of long time ago contributions to Humbug, I think enough time has elapsed for us to have recovered and to consider some more of the philosophy contained in "The Little Pun Book" sent to me some time ago by John Warner. Remember that name and blame him!

—Mr. Chan was a manufacturer of teakwood stands. For several weeks he noticed that a stand or two was stolen each night. Seeing small footprints near the door of his shop, he thought a small boy was the culprit. To set a trap he dug a large pit and covered it with branches. Next morning he looked in the pit and there was a bear clutching two stands. "Aha," he exclaimed, "Boy-foot bear with teaks of Chan."

—An unscrupulous lawyer stayed up with a pretty widow all one night trying to break her will.

—A woman, fond of trimming her lawn with a nail scissors, said, "That's all there is. There's isn't any mower."

—A man moved to Kansas City with the firm belief that Missouri loves company.

—A young Spanish girl was named Carmen Cohen. Her mother called her Carmen and her father called her Cohen. By the time she was twelve, she didn't know if she was Carmen or Cohen.

—Use "conscience-stricken" in a sentence: Don't conscience stricken before they're hatched.

—As old Noah said after the animals boarded the ark, "Now I herd everything."



While hunting, Ed and Fred got lost in the woods. Trying to reassure his friend, Ed said, "Don't worry. All we have to do is shoot in the air three times, stay where we are, and someone will find us." They shot in the air three times and waited but no one came. After a while they tried again. Still no response. When they decided to try once more, Fred said, "It better work this time. We're down to our last three arrows."

The Lion

—Herb Hillman
Humbug's Nest
P.O. Box 135
Whitingham, VT 05361

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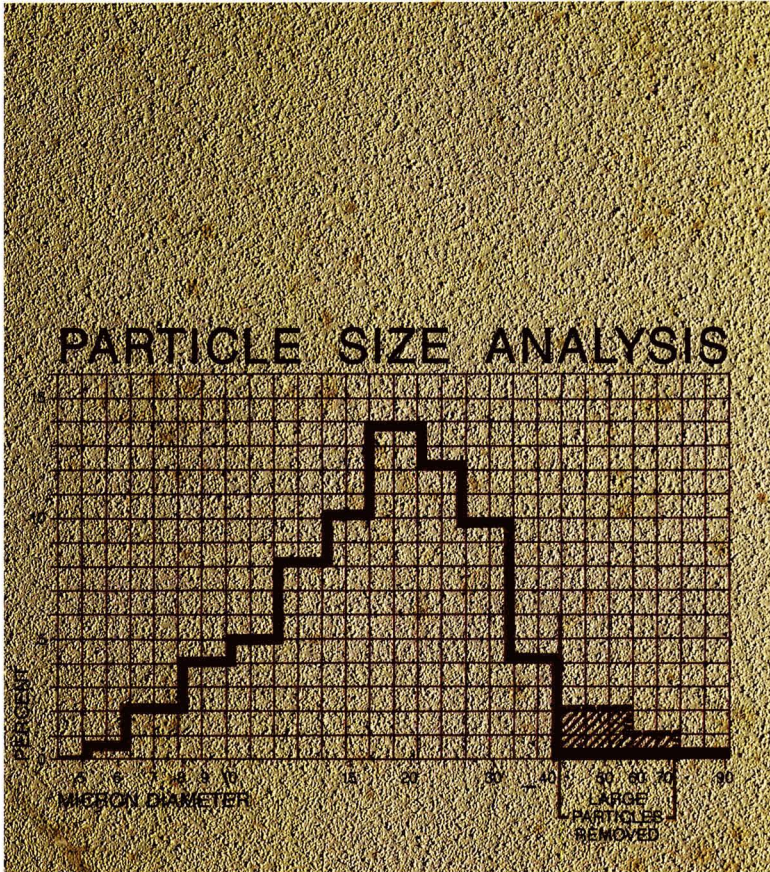
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