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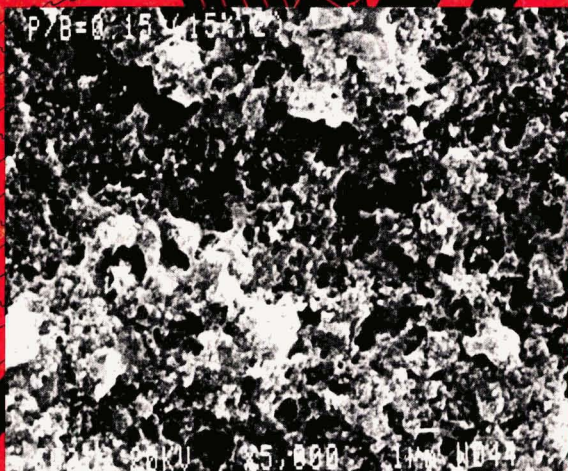
## JOURNAL OF COATINGS TECHNOLOGY

JCTAX 60 (757) 1-82 (1988)

### February 1988



66th ANNUAL MEETING  
SOCIETY OF COATINGS TECHNICIANS  
IN CONJUNCTION WITH THE  
1988 INTERNATIONAL COATINGS EXPOSITION  
CHICAGO, ILL. OCTOBER 18-20, 1988



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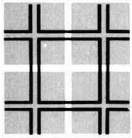
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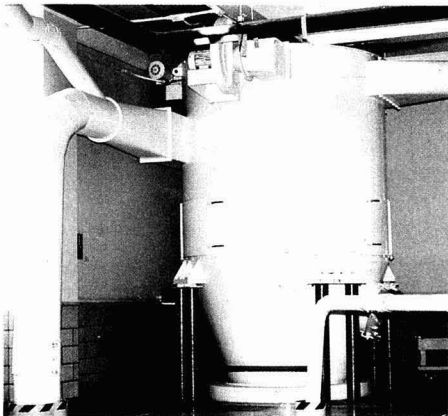




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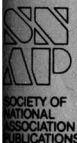
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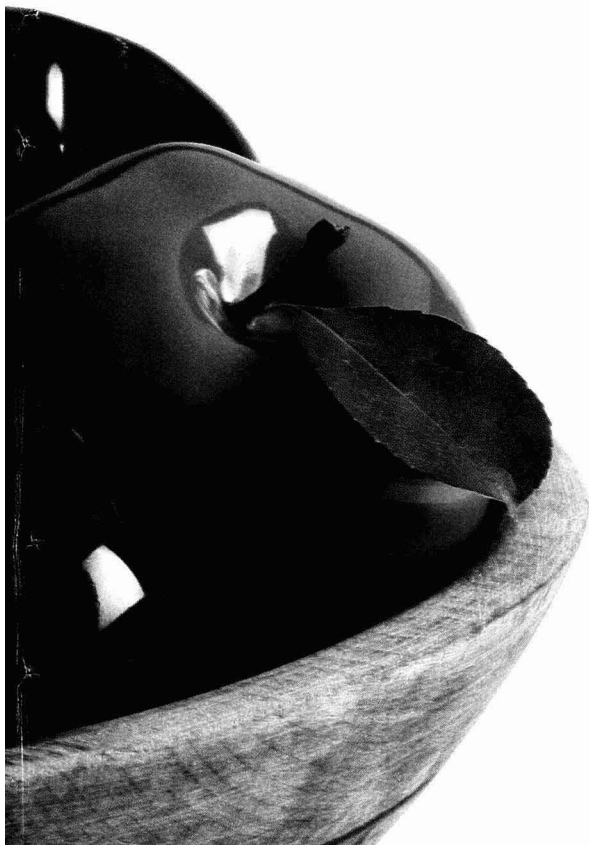
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## ... With Apologies to the Aztecs

Through the centuries the calendar has been dictated, manipulated, and stipulated by Pharaohs, Caesars, and Popes, essentially for the betterment of their followers. Crops were planted and harvested, religious festivals celebrated, and notable occurrences referred to throughout recorded history, all by the use of the calendar. Succeeding minor refinements led to the calendar we hold as ours today—invented to facilitate the recording of time's passage. What a boon to man(person)kind!

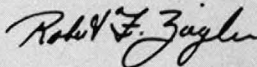
However, there came a time when the calendar was looked at not with expectation, but with trepidation. The modern world moved too fast, it seemed, to allow the kind soul trotting steadily forward to plan ahead—say, past his nose.

And that is why not long ago—historically speaking—a forgotten person (an Editor, perhaps) invented the Deadline. No longer do we pass through life oblivious to important dates, hesitant to look a calendar straight in the eyelet. The deadline demands recognition. Even its name denotes dread and the possibility of dire consequences if ignored.

So it is that the deadline demanding your attention now is March 1. This is the date on which notification must be made for entering presentations in the Roon Awards Competition at the 1988 Annual Meeting. Prospective authors are invited to notify Committee Chairman Gary Gardner, Tnemec Co., Inc., P.O. Box 1749, Kansas City, MO 64141, of their intentions.

The chance to increase prestige, report important research results, and gain the recognition of peers is in Chicago, October 5-7, as is \$4,000 in total prize money. Details of the awards can be found in the January 1988 JCT (page 18), or from Federation headquarters.

To miss a meal may be good for the waistline. To miss this deadline may be an opportunity wasted.



Robert F. Ziegler  
Executive Vice-President



# Abstracts of Papers in This Issue

## **INVESTIGATION OF ELECTRICAL RESISTIVITY-PIGMENT VOLUME CONCENTRATION RELATIONSHIP IN CARBON BLACK FILLED CONDUCTIVE PAINT—A. Calahorra**

Journal of Coatings Technology, 60, No. 757, 25 (Feb. 1988)

Carbon black filled conductive paints are very useful for antistatic and EMI shielding applications. However, there is a certain limit to the conductivity that can be achieved. In this work, the relationship between electrical resistivity and carbon black loading of dry paint films was investigated.

The critical pigment volume concentration (CPVC) of the formulation studied was found by the density method, in which specific volumes of dry paint films with different pigment loading were determined, and was confirmed by micrographical examination.

It is shown that the volume resistivity of these paints is proportional to the cube root of the volume concentration of the carbon black pigment and that the upper limit of the volume conductivity attainable corresponds to the CPVC of the formulation. Beyond this point, conductivity decreases due to void formation in the dry paint film.

## **A FURTHER STUDY OF WATER-SOLUBLE ACRYLIC RESINS AND COATINGS—Z-Z. Jin, Y-D. Hu, and Y. Zhu**

Journal of Coatings Technology, 60, No. 757, 31 (Feb. 1988)

The solubility behavior of amine neutralized acrylic copolymers changes as the acrylic acid (AA) content increases. The variations of the viscosity curve from an "N" to a "reverse S" and finally to a linear plot, and the study of the solution morphology, indicate that the amine neutralized acrylic copolymer is soluble in water-cosolvent as the AA content exceeds 20 mol %. The variation in viscosity of two acrylic coatings caused by concentration and temperature are reported. Several determining factors in the degree of crosslinking of the coatings are discussed.

## **DEVELOPMENTS IN HIGH SOLIDS MAGNETIC DISPERSIONS AND COATINGS—J.W. Gooch**

Journal of Coatings Technology, 60, No. 757, 37 (Feb. 1988)

Development of magnetic dispersions required novel and quick methods for determining the degree of dispersion during milling in the liquid state, since magnetic dispersions degenerate by agglomeration within minutes. Improved formulations were developed by observing compatibility of resins and solvents with acicular magnetic iron oxide powders and results were interpreted in rheological terms for the liquid dispersions, since rapid feed-back of information was possible. Coatings were characterized by surface gloss, x-ray radiography, optical and electron microscopy together with magnetic measurements. Results show that viscometric trends, degree of dispersion, and magnetic properties are interrelated, and that capillary viscometry flow data is the most consistent method of monitoring the "goodness" of the liquid dispersion before the coating is applied to uniaxially oriented polyester tape.

## **CATHODIC BLISTERING OF TWO ALKYD PAINTS—V.S. Rodríguez and H. Leidheiser, Jr.**

Journal of Coatings Technology, 60, No. 757, 45 (Feb. 1988)

The blistering of two alkyd coatings during the application of a cathodic potential while immersed in alkali chloride solutions has been studied. Factors that affected the rate of cathodic blistering include applied potential, temperature, nature of the electrolyte, type of coating, and the presence of soluble salt beneath the coating. In the case of a zinc chromate alkyd, the rate of blistering increased as the potential was more negative (cathodic), as the temperature was increased, as the coating thickness was decreased, and when soluble salt was present beneath the coating. The rate of blistering of the zinc chromate alkyd under comparable conditions decreased in 1.0M solutions in the order: KCl > NaCl > LiCl. The rate of cathodic blistering of a lead oxide alkyd coating was greater than that of the zinc chromate alkyd coating.

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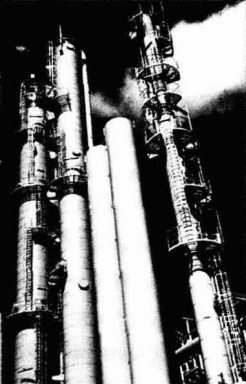
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# Abstracts of Papers in This Issue

## HYDROPHILIC-LIPOPILIC BALANCE SYSTEM AND THE EMULSIFICATION OF COATINGS COMPONENTS —Philadelphia Society Technical Committee

Journal of Coatings Technology, 60, No. 757, 53 (Feb. 1988)

The Technical Committee of the Philadelphia Society for Coatings Technology established a committee to apply the HLB system of detergent classification to hydrophobic coatings components. Such a classification has been applied to components such as oils and waxes useful to the pharmaceutical industry. The object of this study was to add to this list the HLB classification of various oils, resins, and vehicles that, when emulsified, would be useful in water-based coatings.

The technique followed for the HLB resin classification was developed from recommendation of ICI Americas, Inc., in publications on the HLB system. A literature search was conducted and a bibliography of references is included.

The technique was applied to 14 oils, resins, and coatings vehicles, and a "Required HLB" value determined for them. The working procedure utilized solvents to pre-dissolve a component into a low viscosity solution. The influence of the solvent or solvents on the emulsification of a component was explored, especially the effect of water soluble solvents such as glycol ethers commonly used in coatings formulations as "coupler solvents."

## Papers to Be Featured In the March Issue

*1987 Roon Awards Competition Third Prize  
Winning Paper*—"New Heterocyclic Pigments"—  
A. Iqbal, et al., of CIBA-GEIGY AG

"Crowding and Spacing of Titanium Dioxide Pigments"—J.H. Braun, of E.I. du Pont de Nemours & Co., Inc.

"Positron Implantation and Annihilation in Protective Organic Coatings"—Cs. Szeles, et al., of Lehigh University

"How to Calculate Crosslink Structure in Coatings"—D.R. Bauer, of Ford Motor Co.

"Recent Advances in Coatings Science Technology"—R.B. Seymour, of University of Southern Mississippi

# Navy declares war in jungle. Polyphase wins.

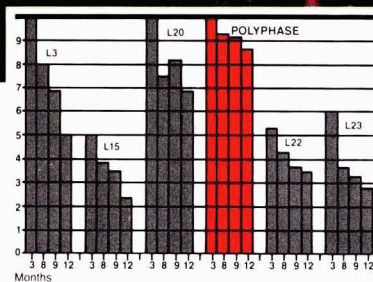


Chart from page 27 of Naval study shows average defacement ratings of latex paints. Copies of complete study available on request from Troy.

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## Chicago, Golden Gate, and St. Louis Societies Win 1987 MMA Awards for Notable Achievements

The 1987 MMA Awards for notable achievements by Constituent Societies of the Federation were won by the Chicago, Golden Gate, and St. Louis Societies. They were cited and presented with their Awards at the recent FSCT Annual Meeting in Dallas.

Established in 1975 by Materials Marketing Associates, Inc., a national marketing group of manufacturers' representatives, the Awards recognize notable Society achievements in the field of education, manufacturing and training procedures, technology, public service, and for other achievements deemed proper and desirable by the MMA Awards Committee. (Society papers presented at the Federation Annual Meeting are not eligible).

There are three categories of Awards, based on size of Society membership.

Each winning Society receives \$350 in cash, plus a handsome plaque appropriately engraved.

### Educational Contribution Of Coatings Course

The Chicago Society was recognized for the excellence of the coatings technology course sponsored at DePaul University. Designed to introduce both technical and non-technical personnel to the fundamentals of the coatings industry, this 16-week evening course covered formulating techniques, raw materials, quality assurance, application methods, problem solving, and

environmental considerations and governmental regulations.

Presentations were by guest lecturers from industry, experienced and knowledgeable in their respective fields.

### Industry Contribution Through WCCS Symposium/Show

The Golden Gate Society was cited for sponsoring the 1987 Western Coatings Societies' Symposium and Show, held Feb. 23-25, in Monterey, CA.

The event, which attracted over 1800 registrants and featured program sessions of 26 technical papers and exhibits of 91 supplier firms, provided industry personnel in the western U.S. with the opportunity to learn of new technologies, raw materials, equipment, and services available to them.

Proceeds from the event were used to help support the Society's scholarship program.

### Educational Contribution Of Motivational Seminar

The St. Louis Society award was for development and presentation of a novel seminar, designed for plant, laboratory, and office managers, which focused on "How to Motivate Your Employees."

Programming featured techniques and training aids designed to help managers deal more effectively with their personnel.

### Principles Governing Awards

The President of any Society wishing to enter the competition must send a letter of intent, no later than March 31, to the MMA Awards Committee Chairman (Raymond Uhlig, PPG Industries, Inc., 94325 Rosanna Drive, Allison Park, PA 15101).

A complete description of the Society activity to be considered in the competition must be submitted by the Society President to Chairman Uhlig by July 31.

Not eligible for the Awards are Society papers offered for presentation at the Federation Annual Meeting, and previously submitted entries.

The following are members of the Materials Marketing Associates who sponsored the 1987 MMA Awards: George C. Brandt, Inc., Elmhurst, IL; Carmona Chemical Co., San Francisco, CA; C.D.I., Inc., Portland, OR; Chemroy Chemicals, Ltd., Ontario, Canada; Dorsett & Jackson, Inc., Los Angeles, CA; Horton Earl Co., St. Paul, MN; D.N. Lukens, Inc., Westboro, MA; Majemac Enterprises, Inc., Clearwater, FL; Matteson-Ridolfi, Inc., Riverview, MI; McCullough & Benton, Inc., Atlanta, GA; Mehaffey and Daigle, Inc., New Orleans, LA; Pioneer Chemical, Inc., Mesquite, TX; Schabel Products Corp., Cleveland, OH; Wm. B. Tabler Co., Inc., Louisville, KY; Van Horn, Metz & Co., Inc., Conshohocken, PA; Walsh & Associates, Inc., St. Louis, MO; and C. Withington Co., Inc., Pelham Manor, NY.

Material Marketing Associates (MMA) Awards were presented by Awards Chairman Felix Liberti to the Chicago, Golden Gate, and St. Louis Societies. Shown (from left) are: MMA President Art Benton, Ted Fuhs (Chicago), Pat Shaw (Golden Gate), John Folkerts (St. Louis) and Mr. Liberti



# PICTORIAL STANDARDS OF COATINGS DEFECTS

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

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**Federation of Societies for Coatings Technology**

# FSCT Schedules Two-Day Seminar on Project Management For Presentation at Regional Locations in May and June

"Project Management for the Coatings Chemist," a two-day seminar designed to assist bench-level chemists and their immediate supervisors in dealing with a multiplicity of projects, will be presented at four locations in May/June, 1988, under the auspices of the Professional Development Committee of the Federation of Societies for Coatings Technology.

The seminar will offer project managers and team members straightforward techniques for planning and monitoring small and medium-sized projects. Attendees will be introduced to the principles and practice of project management through a combination of lecture, discussion, exercises, case studies, and group work. Topics to be covered include: defining the role of the project manager; clarifying authority, responsibility, and accountability; developing the project schedule; estimating resource requirements; controlling project performance; developing effective progress reports; and bringing projects to closure.

The seminar will be presented in the following areas: Chicago, May 9-10; San Francisco, June 6-7; Orlando, June 13-14; and Philadelphia, June 20-21.

Stanley E. Portny, President, Stanley E. Portny and Associates, Inc., Alexandria, VA, will conduct the seminars. Mr. Portny is a nationally recognized authority in planning, management, and the creative use of information to support management deci-

sion making. He specializes in tailoring his presentations to meet the special and unique needs of his audience, and this seminar will be specifically geared to the coatings industry.

For further information, contact Federation of Societies for Coatings Technology, 1315 Walnut St., Suite 832, Philadelphia, PA 19107.

## "Coatings for Wood Substrates" Papers Now Available

Papers presented at the recent seminar on "Coatings for Wood Substrates," sponsored by the Federation of Societies for Coatings Technology, in Seattle, WA, on May 1-2, are available in limited quantities.

The package contains 10 of the presentations given at the seminar. Included are the following:

"Finishing Redwood Exteriors: Challenges and Opportunities"—K. Kersell, The Pacific Lumber Co., Mill Valley, CA

"Plywood Applications, Characteristics, and Finishing Recommendations"—R.A. Carlson, American Plywood Association, Tacoma, WA

"Stains for Wood Siding"—D. Williamson, Olympic Home Care Products Co., Seattle, WA

"The Mildew Problem on Coated Wood Surfaces"—M.C. McLaurin, Buckman Laboratories, Inc., Memphis, TN

"Coatings Research at the Forest Products Laboratory"—W.C. Feist, Forest Products Laboratory, Madison, WI

"Hardboard Siding—Composition and Properties: Painting Recommendations"—T.J. Rieth, Masonite Corp., Towanda, PA

"Painting Hardboard Siding"—S. Vout, The Valspar Corp., Minneapolis, MN

"Coating Wood Furniture—Changes Are Here"—R.S. Bailey, Lilly Industrial Coatings, Inc., Indianapolis, IN

"Preservative Treatments for Wood and Successful Coating Techniques"—A.S. Ross, Koppers Company, Inc., Monroeville, PA

"Investigation of Latex Stain Blocking Primers on Wood Substrates"—F. Marshall, DPI Quality Paints, Inc., Clearwater, FL

Cost of the complete set of seminar papers is \$75. To order, contact Ms. Meryl Cohen, FSCT, 1315 Walnut St., Suite 832, Philadelphia, PA 19107, (215) 545-1506.

## Deadline Nears for Entering Roon Awards Competition; Cash Prizes for 1988 Winning Authors Will Total \$4,000

Prospective entrants in the 1988 Roon Awards competition are reminded that they must advise of their intent to compete by March 1.

Winners in the competition for the best technical papers presented at the 1988 Annual Meeting of the Federation of Societies for Coatings Technology (to be held Octo-

ber 19-21 at McCormick Place, Chicago IL) will share a total of \$4,000 in cash prizes.

Sponsored by the Federation's Coatings Industry Education Fund (formerly the Paint Research Institute), the Awards were established in 1957 by the late Leo Roon, founder of Nuodex Products Co. They are

supported by funds provided through the Roon Foundation, and are presented to the winning authors at the FSCT Annual Meeting each year.

Papers to be considered for the competition are those by individuals associated with the organic coatings industry, including raw material suppliers and educators, which must: (1) Describe original work not previously published or presented; (2) Be directly related to the protective coatings industry; (3) Be of such a caliber that they reflect a step forward in real scientific contribution to the coatings industry; and (4) Be accompanied by clearance for publication.

Those wishing to enter the competition must send a letter of intent, along with the title of their proposed paper and a brief abstract by the March 1 deadline to the Chairman of the Roon Awards Committee: Gary Gardner, Tnemec Co., P.O. Box 1749, Kansas City, MO 64141. Deadline for receipt of manuscript entries is May 15.

### FSCT SPC Regional Presentations March 1988

#### Level I

Philadelphia  
March 14-15

Chicago  
March 21-22

Cleveland  
March 28-29

#### Level II

Philadelphia  
March 16-18

Chicago  
March 23-25



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# Regulatory UPDATE

FEBRUARY 1988

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 Roy F. Weston, Inc., Washington, D.C.

**Comment Period Extended on Polymer Rule**—The comment period on proposed national emission standards for volatile organic compounds from polymer production plants has been extended for 60 days from December 10, 1987. EPA's proposed rule would require new, modified, and reconstructed polypropylene, polyethylene, polystyrene, and polyethylene terephthalate plants to control process and fugitive emissions of volatile organic compounds.

Comments due in duplicate by February 8, 1988, at Central Docket Section (LE-131), Attention: Docket No. A-82-19, U.S. EPA, 401 M Street, S.W., Washington, D.C. 20460. Contact Sims Roy, U.S. EPA, Research Triangle Park, NC 27711 (919) 541-5578.

**New Test Standards for Propylene Oxide Take Effect**—Manufacturers and processors of propylene oxide may now follow new test standards and reporting requirements for inhalation developmental toxicity testing. EPA has modified and adopted study plans submitted by industry as acceptable standards for conducting the inhalation developmental toxicity testing required under the Toxic Substances Control Act (TSCA). See 52 Federal Register 35706 (Sept. 23, 1987). Contact Edward A. Klein, Director, TSCA Assistance Office (TS-799), Office of Toxic Substances, U.S. EPA, Rm. E-543, 401 M Street, S.W., Washington, D.C. 20460 (202) 544-1404.

**Senate Tables Tin Paint Bill**—The U.S. Senate indefinitely postponed further consideration of a bill to ban organotin antifouling paints. The bill, S. 1788 (Tribble, R-VA), prohibits the use of organotin paints with a release rate of more than three micrograms per centimeter per day. The three microgram release rate limit would prevail pending final action by EPA to set a release rate limit. The bill bans the use of organotin based paints for any vessel 25 meters or less. The House of Representatives earlier passed a bill (H.R. 2210, Jones, D-NC) that would ban tributyltin and other organotin paints on boats smaller than 65 feet.

In separate action, the FIFRA Scientific Advisory Panel announced that it will soon release a statement on tributyltin.

**Expansion of Good Lab Practice Standards Proposed**—EPA is proposing to expand the scope of its Good Laboratory Practice (GLP) standards under both Toxic Substances Control Act (TSCA) and Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) programs. EPA proposes to expand the scope of the TSCA GLP standards to apply to testing in the field. The FIFRA proposal would expand the scope of the FIFRA GLP standards to field tests and to testing for ecological effects, chemical fate, residue chemistry, and product performance (efficacy). See 52 Federal Register 48933 (TSCA) and 48920 (FIFRA) (Dec. 28, 1987).

Comments on both the TSCA and FIFRA GLP standards are due on or before March 28, 1988.

TSCA comments due in triplicate at Document Control Number OPTS-46016, TSCA Public Information Office (TS-793), Office of Pesticides and Toxic Substances, U.S. EPA, Rm. NE-G004, 401 M Street, S.W., Washington, D.C. 20460. Contact Edward A. Klein, Director, TSCA Assistance Office (TS-799), Office of Toxic Substances, U.S. EPA, Rm. E-543, 401 M Street, S.W., Washington, D.C. 20460 (202) 544-1404.

FIFRA comments due at Document Control Number OPP-300165, Information Services Section, Program Management and Support Division (TS-757C), Office of Pesticide Programs, U.S. EPA, 401 M Street, S.W., Washington, D.C. 20460. Contact Daniel A. Helfgott, Office of Compliance Monitoring (EN-342), Rm. E-707B, 401 M Street, S.W., Washington, D.C. 20460 (202) 382-7825.

**EPA Hazardous Waste Symposium Set for May 9-11 in Cincinnati**—EPA's Hazardous Waste Engineering Research Laboratory has announced the 14th Annual Research Symposium on Land Disposal, Remedial Action, Incineration and Treatment of Hazardous Waste, to be held May 9-11, in Cincinnati. Topics to be covered include: remedial action treatment and control technologies for soil and water; landfill liner and cover systems; personnel protection; underground storage tanks; treatment options for hazardous waste; waste minimization; and biosystems for hazardous waste destruction. For program and registration information contact Kathleen Kelly, JACA Corp. (215) 643-5466.

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.



**Methylene Chloride Labeling Due Soon**—A Consumer Product Safety Commission (CPSC) policy on labeling household products that contain methylene chloride will take effect March 14, 1988 for products whose labels are printed after that date. A later effective date is provided for products packaged after the March date. The CPSC Policy identifies as hazardous substances those products that contain methylene chloride. Under the new policy, the products are misbranded if not properly labeled. Among the products considered to be hazardous due to their methylene chloride exposure potential are spray paints, wood stains, and varnishes. See 52 Federal Register 34698 (Sept. 14, 1987). Contact Charles M. Jacobson, Division of Regulatory Management, Consumer Product Safety Commission, Washington, D.C. 20207 (301) 492-6400.


**New York Proposed VOC Regulation for Architectural Coatings**—The New York State Department of Environmental Conservation has proposed adoption of a VOC regulation for architectural coatings similar to current California architectural coatings regulations. Public hearings on Draft Rule—Part 205, Architectural Surface Coatings, are scheduled to be held in April. Contact Ricky M. Leone, Assistant Sanitary Engineer, Bureau of Abatement Planning, Division of Air Resources, New York State Department of Environmental Conservation, 50 Wolf Road, Albany, NY 12233 (518) 457-6379.

**Health Advisory Issued for Drinking Water Contaminants**—EPA issued drinking water health advisories for 49 contaminants including 25 organic chemicals and seven inorganic chemicals. The advisories are intended to provide information for those who might have to deal with emergency spills or drinking water contamination. They provide information on health effects, chemical and physical properties, methods of analysis, and treatment technologies. For more information, contact Jennifer Orme, Health advisory Program Coordinator, Office of Drinking Water (WH-550D), U.S. EPA 401 M St., S.W., Washington, D.C. 20460 (202) 382-7571. For copies, contact NTIS, Port Royal Rd., Springfield, VA 22161, (800) 336-4700. Reference PB87-206306/AS for the organics; and PB 87-200176/AS for the inorganics.

**Solvent Seminars Slated by EPA**—EPA's Center for Environmental Research Information and Office of Solid Waste and Emergency Response has scheduled a number of solvent reduction seminars for February. The seminars will comprehensively cover technical and regulatory options for solvent waste management. The seminars are intended for solvent waste generators. Sessions are planned for Atlanta, Boston, Chicago, Kansas City, and Seattle. For schedule and registration information, contact Robin Gold, JACA Corp., (215) 643-5466.

## SUMMARY CALENDAR OF REGULATORY ACTIONS

February 1988	EPA sponsored solvent reduction seminars begin. (See this issue.)
February 8, 1988	Comments due on EPA polymer production plant VOC limits. (See January 1988 issue.)
February 27, 1988	Warnings required for first 27 chemicals listed under Calif. Proposition 65. (See January 1988 issue.)
March 1988	Calif. Scientific Advisory Panel to consider additions to Proposition 65 list. (See January 1988 issue.)
March 14, 1988	CPSC Policy on labeling household products containing methylene chloride takes effect. (See this issue.)
March 18, 1988	Petitions due for judicial review of EPA organic chemicals, plastics and synthetic fibers category effluent limitation guidelines, pretreatment standards and new source performance standards. (See January 1988 issue.)
March 23, 1988	Generators of 100-1000 kg/month of hazardous waste must file exception reports when wastes are shipped but delivery is not confirmed.
March 28, 1988	Comments due on EPA's expanded Good Laboratory Practice standards. (See this issue.)
April 1988	Comments due on New York State Proposed Regulation for Architectural Coatings. (See this issue.)
May 9-11, 1988	EPA sponsored hazard waste symposium. (See this issue.)



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## NPCA Receives National Award for PIP Program; Clark Award Winners Honored at Centennial Meeting

The National Paint and Coatings Association's Picture It Painted (PIP) program has received national recognition as a winner of the 1987 Gold Circle Award at a special awards ceremony at the American Society of Association Executives (ASAE) 5th Management Conference, held November 15-18, 1987, in Nashville, TN. The Gold Circle trophy is sponsored by ASAE to recognize outstanding communication programs of trade associations nationwide.

PIP was selected as one of 38 first-place winners in a competition of over 800 entries. NPCA received first prize, while competing against 71 other national associations, in the Public Relations Program for a Single Purpose category.

According to a NPCA spokesperson, the purpose of the PIP program, as outlined in the competition, is two-fold: to dispel the perception of paint as purely a maintenance tool and to generate favorable publicity for NPCA members.

The Gold Circle Award is the latest of three national awards NPCA has received for its seven-year-old PIP campaign. In 1985, PIP was selected as one of the 150 best community relations programs in a national competition sponsored by the Community Relations Report. One year later, the program was voted one of the top 100 examples of community outreach by the White House Office of Private Sector Initiatives.

Since its inception in 1980, the PIP campaign has brought a new coat of paint to hundreds of buildings across the country through the efforts of NPCA's 28 local affiliates.

### 1987 Clark Award Presented To Four Local Associations

Four local associations were revealed as winners of the 1987 Allen W. Clark Award during the NPCA's 100th Annual Meeting in Washington, D.C. The Clark Award is presented annually by NPCA to a local association in recognition of an exceptional community service project undertaken through the Picture It Painted program.

Southern California PCA won first place in the competition and Baltimore PCA was the second place winner. The Louisville and Wisconsin PCA were awarded honorable mentions. Barring a tie in 1985, this

is the first time in the history of the competition that multiple awards have been presented.

The Southern California local was awarded first prize for its sponsorship of two projects. First, they teamed with Los Angeles Mayor Tom Bradley in the establishment of a city-wide anti-graffiti Paint Bank. The local presented the mayor with a \$100,000 donation—representing an in-kind contribution of paint—to be offered free of charge to Los Angeles residents and businesses to erase graffiti. The second effort mustered the support of close to 200 paint industry volunteers to renew MacLaren Children's Center, a facility that provides emergency shelter to over 5000 battered and abused children a year. The

recruits, from the local union and Painting Contractors, provided a colorful interior and exterior makeover of MacLaren's dormitories as the first step to ongoing painting of the 10-acre facility.

The Baltimore PCA earned second place for its sponsorship of a city-wide mural contest with the mayor's office. The project brought award winning designs of local artists to high visibility graffiti trouble spots in Baltimore's six districts.

The Allen W. Clark award is named in honor of the founder of the *American Paint and Coatings Journal*, who was responsible for launching the paint industry's initial community service campaign in 1914 called Clean-Up, Paint-Up, Fix-Up.

## DuPont Surveys Uncover Indicators Of Industrial Safety Success

Surveys conducted by the DuPont Co., Wilmington, DE, at 150 non-company locations since 1985 and 11 company sites in 1983 have identified three areas of worker perception and belief that indicate the success of safety at an industrial facility.

The studies found the key indicators to be worker perceptions of how committed top management is to safety, how involved supervisors are in safety, and how much workers participate in safety.

The safety climate surveys used 100-item questionnaires that dealt with nine areas, including management commitment, supervisory involvement, worker "buy-in," perceptions of safety rules and procedures, working conditions, and the effectiveness of the safety organization.

Initially, responses from the safest DuPont sites were used to build correlations between worker perceptions and beliefs and safety performance. Presently, responses from new sites are compared against the locations with the highly successful safety programs.

The data show that perceptions concerning top management had the greatest relation to safety performance. One issue of special importance was how workers thought management balanced production and safety. If production was seen as more important than safety, then managers and

workers tend to bend safety rules to increase output.

Supervision issues played a key role because supervisors' actions directly affect workers. Key issues here concerned perceptions of how supervisors react to safety, follow safety rules, and respond to safety suggestions.

A "successful" program is defined as having less than one recordable injury per 100 employees per year or as having reduced injuries by 50% in the last three years.

## Exxon Chemical to Expand Neo Acids Production Plant

Exxon Chemical Co., Houston, TX, will expand the neo acids production facility in its Baton Rouge, LA, chemical complex by 50%. The expansion, expected to begin during the second half of the year, is the third in a series of previously announced capacity increases that began in 1986.

The project includes improvements to process controls for product quality as well as changes designed to increase production flexibility.

The neo acid expansion comes one year after Exxon announced the addition of iso and linear acids to its product line.



## Methods of Combating Duct Corrosion To Be Focus of Study by Battelle Labs

Two programs aimed at helping utilities select cost-effective methods to combat corrosion of outlet ductwork in coal-fired power plants have been initiated by Battelle Columbus Labs, Columbus, OH.

The two-year programs are being conducted for the Electric Power Research Institute (EPRI) and will evaluate methods used to prevent duct corrosion caused by flue gas desulfurization. Corrosion occurs when flue gases from sulfur dioxide scrubbers form corrosive condensate in the outlet ducts that lead to the stack.

Battelle's two programs will provide utilities with a computer model that predicts corrosion rates of alloys and an analysis of what factors affect deterioration of organic coatings.

The first program will include laboratory and field experiments on stainless steels, nickel-base alloys, and titanium. Results will be compiled into a computer model which will in-turn determine the rates of

corrosion for each alloy as a function of chemical composition of the environment inside outlet ducts.

The second program will analyze the effects of temperature, flue gas composition, and composition and acidity of condensates on eight different organic coatings. Results will allow utilities to identify what variables are important in causing deterioration of these coatings.

## American Cyanamid Completes New Powder Coating Lab

American Cyanamid Co., Wayne, NJ, has announced the completion of a new powder coating laboratory. The new facility is part of the company's Chemical Research Division, Stamford, CT.

The laboratory will be used for evaluating new crosslinking agents for powder coatings.

## TAFI Inc. Breaks Ground For New Headquarters

TAFI Inc., Concord, NH, specialists in high temperature technologies, has broken ground for the construction of new headquarters located on an 18-acre site near the Concord airport. The multimillion dollar facility is scheduled to be completed in March.

The new building will include design, manufacturing, marketing, and administrative facilities for the firm's worldwide activities. In addition, a special facility will encompass a full scale prototype plant and demonstration unit for the research and development of unique plasma and arc spray coatings, as well as superalloys, metal matrix composites, superconductive, and other advanced materials.

## OSHA Honors U.S. Paint; Company Qualifies for VPP

U.S. Paint Div., Grow Group, Inc., St. Louis, MO, was honored as the first paint and coatings manufacturer to become part of a stringent safety program of OSHA, and qualified for participation in the Voluntary Protection Programs (VPP).

U.S. Paint qualified for the Try level, which is the intermediate of three safety levels in the VPP. The company prepared three years to qualify for the Try program. Worksites at the Try level are evaluated once a year, while those at the top level, Star, are evaluated once every three years. Worksites at the Try level are not subject to programmed OSHA inspections. The beginning level is Demonstration.

U.S. Paint has become the 56th worksite, of a possible 5 million U.S. worksites, to receive the award.

The VPP emphasize cooperative efforts of all people at a worksite to establish an ongoing safety program and to reduce any rates above the industry average.

## Coalition Established To Secure Safe Soil Levels

A unique coalition, consisting of scientists and administrators from various state, federal, public, and private interest areas, has been formed to develop procedures for establishing safe standards for soil contaminants.

Named the Council for Health and Environment Safety of Soil (CHESS), the new organization is an offspring of the International Society of Regulatory Toxicology and Pharmacology (IS RTP), Columbia, MD.

The group is being charged with establishing uniform procedures for developing standards, which at the present time vary from state-to-state because of different risk assessment models being used.

## E.C.C. America, Inc. Expands Capacity For the Paper and Board Industry

E.C.C. America, Inc., Atlanta, GA has announced that the company is completing a \$50 million expansion at its Anglo-American Clays subsidiary in Sandersville, GA. The expansion is designed to support the paper and board industry.

The development will result in a 40% increase in production capacity for its kaolin products. The expansion includes new capacity for high brightness and high glossing clays, delaminated clays, and calcined clays.

The Sandersville expansion includes construction of E.C.C. America's fifth calciner. The new furnace is scheduled to be on-line in mid-year and is identical to the company's fourth calciner commissioned early in 1987.

Further expansions are scheduled to be completed by mid-year to add auxiliary

capacity to produce coating clays for the paper and board markets.

E.C.C. America is also expanding their Sylacauga Calcium Products subsidiary in Sylacauga, AL. The expansion program will increase capacity for the ultra-fine ground calcium carbonates by 50%.

## Hercules Tech Center Houses Liquid Molding Resin System

Hercules Incorporated, Wilmington, DE has announced the completion of a multi-million-dollar technical center located adjacent to the company's Research Center in Wilmington. The facility houses a new liquid molding resin system.

The center provides an applications development facility that includes full-scale production for liquid reaction injection molding (RIM) and resin transfer molding (RTM) of large, complex parts. In addition, the facility utilizes state-of-the-art liquid resin injection equipment.

Hercules is also increasing production capacity for its advanced liquid molding products with the construction of a new facility in Deer Park, TX.

The Deer Park facility is scheduled for completion in the first quarter of the year and features a modular design that will enable Hercules to expand and commercialize improved liquid molding products now under development.

## EM Industries Opens New UV Curing Applications Lab

EM Industries, Inc., a Division of E. Merck, Darmstadt, W. Germany, has announced the formation of an ultraviolet curing applications laboratory in Hawthorne, NY.

The new facility will innovate, investigate, and test new uses for a line of EM's photoinitiators, as well as evaluate EM products in conjunction with the various oligomers, monomers, additives, and substrates available to formulators.

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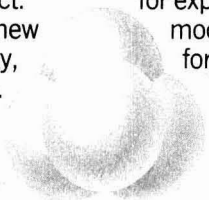
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# Investigation of Electrical Resistivity-Pigment Volume Concentration Relationship in Carbon Black Filled Conductive Paint

Arie Calahorra

RAFAEL—Armament Development Authority\*

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Carbon black filled conductive paints are very useful for antistatic and EMI shielding applications. However, there is a certain limit to the conductivity that can be achieved. In this work, the relationship between electrical resistivity and carbon black loading of dry paint films was investigated.

The critical pigment volume concentration (CPVC) of the formulation studied was found by the density method, in which specific volumes of dry paint films with different pigment loading were determined, and was confirmed by micrographical examination.

It is shown that the volume resistivity of these paints is proportional to the cube root of the volume concentration of the carbon black pigment and that the upper limit of the volume conductivity attainable corresponds to the CPVC of the formulation. Beyond this point, conductivity decreases due to void formation in the dry paint film.

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## INTRODUCTION

Carbon black filled conductive paints are well known for their application in many fields, such as antistatic protection of sensitive devices, electromagnetic radiation shielding and absorption, and space heating.<sup>1-3</sup> Carbon black pigments availability, inertness to many environments, and their relatively low cost have made them attractive and useful as conductive fillers for plastics, elastomers, and paints.<sup>4</sup>

The structure and morphology of a carbon black pigment determine its effectiveness as a conductive filler. The higher the structure of its aggregates, the higher will be their volume fraction in the paint film and the resulting conductivity. Other parameters of carbon black, such as particle size, porosity, density, and the specific surface area affect its volume fraction in the composite and the system's conductivity as well. Eggshell structured hollow particles produced by controlled oxidation of a furnace black pigment increase its specific surface area, decreasing density and consequently improving the conductivity of the pigment per unit weight.<sup>3,5</sup> The extent of loading, expressed as the volume concentration of the conductive carbon black filler in the dry paint's film, determines the actual conductivity of a given pigment-binder system.

Three regions can be distinguished as the carbon black pigment volume concentration (PVC) in a polymer matrix is increased.<sup>5-7</sup> In the first region, at low PVC, the film behaves as a dielectric medium. At a certain PVC, often called the Percolation Threshold, resistivity decreases rapidly as PVC further increases. This is the Percolation region. It derives its name from the quantum mechanical process of tunnelling or percolation of electrons by which conductivity is possible in this region. According to that theory, a small portion of a stream of electrons penetrates a potential barrier under a given electrical field although their energy is lower than that of the barrier. The electrical current thus created is an exponential function of the barrier width.

For carbon black filled paints, the interaggregate gap filled by the dielectric binder serves as the potential barrier between adjacent conductive agglomerates acting as electrodes. Consequently, the interaggregate gap is the

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**Table 1—Volume Resistivity and Specific Volume of Compositions Prepared**

Volume Concentration PVC (%)	Cube Root of PVC (%) <sup>1/3</sup>	Volume Resistivity (kohm cm)	Specific Volume (cc/gr)
15.4	2.49	33.3	0.911
27.4	3.00	2.6	0.835
29.0	3.07	4.15	0.880
30.1	3.11	3.5	0.823
31.25	3.15	1.64	0.777
34.6	3.26	12.0	0.911
37.7	3.36	25.4	1.17

main factor in determining the system's conductivity. Upon narrowing this gap by increasing carbon black aggregates' volume by using grades of lower density or increasing PVC, the carbon black-polymer composites' conductivity increases, respectively.

It was shown that resistivity in this region can be correlated to the pigment loading by equation (1):<sup>8-10</sup>

$$\rho = \exp\left(\frac{a}{PVC}\right)^p \tag{1}$$

where  $\rho$  is the effective resistivity at a particular voltage,  $a$  and  $p$  are constants, and PVC is the volume concentration of carbon black in the dry paint film.

Ideally, as in the case of a theoretical array of spherical particles in a cubic lattice, the interparticle separation is proportional to the cube root of the volume fraction of the particles, so that the theoretical absolute value of  $p$  is 1/3.

A comprehensive discussion of tunnelling/percolation mechanism in carbon black-polymer matrix systems is given by Medalia,<sup>5</sup> Sichel,<sup>7</sup> and Blythe.<sup>8</sup>

In the third region, at high PVC, resistivity decreases to a constant value where additional loading does not significantly change the resistivity level. At this region, the interaggregate gap becomes so small that a network of conductive paths is established, representing a state of metallic conductivity.<sup>5</sup> This point is of practical importance since it indicates the upper limit of conductivity attainable by a specific carbon black pigment.

In terms of modern paint technology, the PVC at which the binder just fills the voids between the packed pigment aggregates, leading to minimal interaggregate gap, is defined as the critical pigment volume concentration (CPVC). Its importance lies in the fact that many of the dry paint film properties, such as permeability, internal stresses, corrosion resistance, flexibility, gloss, and adhesion markedly change at this point.<sup>11-13</sup> However, the most important parameter for formulation and interpretation of pigment behavior in paint films is the reduced PVC,  $\Lambda$ , defined as the ratio of PVC to CPVC. When  $\Lambda < 1$ , pigment particles are dispersed in the binder matrix, while  $\Lambda > 1$  indicates incomplete pigment imbedment (in the binder) and inclusion of air voids.<sup>14</sup>

**EXPERIMENTAL**

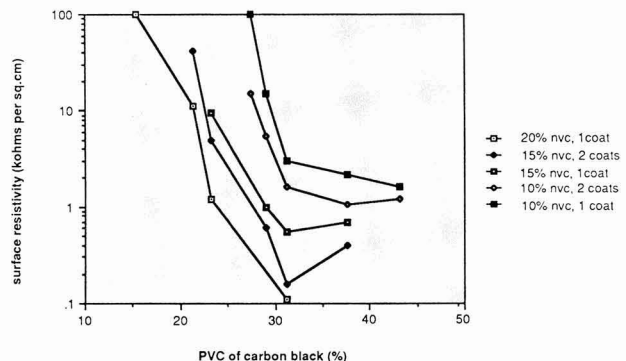
**Materials**

In the present study, the binder was based on Tamalkyd 4-252-M55, a soybean modified medium oil length alkyd 55% solids in mineral spirits (Tambour Paints Ltd., Acco, Israel). Ketjenblack EC-DJ600 (Akzo Chemie, the Netherlands) was the conductive filler. It has a di-butylphthalate (DBP) absorption value of 510 mL/100g and an apparent bulk density of 125 g/cc. This carbon black is claimed by its manufacturer to be 30% more electrically efficient than the well known EC grade.<sup>15</sup> No auxiliary materials were added to the formulation apart from an antiskinning agent.

**Preparation and Application of Paints**

Conductive paints with carbon black volume concentration varying between 15.4-37.7% (0.06-0.2 pigment/binder, w/w solids), were prepared by dispersing Ketjenblack EC-DJ600 in the previously mentioned alkyd with a parallel-disc impeller driven by a high speed stirrer using glass beads, 2-3 mm in diameter, as the dispersing media. Formulations prepared were diluted with measured quantities of xylene to facilitate mixing and dispersion, since the consistency of the mixture grew higher

**Figure 1 — Surface resistivity as a function of carbon black content and film thickness**





with carbon black loading. The level of dispersion was monitored with a Hegman Gauge. Each paint was dispersed to at least Hegman 5.5.

Final dilution to application consistency was carried out after an antiskinning agent was added. The paints were diluted to several nonvolatile compositions. Multi Applicator® no. 2312 (Byk Mallinckrodt, W. Germany) was used to apply paints to solvent cleaned Mylar® film (Du Pont, USA) substrates and were let to dry in ambient conditions for at least 24 hr followed by 1 hr at 100°C. Substrates were also coated by dipping up to two coats with an intermittent drying of 24 hr.

### Electrical Resistivity

Surface electrical resistivity was determined with an electrometer equipped with two 1 sq cm cross section electrodes spaced 1 cm apart. At least three measurements were taken for each sample and their average was recorded. Volume resistivity was obtained by multiplying the surface resistivity by the average film thickness.

### Specific Volume

In order to determine the specific volume, the area of coated substrates was measured with an accuracy of 0.01 sq mm. Coating thickness was determined with a micrometer (1 μm accuracy). The specific volume was calculated using the relation:  $V = At/W$  where  $A$ ,  $t$ , and  $W$  are the area, thickness, and weight of the sample, respectively. Volume resistivity and specific volume of some of the compositions prepared are shown in Table 1.

### Scanning Electron Microscopy

The microstructure of the carbon black filled paints was studied using scanning electron microscope (SEM), (JSM 840, JEOL, Japan).

## RESULTS AND DISCUSSION

In the present investigation, two main topics have been studied. The first is concerned with the dependence of the electrical resistivity of Ketjenblack EC-DJ600 filled alkyd-based paints on pigment loading, the paint's nonvolatile content, and dry paint film thickness. The second deals with the relation between the composition which yields the lowest resistivity and the CPVC, using density measurements and morphology studies.

### Electrical Resistivity of Paints Investigated

EFFECTS OF PAINT COMPOSITION: The measured surface resistivity of conductive paints applied by dipping is shown in Figure 1 as a function of carbon black loading expressed as the PVC, the nonvolatile contents (NVC), and the number of coats. PVC values were calculated using equation (2) from the pigment-solid binder weight ratios, as they appear in the formulations:

$$PVC = \frac{P/B}{P/B + dP/dB} \quad (2)$$

where  $P/B$  is the pigment-solid binder weight ratio,  $dP$  is

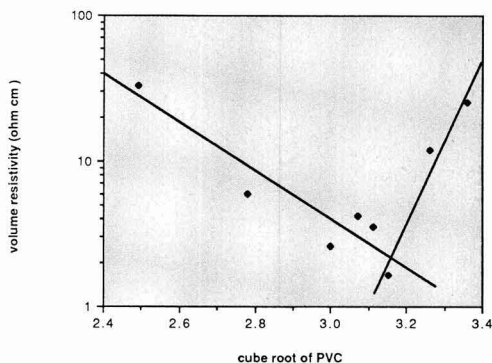


Figure 2—Volume resistivity as a function of the cube root of volume concentration of carbon black

the real carbon black density, which is  $0.345 \text{ g cm}^{-3}$  considering its DBP absorption, and  $dB$  is the density of the binder ( $1.05 \text{ g cm}^{-3}$  in this case).

Later in this study, weight percent of carbon black in the dry film is calculated from these data for interpretation and CPVC evaluation, respectively. It can be seen that as the dry film thickness increases either by adding a second coat or by increasing NVC, the surface resistivity decreases. This is quite obvious since surface resistivity is related to the volume resistivity by equation (3):

$$\rho_s = \frac{\rho_v}{t} \quad (3)$$

where  $\rho_s$  and  $\rho_v$  are the surface and volume resistivities, respectively, and  $t$  is the film thickness.<sup>8</sup> When  $t$  is increased for a material having certain  $\rho_v$ , the measured  $\rho_s$  decreases. However, when different carbon black loadings are concerned, two regions can be distinguished in Figure 1: a region characterized by a logarithmic decrease of resistivity as pigment loading increases and a region where comparatively little decrease or even an increase in resistivity occurs as loading is further increased. A distinct transition point between these two regions is observed at  $PVC = 31.25\%$ .

CORRELATION WITH THE THEORETICAL MODEL OF CONDUCTIVITY: In order to further investigate the behavior of these paints, they were applied by an applicator on Mylar films as previously described, and their volume resistivity was calculated after measuring film thickness using equation (3).

The volume resistivity as a function of the cube root of the volume fraction of carbon black in the dry film is shown in Figure 2. The linearity obtained up to about 3.2 of  $(PVC)^{1/3}$  indicates the existence of the correlation described by equation (1) where  $p = 1/3$ . However, plotting the logarithm of the volume resistivity on a logarithmic scale vs carbon black volume concentration (Figure 3), enables a more accurate determination of the value of  $p$ . By calculating the slope of the least square line in Figure 3,  $p$  was found to be 0.43, which is somewhat higher compared to the theoretical value of  $1/3$ . This may be

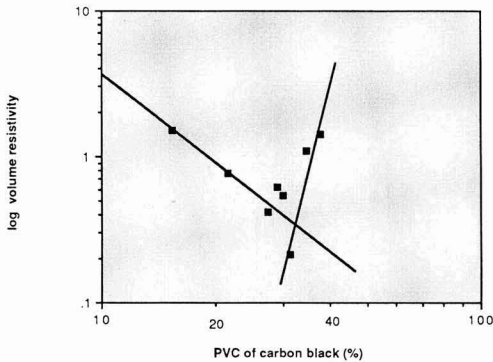


Figure 3 — Log volume resistivity as a function of the volume concentration of carbon black

attributed to imperfect pigment packing due to particle size distribution and irregular shape of carbon black aggregates.

Both Figures 2 and 3 thus show that up to PVC = 31.25%, the electrical resistivity of the paints studied conforms to the model described by equation (1), i.e., there exists an exponential correlation between resistivity and interaggregate gap expressed as PVC. This indicates that the percolation of electrons through dielectric gaps in the dry film is the mechanism by which conductivity in this range of carbon black loading exists. At this point (PVC = 31.25%), a sharp change occurs where the resistivity suddenly increases with PVC, implying that the percolation model is not valid any more.

**CPVC Determination**

DENSITY METHOD: The characteristic behavior of the resistivity described previously implies that the transition occurs at the CPVC. At  $\Lambda > 1$ , insufficient binder solids are available to bind the pigment aggregates and air voids begin to become incorporated into the dry paint film,<sup>16</sup> increasing its resistivity.

One of the simplest procedures for determining the CPVC is the density method suggested by Pierce and Holsworth,<sup>17</sup> following Cole.<sup>18</sup> Accordingly, the specific volumes of dry paint films, having different PVCs, are calculated as described above and plotted vs the weight fraction of the pigment as in Figure 4.

For  $\Lambda < 1$ , the specific dry film volume is determined by the sum of the volumes of the pigment and binder solids as described by equation (4):

$$v = (v_p - v_R) f_p + v_R \tag{4}$$

where  $v$  is the specific volume of the dry film,  $v_p$  and  $v_R$  are the bulk specific volumes of the pigment and resin, respectively, and  $f_p$  is the weight fraction of the pigment in the dry film.

For  $\Lambda > 1$ , where insufficient quantity of binder is available to fill the interaggregate space, the dry film

volume includes air voids and depends on pigment packing. In this case, it is described by equation (5):

$$v = X v_p f_p \tag{5}$$

where  $X$  is the pigment packing factor. The interception of the two lines described by equations (4) and (5) yields the weight fraction of pigment corresponding to the CPVC. The specific volume of the EC-DJ600—alkyd system as a function of the pigment weight in the dry film is shown in Figure 4.

As predicted by the density method, the specific volume vs weight percent plot consists of two linear branches intersecting at 13% wt of EC-DJ600 in the dry film, corresponding to the CPVC of this specific formulation. Both lines were drawn by the least squares method.

The intercept for the line of  $\Lambda < 1$ , with the 0% wt pigment ordinate, yields the specific volume of the binder while its intercept with 100% wt should correspond to the specific volume of the pigment. However, this is not the case and this line intercepts 100% wt at a nonreal negative specific volume. This discrepancy can be explained by an incomplete wetting of carbon black aggregates by the binder due to low affinity and by the existence of relatively large agglomerates due to a nonoptimal dispersion process. These agglomerates allow air voids to remain in the film, resulting in less than theoretical values. The slope of the line passing through the origin, describing specific volumes for paints with  $\Lambda > 1$ , represents the product of the packing factor  $X$  and the pigment's bulk specific volume. It was found to be 0.267 based on bulk density of 0.125 g cm<sup>-3</sup>.<sup>15</sup> Despite the incomplete packing, identification of CPVC is very clear and the correspondence of CPVC and the point of lowest resistivity is quite evident.

SEM STUDIES: Morphological studies with scanning electron micrographs (SEM) were used by Culhane, et al.<sup>19</sup> to interpret the behavior of latex paints with increasing calculated and experimental  $\Lambda$  values. Similarly, they are used in the present work to support the determination

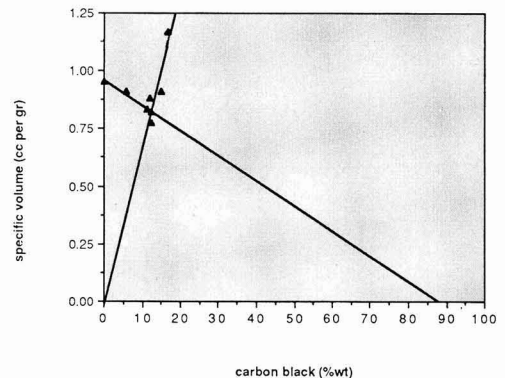


Figure 4 — Specific volume of dry paint films as a function of carbon black weight content

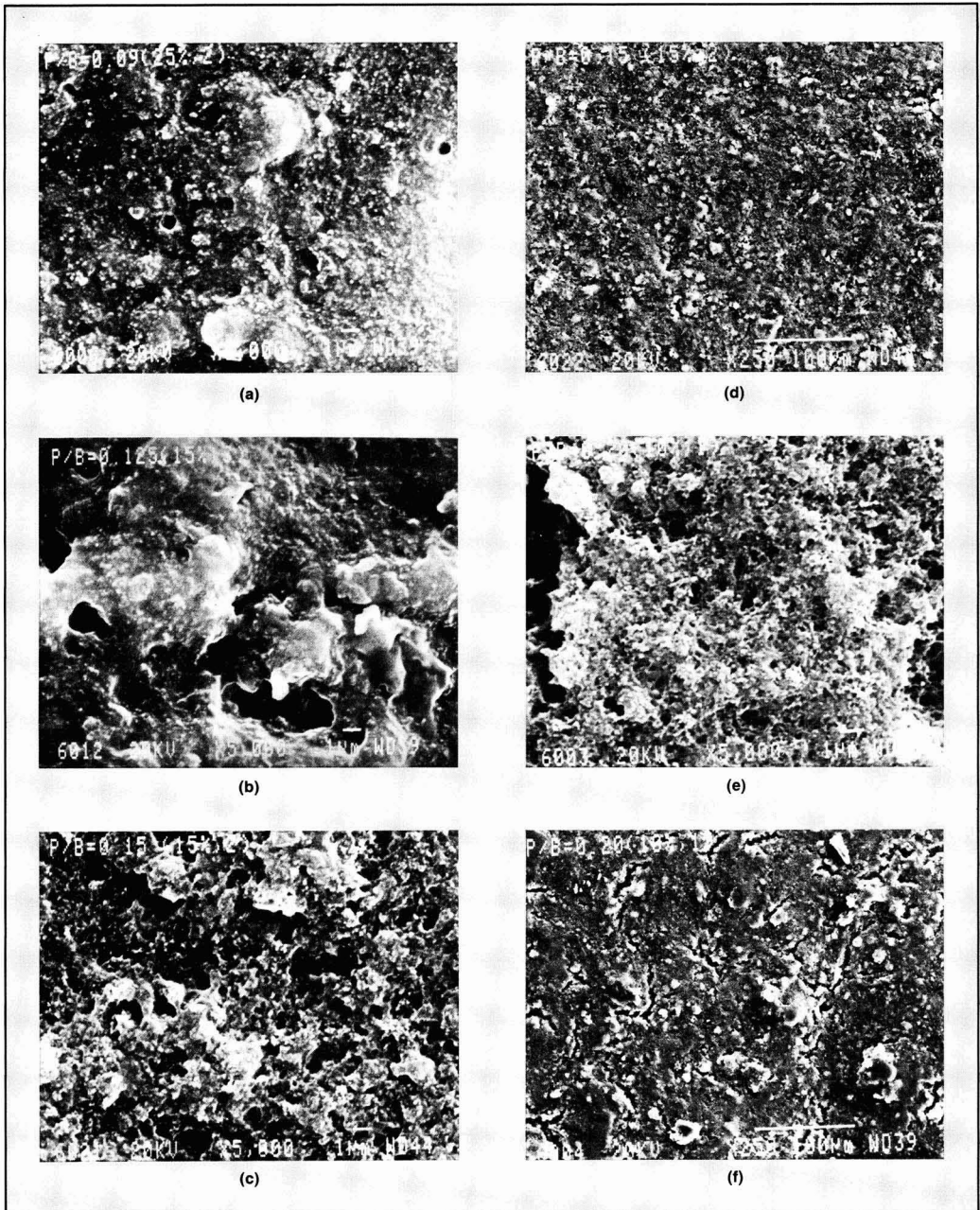


Figure 5 — SEM micrographs of the surface of carbon black filled conductive paints with different  $\Lambda$  values: (a) —  $\Lambda = 0.68$ ; (b) —  $\Lambda = 0.88$ ; (c) —  $\Lambda = 1$ ; (d) —  $\Lambda = 1$ ; (e) —  $\Lambda = 1.2$ ; and (f) —  $\Lambda = 1.2$

of CPVC by the density method. SEM micrographs of paint films having carbon black volume concentration below and above CPVC are shown in *Figure 5*.

*Figures 5a* and *5b* show micrographs for paints with  $\Lambda = 0.68$  and  $0.88$ , respectively. It is evident that, apart from casual imperfections, the films are continuous with no cracks or voids, as expected when  $\Lambda < 1$ .

*Figures 5c* and *5d* show micrographs of paints with  $\Lambda = 1$ , where the PVC is very close to the CPVC of this composition. It seems that the film is porous but still continuous. These pores may be attributed to the actual packing of the irregularly shaped carbon black aggregates as compared to the ideal packing assumed at  $\Lambda = 1$  by definition.<sup>19</sup> Passing over the critical composition to  $\Lambda = 1.2$ , pores, air voids, and cracks 5-10  $\mu\text{m}$  in size tend to form in the film, as shown in *Figures 5e* and *5f*. The formation of porous structure by these compositions further supports the identification of the CPVC and explains the rise in specific volume and resistivity when  $\Lambda > 1$ , due to the enlargement of the average interaggregate distance.

## CONCLUSIONS

Conductive alkyd paints with resistivities as low as 1.6 ohms cm were prepared with Ketjenblack EC-DJ600.

The lowest resistivity was achieved with PVC = 31.25%. It was shown, by the density method and by micrographic examination, that this value corresponds to the CPVC of the formulation.

Up to this point, resistivity is an exponential function of the PVC, as predicted by the percolation theory. The value of  $p$  for  $\Lambda < 1$  calculated from the slope of  $\log(\log \rho_v)$  vs  $\log(\text{PVC})$  was 0.43 compared to 0.33 predicted by theory, indicating a nonideal packing of the pigment aggregates, probably due to the high structure of the pigment.

## ACKNOWLEDGMENT

The author thanks Dr. S. Kenig who reviewed this article and Tambour Paints Ltd., Acco, Israel, for supplying the alkyd.

## References

- (1) Baudler, B.A. and Simpson, B., Report No. NSW-TR-82-482, NTIS ADA 134193, 1982.
- (2) Saunders, J.A., U.S. Patent 4035265, July 1977.
- (3) Bigs, D.M., *Polym. Composites*, 7, No. 2, 69 (1986).
- (4) Garret, M.D., in "Pigment Handbook," Vol. 1, 709, Patton, T.C. (Ed.), J. Wiley and Sons Inc., New York, 1973.
- (5) Medalia, A.I., *Rubber Chem. Technol.*, Rubber Reviews for 1986, July-August 432, 1986.
- (6) Frame, R.I. and Tedford, D.J., *IEEE Trans. on Electr. Insul. EI-21*, (1), 23, 1986.
- (7) Sichel, E.K., "Carbon-Black Polymer Composites," Marcel Dekker Inc., New York, 1982.
- (8) Blythe, A.R., "Electrical Properties of Polymers," Cambridge University Press, Cambridge, UK, 1979.
- (9) Verhelst, W.F., et al., *Rubber Chem. and Technol.*, 50, 735 (1977).
- (10) Shen, L-F., et al., *IEEE 29th Electr. Comp. Conf.*, 286, 1979.
- (11) Asbek, W.K. and Van-Loo, M., *Ind. Eng. Chem.*, 1470, July 1949.
- (12) Payne, H.F., "Organic Coating Technology," J. Wiley and Sons Inc., New York, 1963.
- (13) Perera, D.Y. and Vanden Eynde, D., "Effect of Pigmentation on Internal Stress in Latex Coatings," *JOURNAL OF COATINGS TECHNOLOGY*, 56, No. 717, 47 (1984).
- (14) Bierwagen, G.P. and Hay, T.K., *Progr. Org. Coat.*, 3, 281 (1975).
- (15) Electroconductive Carbon-Black Ketjenblack EC-DJ600, Akzo Chemie, The Netherlands, Tech. Bull. EC.5.2.0.1E.
- (16) Hesler, K.K., "Practical Technique for the CPVC Determination of Titanium Dioxide-Containing Latex Paint Systems," *JOURNAL OF COATINGS TECHNOLOGY*, 50, No. 664, 57 (1978).
- (17) Pierce, P.E. and Holsworth, R.M., "Determination of Critical Pigment Volume Concentration by Measurement of the Density of Dry Paint Films," *Official Digest*, 37, No. 482, 272 (1965).
- (18) Cole, R.J., *J. Oil and Colour Chemists' Assoc.*, 45, 776, 1962.
- (19) Culhane, W.J., Smith, D.T., and Chiang, C.P., "Characterization of Pigment Volume Concentration Effects in Latex Paints," *JOURNAL OF COATINGS TECHNOLOGY*, 55, No. 698, 53 (1983).

## ERRATA

The winner of the 1987 PaVaC Award of the New York Society was Richard Schmidt, formerly with Insl-X Products. On page 89 of the December issue of the JCT, it was reported that Richard Smith was the recipient. The Editor apologizes for this error.



# A Further Study of Water-Soluble Acrylic Resins and Coatings

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Nanjing University\*

The solubility behavior of amine neutralized acrylic copolymers changes as the acrylic acid (AA) content increases. The variations of the viscosity curve from an "N" to a "reverse S" and finally to a linear plot, and the study of the solution morphology, indicate that the amine neutralized acrylic copolymer is soluble in water-cosolvent as the AA content exceeds 20 mol %. The variation in viscosity of two acrylic coatings caused by concentration and temperature are reported. Several determining factors in the degree of crosslinking of the coatings are discussed.

## INTRODUCTION

Water-borne acrylic resins have been widely used in baking enamels in industry. The relationship between viscosity and concentration is so important that it has held the interest of many people. Wicks, Hill, and co-workers<sup>1-4</sup> have shown that the changes in viscosity on diluting cosolvent resin solutions with water are abnormal as compared to true polymer solutions. They considered that the abnormality is due to the formation of polymer aggregates and that the so-called "water soluble" acrylic resin is not really water soluble, but water diluted. This anomalous viscosity variation may result in a number of problems, such as: difficulty in resin handling at intermediate concentration due to high viscosity; thin films resulting from extensive dilution to reach application viscosity; and so on.

The aggregation and phase separation phenomena of the acrylic resin in cosolvent-water mixture certainly relate to the relative composition of the ionizable and non-ionizable parts of the resin. In the present work, a series of binary and one of quaternary acrylic resins in cosolvent with different acrylic acid (AA) content were prepared,

and the viscosity change and phase separation behavior upon dilution with water were studied. Results also have been used to discuss some determining factors on forming the acrylic coating films.

## EXPERIMENTAL

### Synthesis of the Acrylic Resin and Coatings

The composition and the molecular weight of the acrylic copolymers synthesized are listed in *Tables 1* and *2*.

All copolymers were prepared by radical polymerization in *n*-butanol using azobisisobutyronitrile (AIBN) for binary copolymers, or benzoyl peroxide (BPO) for quaternary copolymers as the initiators. All monomers were re-distilled before use. A four-neck 250 mL flask fitted with stirrer, thermometer, reflux condenser, and dropping funnel was charged with 70 mL of *n*-butanol. The mixture of monomers and initiator was slowly added to refluxing *n*-butanol over a period of three hours with agitation. Then, the resulting solution was maintained at refluxing temperature for an additional one and two hours for the binary and quaternary copolymer systems, respectively, to complete polymerization. Excess solvent and unreacted monomers were removed by vacuum distillation.

Table 1—Feeding Composition and MW of the Binary Acrylic Resins

No.	Composition(mol%) AA <sup>a</sup>	BMA <sup>b</sup>	Weight Avg. Molecular Wt. <sup>c</sup>	Polydispersity <sup>e</sup> (Mw/Mn)
1.....	10	90	11,800	1.66
2.....	30	70	13,700	2.08
3.....	50	50	9,500	1.96
4.....	60	40	10,700	1.96

- (a) Acrylic acid.  
(b) Butylmethacrylate.  
(c) Obtained by gel permeation chromatography.

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**Table 2—Feeding Composition and MW of the Quaternary Acrylic Resins**

No.	AA	Composition(mol%)			Weight Avg. Molecular Wt.	Polydispersity (Mw/Mn)
		MMA <sup>a</sup>	BA <sup>b</sup>	St <sup>c</sup>		
I....	10	44.4	33.7	11.9	10,000	1.78
II...	20	39.5	29.9	10.6	10,800	2.05
III...	26.5	36.3	27.5	9.7	11,100	1.78
IV...	50	24.7	18.7	6.6	11,400	1.51

(a) Methyl Methacrylate.  
(b) Butyl Acrylate.  
(c) Styrene.

After distillation, the polymer/cosolvent ratios were adjusted to 70/30 and 100/30 for the binary and quaternary systems, respectively. The residue n-butanol was used as cosolvent. Finally, N,N-dimethylaminoethanol (DMAE) was added to the systems for neutralizing the carboxylic groups until 75% of AA was neutralized. The acrylic resin prepared was mixed with the curing agent, hexamethoxymelamine resin (HMMM), catalyst, and anti-foam agent to form the acrylic coatings.

Initiator levels were adjusted to obtain samples having similar molecular weights. In this study, the initiator

concentration range was 2.00-3.00 wt %, based on the monomer weight.

### Molecular Weight Measurement

The weight average molecular weights, number average molecular weights, and polydispersities were determined by gel permeation chromatography (GPC). The GPC columns were packed with Styragel (Water Associated), and tetrahydrofuran (THF) was used as the mobile phase. Polystyrene samples were used to calibrate the chromatographic system.

### Viscosity Measurement

The acrylic resin-cosolvent mixtures were diluted by adding water and the viscosities of the diluted mixtures were determined at 30°C with a NDJ-1 rotating viscometer with shear rates of 6-30 sec<sup>-1</sup>.

The concentration of nonvolatile component of each copolymer solution was determined by weighing the residue after heating a certain quantity of samples in an aluminum dish at 140°C for one hour.

### Microscopic Measurement

Following the dilution processes, the resin-cosolvent-water mixtures were examined with an Olympus phase contrast microscope (PCM), and the solution of 45 wt % of all samples was examined with a JEM-200 cx transmission electronic microscope (TEM).

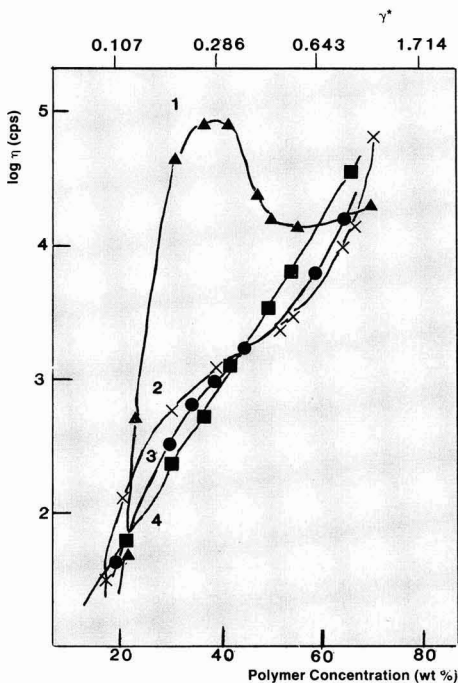
### Determination of the Degree Of Crosslinking of Coatings

The degree of crosslinking of the coatings was determined by solvent extraction. A mixture of benzene and ethyl acetate (1:1) was used as the extraction agent. A weighed sample was extracted for a period of one-half hour in a Soxhlet extractor. The degree of crosslinking is calculated as the weight percent of the residue left after the extraction: the more the residue, the higher the degree of crosslinking.

## RESULT AND DISCUSSION

### Relationship between Viscosity and Concentration

The viscosity-concentration curves obtained for the samples listed in Tables 1 and 2 are shown in Figures 1 and 2. The shapes of the curve of samples 1 (binary) and I (quaternary) are similar to Wicks' results. It can be seen that, as water was added to the resin-cosolvent mixture, its viscosity decreased first and then increased on further dilution, until, after passing over a maximum, the viscosity fell again very rapidly. Wicks, et al.,<sup>4</sup> proposed that, in the initial stage of dilution with water, since H<sub>2</sub>O associated with polymer and intermolecular ionic pairs decreased, the viscosity fell. On further dilution, aggregates of the copolymer were formed, the system became more crowded, and viscosity increased. As more water was added, the decrease of the crowding state resulted in a rapid decrease in viscosity. As the content of AA in-



**Figure 1—Variation of the viscosity of binary acrylic copolymer-cosolvent solution on dilution with water. (\*) is the weight fraction of the cosolvent**

$$= \frac{W_c}{W_c + W_{H_2O}}$$

where  $W_c$  is the cosolvent weight and  $W_{H_2O}$  is the water weight

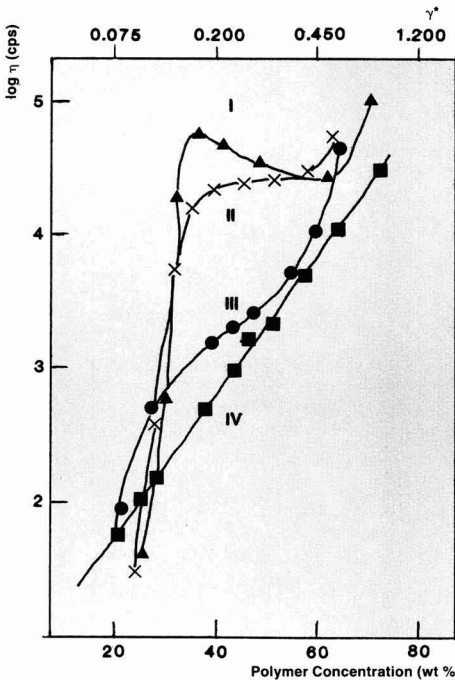


Figure 2—Variation of the viscosity of quaternary acrylic copolymer-cosolvent solution on dilution with water. [(\*)—See Figure 1.]

creased to 20 mol % or more, the shape of the viscosity curve changed from an "N" plot to a "reverse S" plot, and then approached a linear plot, successively. Since the variation of the molecular weight was relatively small, it is reasonable to consider that these results are mainly reflecting the influences of AA content on the solubility behavior of acrylic copolymers in water-cosolvent mixture.

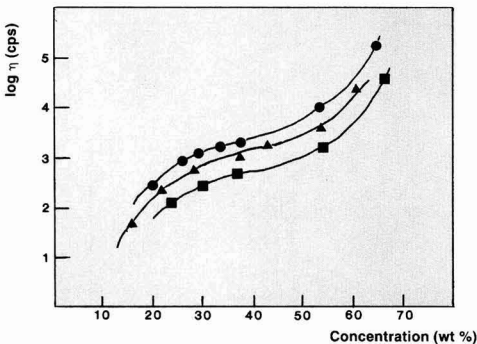


Figure 3—Variation of the viscosity of acrylic resin and coatings on dilution with water. Legend: ●—Acrylic resin III; ▲, ■—Acrylic coatings

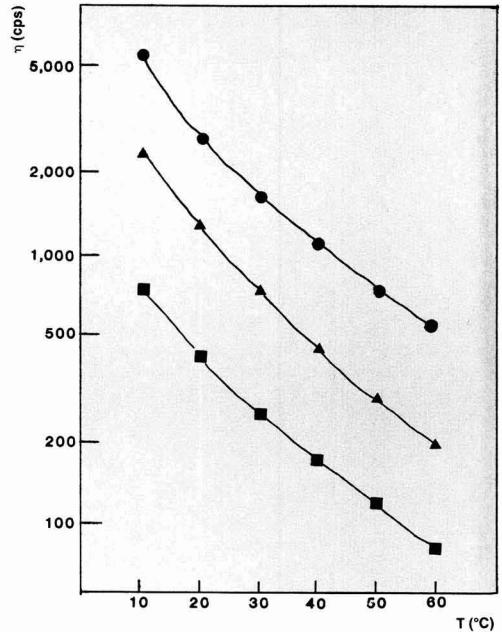


Figure 4—Variation of the viscosity of acrylic resin and coatings as a function of temperature. Legend: ●—Acrylic resin III (at concentration of 45 wt %); ▲, ■—Acrylic coatings (at concentration of 50 and 40 wt %)

The dilution curves of acrylic resin III and two acrylic coatings (the mixtures of the resin catalyst and curing agent) prepared previously are shown in Figure 3. It can be seen that, with the water added, the viscosity of the systems decreased progressively. This relationship was very beneficial in application.

### Relationship between Viscosity and Temperature

The curves listed in Figure 4 have shown the relationship between the viscosity of the resin solution and the coatings and temperature. It can be seen that as the temperature increased, the viscosity of the systems decreased sharply. The lowest curve indicates the coating at a concentration of 40 wt %. From the curve, it can be seen that the viscosity of the coating is just located in the application viscosity range of acrylic coatings of 100-150 cps in the temperature range of 35-50°C.

According to this relationship, the problem of sagging could be solved with the technique of spraying hot coating on a cool workpiece.

### Morphology of the Solution

Are the acrylic copolymers in true solution as the AA content increases to a certain level? To get more evidence, we made a direct observation following the dilution processes with PCM.

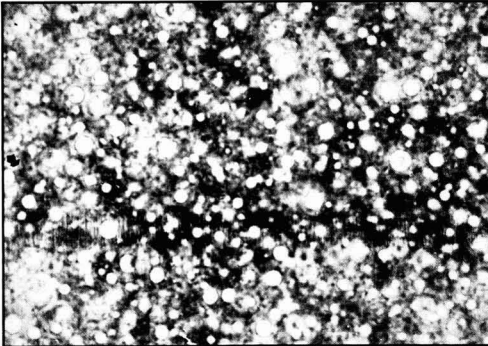


Figure 5—PCM photo of Sample 1 at concentration of 43 wt%. (Amplification is 1,200 ×)

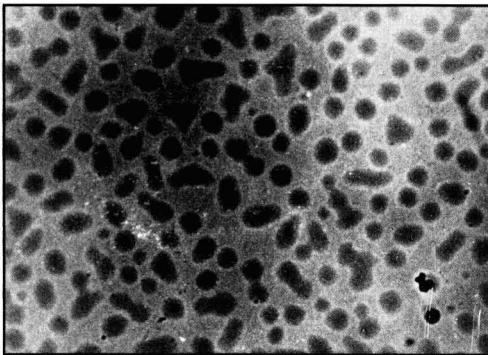


Figure 6—TEM photo of Sample I at concentration of 45 wt%. (Amplification is 7,400 ×)

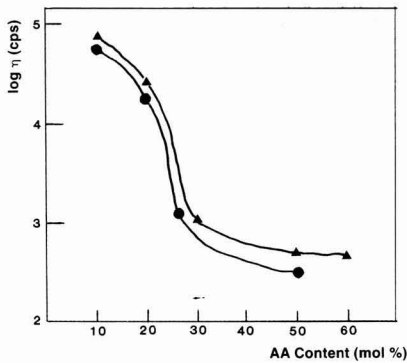


Figure 7—Dependence of the viscosity of acrylic resin-co-solvent-water system on the acrylic acid content of the copolymer at a fixed polymer concentration of 35% by weight. Legend: ▲—Binary copolymers; ●—Quaternary copolymers

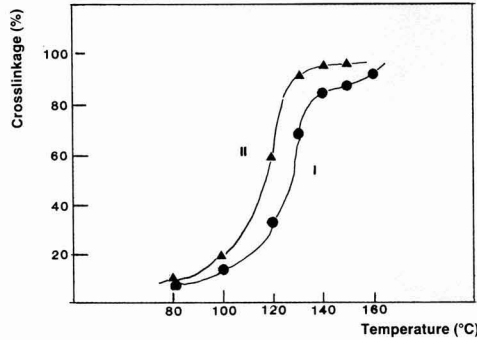


Figure 8—Influence of curing temperature on the crosslinkage of the coatings. I—Coating has no catalyst; II—Coating has catalyst

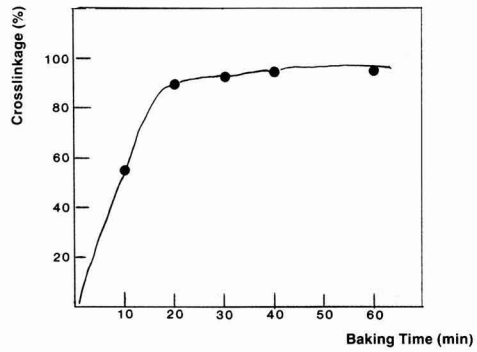


Figure 9—Influence of curing time on the crosslinkage of the coatings

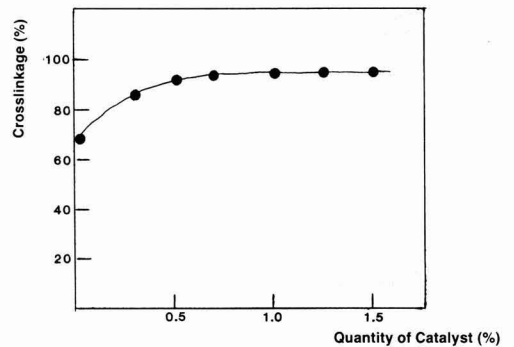


Figure 10—Influence of the quantity of catalyst on the crosslinkage of the coatings



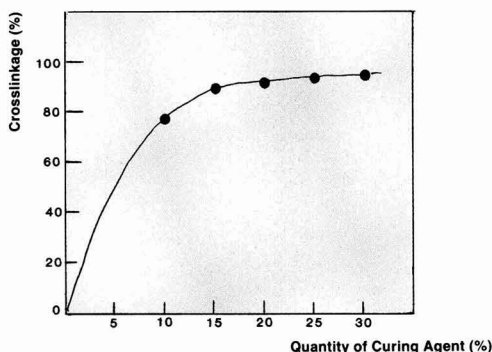


Figure 11—Influence of the quantity of curing agent on the crosslinkage of the coatings

With respect to Curve 1 (Figure 1), aggregates could only be seen in the concentration range of 30-61.5 wt %. (Sample I is similar.) A typical photo of Sample 1 at a concentration of 43 wt % is shown in Figure 5. This was similar to the results of Wicks, et al.<sup>1</sup>

For the samples which have more AA than 20 mol %, however, aggregation was not observed through the whole range of concentrations. To avoid the illusion of aggregate swelling to make the refractive index difference between the aggregates and the solution too small to permit observation, a transmission electron microscope observation was made for these systems. Similar results were obtained with TEM. Figure 6 presents a TEM photo of Resin I at a concentration of 45 wt %, and the aggregates can be seen clearly. For the remaining samples, even though amplifications were from 6,000 to 200,000 times, no aggregates could be seen at all. According to the image-forming principle of TEM,<sup>5</sup> the fact that there is nothing in the photo of TEM means that the sample has a homogeneous physical and chemical property. In addition, it could be considered as a true polymer solution.

#### Relationship of Viscosity and AA Content

Figure 7 shows the relationship between viscosity and AA content of the binary and quaternary acrylic copolymers at a concentration of 35 wt %. The plots can be divided into three regions. In the first region, the copolymer had lower AA content, aggregates formed, and viscosity was higher. In the third region, copolymer was in true solution and viscosity was lower. The second region, in which the AA content ranges from 20 to 30 mol %, is very important. The viscosity and solubility of the system changed abruptly. It should play an important role in the practical resin design.

#### Several Determining Factors in the Degree Of Crosslinking of the Coatings

Water-borne acrylic coatings are thermosetting ones. The coating properties greatly depend on the crosslinkage of the coating film, and this crosslinking depends on

curing temperature and time, and on the quantity of the catalyst and curing agent used in the coating. According to the previous discussions and the properties of the acrylic coatings of varying compositions, we chose the coating of 20% AA content as a sample in order to study the effects of curing temperature, curing time, curing agent, and catalyst to the extent of crosslinking. (See Figures 8-11.) When the degree of crosslinking is greater than 90%, the coating film had application property.

Figure 8 indicates the effects of the curing temperature and the extent of crosslinking (Sample I is the sample which has no catalyst and Sample II is the sample which has catalyst). From Figure 8, it can be seen that the degree of crosslinking of the Coating I and II is greater than 90% at 160°C and 130°C, respectively. Figure 9 shows the effects of curing time to the extent of crosslinking of Coating II at curing temperature of 130°C. From this figure, we can see that at 20 min, the degree of crosslinking is greater than 90%. With the continuous heating, the degree of crosslinking has no apparent increase. Therefore, 130°C and one-half hour are the suitable conditions for curing the coating having catalyst.

Figures 10 and 11 show the influences of catalyst and curing agent on the degree of crosslinking of Coating II at 130°C for one-half hour. These curves indicate that, by controlling the quantities of catalyst and curing agent which are greater than 0.5 wt % and 18 wt %, respectively, the degree of crosslinking can be made greater than 90%.

#### SUMMARY

The solubility behavior of amine neutralized acrylic copolymers has been studied. The viscosity variation observed during water dilution and temperature change has been determined. Also, the morphology of the copolymer solutions has been studied directly with phase contrast microscopy and transmission electronic microscopy. The solubility behavior of amine neutralized acrylic resin in water-cosolvent mixture depends on the acrylic acid content in the copolymers. The water solubility increases with increasing AA content.

Some determined factors on coating film formation were also discussed.

#### ACKNOWLEDGMENT

The suggestions and advice of Professor Rong-Shi Cheng are gratefully acknowledged. Jie Zhang and Qi Wu also assisted in the experiments and their contributions are appreciated.

#### References

- (1) Wicks, Z.W. Jr., Anderson, E.A., and Colhane, W.J., "Morphology of 'Water-Soluble' Acrylic Copolymer Solutions," *JOURNAL OF COATINGS TECHNOLOGY*, 54, No. 688, 57 (1982).
- (2) Hill, L.W. and Richards, B.M., "Viscosity of Cosolvent/Water Solutions of Amine Neutralized Acrylic Copolymers," *JOURNAL OF COATINGS TECHNOLOGY*, 51, No. 654, 59 (1979).
- (3) Hill, L.W. and Wicks, Z.W. Jr., *Progr. Org. Coat.*, 8, 161 (1980).
- (4) Wicks, Z.W. Jr., "Tuliao Gongye" (China), No. 5, 13 (1986).
- (5) Haine, M.E., "The Electron Microscope," Span: London, 1961.

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# Developments in High Solids Magnetic Dispersions and Coatings

Jan W. Gooch  
Georgia Tech Research Institute\*

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Development of magnetic dispersions required novel and quick methods for determining the degree of dispersion during milling in the liquid state, since magnetic dispersions degenerate by agglomeration within minutes. Improved formulations were developed by observing compatibility of resins and solvents with acicular magnetic iron oxide powders and results were interpreted in rheological terms for the liquid dispersions, since rapid feed-back of information was possible. Coatings were characterized by surface gloss, x-ray radiography, optical and electron microscopy together with magnetic measurements. Results show that viscometric trends, degree of dispersion, and magnetic properties are interrelated, and that capillary viscometry flow data is the most consistent method of monitoring the "goodness" of the liquid dispersion before the coating is applied to uniaxially oriented polyester tape.

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## BACKGROUND

The magnetic tape industry is continuously searching for better methods to produce magnetic media materials for specific applications including audio, video, and computer types. The process of manufacturing magnetic tape consists of four major operations: formulation of the magnetic coating; dispersing the magnetic pigment in a resin/solvent solution; coating the liquid dispersion on polyester tape; and calendaring the coated tape.

It is a long process, even under laboratory pilot plant conditions, to observe the results of modifications to a formulation since steps 1 through 3, at a minimum, must be performed before a coating can be evaluated. The dispersion step is critical and difficult to control since the degree of dispersion in the liquid state has not been

satisfactorily determined quantitatively. The rate of particle size reduction is related to the efficiency of dispersing agent and adsorption of resins on the pigment surface. Methods to quickly evaluate the performance of a magnetic dispersion during milling have not been available. Conventional fineness of grind tools are not useful since magnetic pigments form soft agglomerates which deform when stress is applied and give a false reading. These measurements could not be related to magnetic properties. In addition to these ambiguities, the overall dispersion process has not been well-defined, is devoid of a theoretical basis, and is founded from trial-and-error data.

Each use of a magnetic dispersion requires a different formulation to produce specific physical properties, such as hardness, resistance to wear across the recording or playback head, and magnetic properties such as coercitivity and remanence. Coercitivity or coercive force<sup>1</sup> is the magnetizing field which reduces the maximum induction to zero in zero applied field. Remanent magnetic induction is that which remains after a saturated magnetic magnetizing field is reduced to zero. Magnetic squareness of a magnetic tape is the ratio of the remanent to maximum magnetic induction. With uniaxial magnetization, i.e., acicular single domain particles, squareness indicates the degree of alignment of the particles in a tape. This alignment can be estimated by comparing the measured value to the theoretical value of 0.5 calculated for randomly oriented particles which ranges from 0.00 to 1.1. Magnetic skewness<sup>2</sup> is a recent improvement over squareness and is about 50% more sensitive and ranges from one to infinity.

## OBJECTIVES

The overall objective of this research was to develop a formulation(s) for a magnetic coating given the application and necessary properties, i.e., design a coating from

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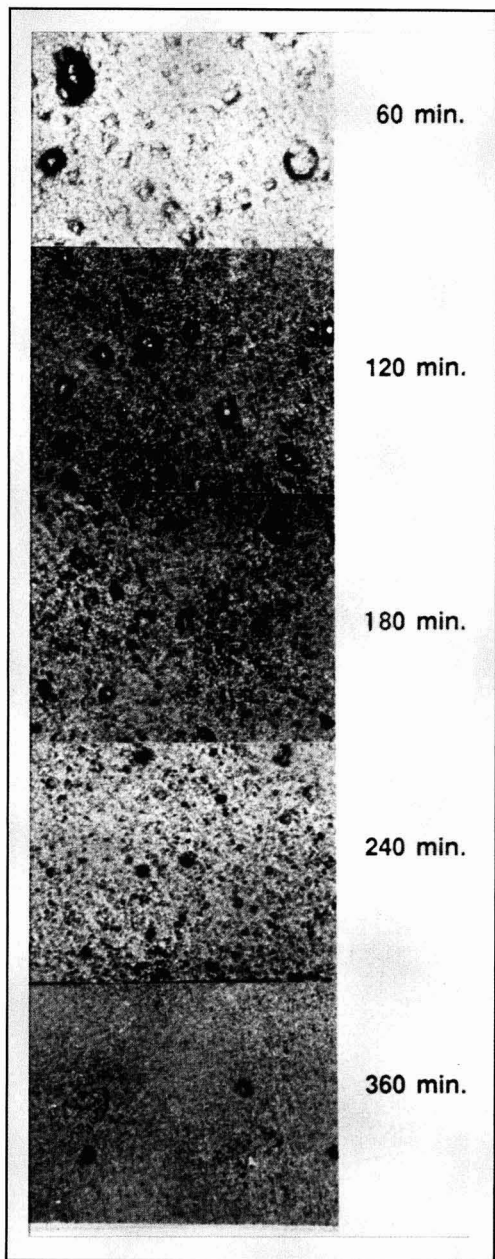


Figure 1—Photomicrographs (x100) of magnetic tape surface at 60, 120, 180, 240, and 360 min of milling

a theoretical basis or data base without a prohibitive number of man-hours or trial-and-error experimentation. Specifically, the objectives were as follow:

- (1) Define the mechanism of dispersion with regard to shear stress-shear rate and resolve differences using multiple methods of measurement for high-solids dispersion.
- (2) Correlate dispersion with coating properties so that measurements can be made in the dispersion stage, but magnetic properties of the coating can be predicted.
- (3) From the data base generated in objectives (1) and (2), select materials and optimize process parameters for preparing high-solids magnetic coatings.

### EXPERIMENTAL APPROACH

Since dispersions exhibit non-Newtonian shear rate trends<sup>3</sup> with shear stress, it was thought that the pseudo-plastic and thixotropic curves could generate shear stress-shear rate curves that would be indicative of dispersion quality. By observing different methods of viscosity measurement, including Haake Rotovisco 2, Brookfield, and capillary, differences could be useful in interpreting the mechanism of dispersion and give insight into optimizing formulation and dispersion parameters.

The dispersing equipment used for this purpose were the Hochmeyer High Speed Dispenser for preparing pre-dispersions, followed by milling in the Chicago Boiler-Red Devil Sand Mill ( $\sim 40,000 \text{ sec}^{-1}$ ) using 3.0 mm silica beads (Potters Mfg. Co.).

The control formulation in *Table 1* was used for the following experiments. Acid-base constants<sup>4</sup> were calculated to select resins and solvents for promoting interaction with pigments. Solubility parameters<sup>5</sup> were evaluated for resin-resin and resin-solvent compatibility/solubility. Wetting agents were screened by acid-base constants, solubility parameters, and from researcher's<sup>6</sup> experience in this field. After the rheology data base was compiled, a dispersing agent and concentration were selected. Then, a factorial experiment design method<sup>7</sup> was employed for optimizing resin compositions in other formulations based on the rate of particle wetting and particle size reduction.

This approach was based primarily on the assumption that "a good dispersion produces a good coating." Although this may not always be true, much work can be eliminated by narrowing the randomness of the tasks. The optimization of coating properties, including tensile strength and elastic modulus, etc., is contained in a separate study.

### MATERIALS

The materials chosen for demonstrating the results of this research were selected to produce a coating 60-70% by weight of pigment in a thermoplastic matrix requiring no curing, but drying in 10 min at 25°C.

The materials selected for this purpose were a mixture of "hard and soft" resins to provide film integrity with flexibility. The materials are listed in *Table 1*.



**Table 1—Formulation of Control Magnetic Media Dispersion**

Component	Weight Percent
DeSoto urethane resin	5.03
Azelaic acid (16.1%)	
Trimethylol propane (22.7%)	
Safflower fatty acids (48.1%)	
Toluene diisocyanate (13.1%)	
Mw = 13,017 g/mole	
Mn = 8,537 g/mole	
Vinyl chloride terpolymer (Union Carbide VAGH)	11.73
Vinyl chloride (91%)	
Vinyl acetate (3%)	
Vinyl alcohol (6%)	
Mw = 39,396 g/mole	
Mn = 21,338 g/mole	
Magnetic iron oxide (Pferrico 2674, Pfizer Corp.)	39.89
Cobalt surface modified small particle iron oxide	
Methyl ethyl ketone	19.16
Toluene	24.19

Solvents were chosen for a fast set-up time and slower total film development. The selection was made on the basis of relative vapor pressures,<sup>8</sup> at 25°C; vapor pressure of methyl ethyl ketone = 100 mm Hg and 22.8 mm Hg for toluene.

The magnetic pigment was selected on the basis of past performance in video magnetic media. These materials will be used exclusively, with the exception of dispersing agents, throughout the study.

## RESULTS AND DISCUSSION

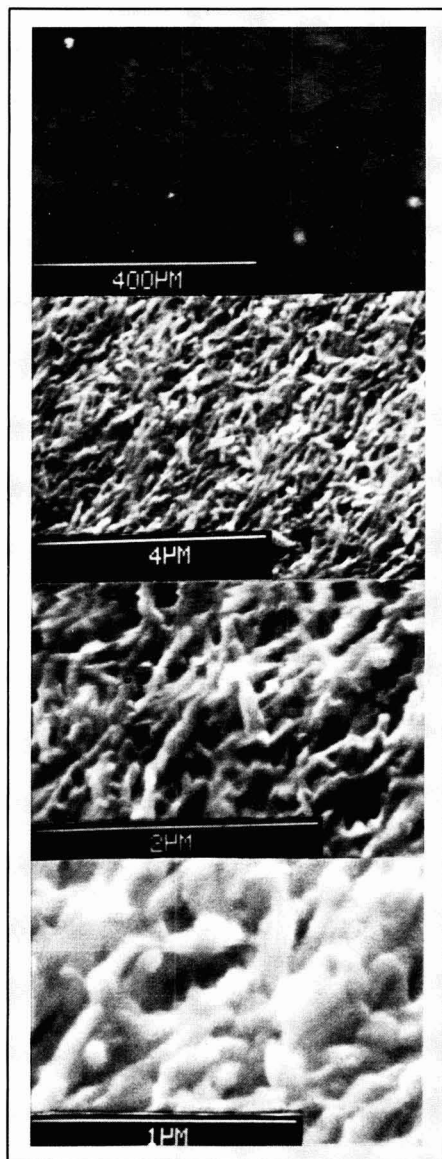
Coatings were prepared from the formulation in *Table 1* without dispersing agents and at increasing dispersing times. The photomicrographs of the surfaces are shown in *Figure 1*. The particles are undispersed agglomerates of the native magnetic particles ( $1 \times 0.1$  micron). The particle size distribution decreases with dispersing time, and the 360 min dispersion coating is examined with scanning electron microscopy (samples coated with gold-palladium) in *Figure 2*. With increasing magnification, the native acicular particles become visible and aligned. The coated tape was drawn through a magnet (1200 gauss) to align the particles in the direction of the tape. Analysis of coatings in *Figure 1* by x-ray radiography showed agglomerated particles increasing in density toward the center.

### Percent Gloss and Particle Size

The surface gloss and particle size of the coatings in *Figure 1* are plotted with dispersion time. Aliquot parts of the dispersion were diluted in urethane resin for particle analysis. The gloss developed logarithmically with dispersion time, and particle size predictably decreased accordingly. The curve fit for % gloss developed is described by equation (1).

$$\% \text{ gloss} = 66 \text{ min} + 25 \ln \text{ min} \quad (1)$$

Particle size reduction measured with the Leeds & Northrup Microtrac Particle Size Analyzer is related to % gloss, as shown in *Figure 3*, and the rate of size reduction is related to the logarithm of dispersing time. The Gardner Glossgard Glossometer ( $60^\circ$ ) was utilized for % gloss measurements.



**Figure 2—Scanning electron micrographs of aligned coating at increasing magnifications for a 360 min dispersion**

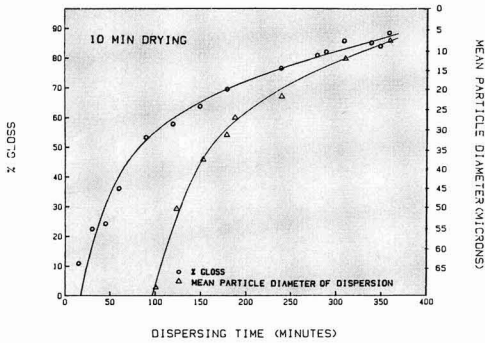


Figure 3—Percent surface gloss of magnetic coating vs dispersing time of liquid dispersion

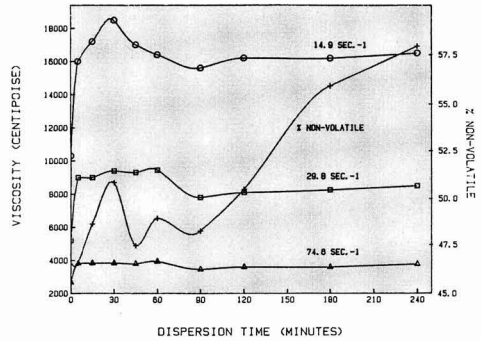


Figure 6—Brookfield viscosity vs dispersion time for 14.9 1/sec, 29.8 1/sec, and 74.6 1/sec. Shear rates demonstrating nonlinearity in viscosity during milling

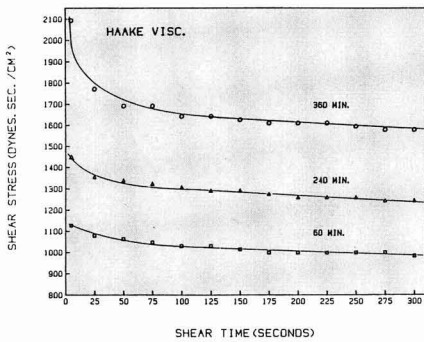


Figure 4—Shear stress vs shear time for 60, 240, and 360 min dispersions

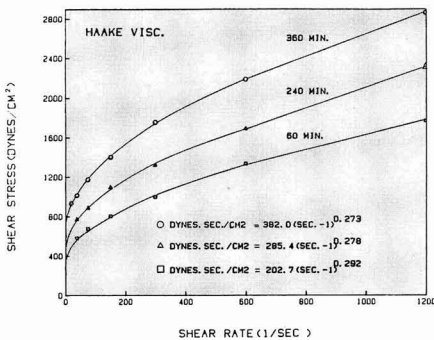


Figure 5—Shear stress vs shear rate for 60, 240, and 360 min dispersions

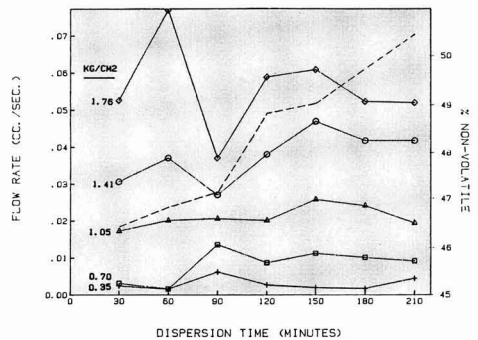


Figure 7—Flow rate vs dispersion time with % nonvolatile content of dispersion with capillary

### Shear Stress-Shear Rate and Time Relationships

The same dispersions previously mentioned were examined with the Haake Rotovisco 2 Viscometer utilizing the MV-1 sensor, and the trends are shown in Figures 4 and 5. Viscosity (shear stress + shear rate) decreases with increasing shear stress which indicates pseudoplasticity<sup>9</sup> and decreases with time at constant shear stress which is indicative of thixotropy. More importantly, viscosity increases with dispersion time in each case. However, the time to perform a measurement and clean-up using the Rotovisco 2 is about 30 min, which is too long to constantly monitor a dispersion during milling. In any event, the curve would provide a near-linear and uneventful curve, unlike the curves generated by the Brookfield RVT Viscometer in Figure 6. Shear rate was calculated from viscosity functions.<sup>10</sup> These unusual and unexpected curves, generated using the #4-spindle, appear to show the viscosity changes during milling. The curves from 90 to 240 min show wide fluctuations due to large particle size distribution and weak magnetic fields caused by iron oxide agglomerates. At 14.9 sec<sup>-1</sup> (10 rpm) the

trend is easily observed and, finally, after 90 min, the curve stabilizes, although it must be realized that particles continue to decrease in size (see *Figure 3*). The variation in % nonvolatile formerly stated is due to a lack of uniformity within the dispersion during milling, but the % nonvolatile becomes more consistent with degree of dispersion.

**Capillary Viscometer**

Still different trends develop in *Figure 7* from the same dispersion using a 0.5 mm diameter capillary viscometer detailed in *Figure 8*. The initial part of each curve exhibits "peaks and valleys," as shown in *Figure 6*, but with increasing shear stress as opposed to decreasing shear stress. Also, the curve continues to change with increasing dispersing time, and only begins to stabilize after 180 min. The changes are primarily due to measured particle size reduction rather than % nonvolatile, an important observation.

The unexpected curves generated from the capillary viscometer are explained best by examining the flow of a dispersion through a capillary tube illustrated and explained in *Figure 9*. As the dispersion flows along the

wall of the capillary, shearing occurs which disrupts the acicular magnetic iron oxide agglomerates of native particles ( $1.0 \times 0.1$  microns). The shear stress,  $s$ , in dynes/cm<sup>2</sup> is generated by gas pressure over the liquid (see *Figure 8*). The velocity,  $v$ , in cm/sec indicates the flow of particles and is very sensitive to soft shearable agglomerates due to the small diameter of the capillary tube, 0.5 mm. The capillary viscometer in *Figure 8* was designed using these principles.

**Differences in Viscosity Measurement**

The capillary viscometer utilizes a different mechanism of detecting viscous flow than the rotating-cylinder in the Haake Rotovisco 2, MV-I sensor. The MV-I sensor possesses a "slip" space between cup and moving cylinder of about 2.0 mm. The Brookfield RVT viscometer, #4 spindle, uses an open reservoir of fluid with at least 1.0 cm slip space. However, the capillary possesses a 0.5 mm (500 microns) for the path of the fluid.

The methods<sup>11</sup> of calculating shear stress,  $s$ , shear rate,  $\dot{\gamma}$ , and viscosity,  $\eta$ , for the capillary viscometer are as follows:

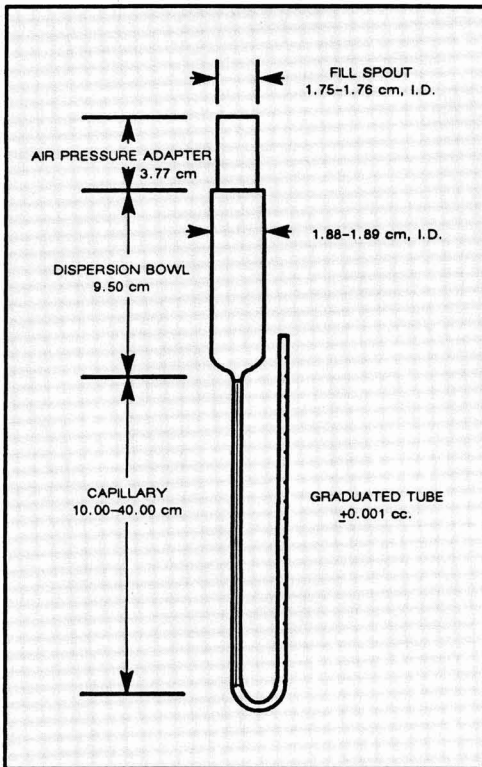


Figure 8—Capillary viscometer

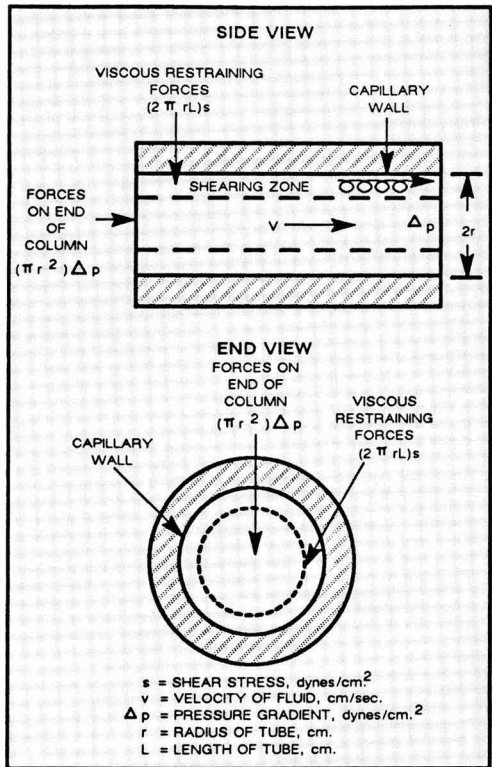


Figure 9—Fluid through a capillary

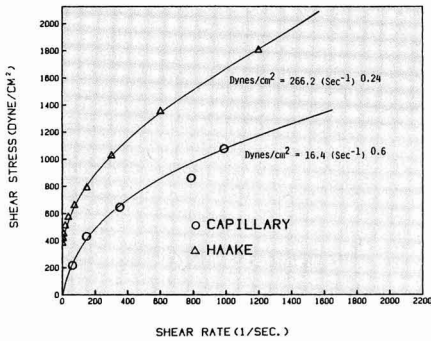


Figure 10—Shear stress vs shear rate for capillary and Haake viscometers for 210 min dispersion

$$s = \frac{\Delta p r}{2L} \quad (2)$$

$$\gamma = \frac{4Q}{\pi r^3} \quad (3)$$

$$\eta = \frac{\Delta p r^4 \pi}{2L 4Q} \quad (4)$$

where

- s = shear stress, dynes/cm<sup>2</sup>;
- $\Delta p$  = pressure gradient, dynes/cm<sup>2</sup>;
- r = capillary radius;
- L = length of capillary;
- $\gamma$  = shear rate, sec<sup>-1</sup>;
- Q = flow rate, cm<sup>3</sup>/sec; and
- $\eta$  = viscosity, dynes · sec/cm<sup>2</sup>.

Dispersions have been characterized by Rabinowitsch<sup>11</sup> in equation (5).

$$(-dv/dr)_w = [(3 + b)/4] (4Q/\pi r^3) \quad (5)$$

where

- v = velocity, cm/sec;
- w = "at capillary wall"; and
- b = Rabinowitsch correction factor for dispersions, dimensionless.

The correction factor, b, is determined by plotting log ( $\Delta p r$ )2L vs log (4Q/ $\pi r^3$ ), taking the slope, and solving in equation (5). It is an index of pseudoplasticity. The b

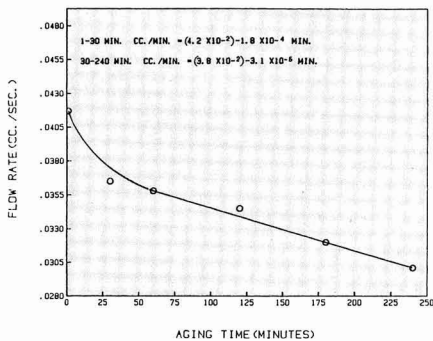


Figure 11—Flow rate of dispersion vs aging time demonstrating rapid degeneration by agglomeration

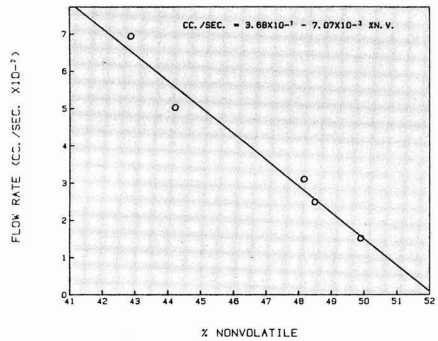


Figure 12—Flow rate of dispersion vs % nonvolatile

correction factor as calculated is 0.6-0.8, but as actually measured is 0.2-0.3 for the magnetic iron oxide pigment dispersion in equation (5), therefore, of limited use for magnetic iron oxide dispersions.

Comparing Haake Rotovisco 2 and capillary (0.5 mm × 200.0 mm) shear stress-shear rates curves in Figure 10, it is obvious that the capillary viscometer measures lower viscosity of a milled dispersion. The difference is due to shear measurement only at the capillary wall-liquid interface; but, the above capillary was calibrated with standard viscosity silicone oils and shear rate correction factors were inserted in the equation to produce the correct viscosities. However, dispersions are pseudoplastic and, therefore, shear-stress sensitive which is experienced primarily at the capillary wall compared to the bulk of liquid in the MV-I sensor. The correction factor reduces with decreasing capillary diameter.

### Dispersion Aging

A property of magnetic iron oxide dispersions is "fast agglomeration with age" and the effect on capillary flow

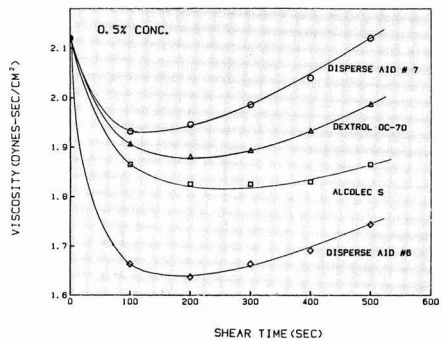


Figure 13—Selection of dispersing agents by observing viscosity vs shear time at 1198 sec<sup>-1</sup>



is shown in *Figure 11*. Agglomerates cause a decrease in the rate of flow. The formation of agglomerates initiates immediately in the absence of shear stress, and the quality of the dispersion degenerates quickly, as described in equations (6) and (7).

$$\begin{aligned} 1-30 \text{ min: cc./min} &= \\ 4.2 \times 10^{-2} - 1.8 \times 10^{-4} \text{ min} &\quad (6) \end{aligned}$$

$$\begin{aligned} 30-240 \text{ min: cc./min} &= \\ 3.8 \times 10^{-2} - 3.1 \times 10^{-5} \text{ min} &\quad (7) \end{aligned}$$

Therefore, a fast measurement technique is imperative due to the rapid formation of agglomerates—less than 10 min.

### Effect of Percent Nonvolatile Content In Dispersion

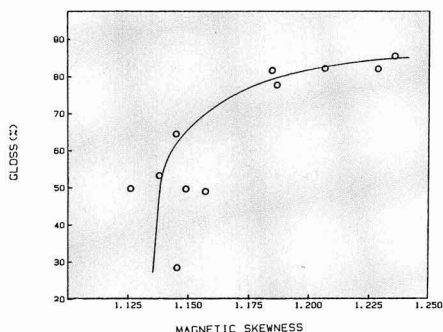
The effect of % nonvolatile in the 210 min dispersion is to linearly decrease flow rate through the capillary as shown in *Figure 12*. From 41% to 52% nonvolatile, the flow rate is expressed in equation (8).

$$\text{cc./sec} = 3.68 \times 0^{-1} - 7.07 \times 10^{-3} \text{NV} \quad (8)$$

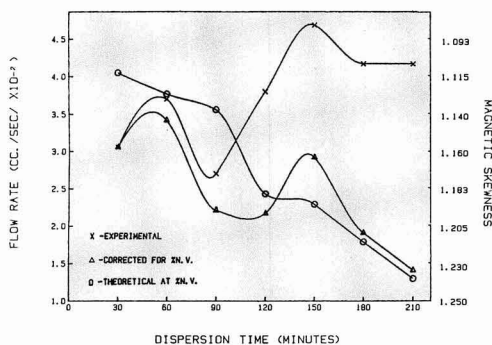
The effect of % nonvolatile is approximately 10 times that of age discussed in *Figure 12*. Therefore, it is always necessary to correct the flow rate for % nonvolatile to effectively reproduce the flow rate. By using a closed system, this variable would be eliminated since % nonvolatile would be constant.

### Selection of Dispersing Agents

From the rheological findings previously stated, it is apparent that the Haake Rotovisco Viscometer with the MV-I sensor can be used to generate low controllable shear ( $1198 \text{ l/sec}^{-1}$ ) within a dispersion. Since it has been demonstrated in *Figure 4* that "viscosity increases with dispersing time," the efficiency of dispersing agents was evaluated by adding dispersing agents to the basic formulation at 0.1-3.0%, % by weight of total formulation weight in *Table 2*. The dispersion was prepared by mixing each agent with the solvent system and pigment, followed by mixing with the resins. The predispersion



**Figure 14—Percent gloss vs magnetic skewness of dried/aligned coating**



**Figure 15—Flow rate vs dispersion time for experimental corrected, for % nonvolatile, and theoretical at % nonvolatile**

was agitated with an electric shaker in each case. *Figure 13* shows the results of each agent at the optimal effective concentration of 0.5%. The initial decreasing slope is due to both drag from large particles and the "yield point" effects, but the consistently increasing slope is due to particle size reduction which is a function of agent penetration and adsorption<sup>12</sup> on the particles which with shear allow them to separate. Disperse Ayd #7 (Daniels Chemical Co.) is clearly the most effective wetting agent in this series. The MV-I sensor was filled with the predispersion and sheared at 512 rpm or 1198 l/sec. This technique was useful for evaluating the compatibility of resins and pigments. Disperse Ayd #7 was added to the formulation in *Table 1* and milling time was reduced, producing a similar flow curve.

### CONCLUSIONS

Formulation development for magnetic coatings has been enhanced by using rheological techniques to monitor the progress of the dispersion stage. This has been successful, and especially fast and accurate using capillary viscometers calibrated for a basic formulation. The same technique is also useful in the manufacturing phase of magnetic media since batches can be monitored in the liquid phase. However, for this, we recommend a continuous "pumping" type capillary viscometer to generate a continuous strip-chart recorder type curve. The resultant curve is continuous and develops a similar pattern as the curve previously mentioned which is reproducible for a given formulation.

Optimization of dispersing agents was accomplished with a Rotovisco 2 Viscometer using an MV-I sensor. The same technique can be used for determining the compatibility of resins.

The rate of particle size reduction is directly related to resin and solvent wetting of pigment surfaces. Particle size reduction is most sensitively monitored by capillary rather than rotating cylinder or spindle type viscometers. This is due to the sensitivity of the capillary to viscosity, particle size and distribution, and especially, agglomerates along the surface of the capillary wall.

The general mechanism of dispersion of iron oxide pigments has been demonstrated by observing particle size reduction while milling, development of surface gloss of coatings from dispersions, reduction of milling time using dispersing agents, and flow of dispersions through capillary viscometers. The mechanism of dispersion is a stepwise process described as follows:

(1) Initial adsorption of solvent is more feasible thermodynamically than resin due to rate of penetration through particles. Therefore, solvent is mixed with pigment initially to wet the surfaces while agitating the mixture.

(2) Solvent and resin solution diffuses through the particles after solvent wetting, but requires agitation to diffuse through the particle agglomerates. Shearing forces are required to reduce the particle size and scatter the native acicular particles as adsorption of solvent and resin continues. The rate of adsorption is much greater than particle breakdown, and adsorption can only occur after free surface is made available. The rate at which this occurs is shown in % gloss vs dispersion time.

(3) The liquid adsorption onto pigment particles is the "rate controlling step" as shown by addition of dispersing agents and development of viscosity. By using these techniques, the milling time was reduced significantly, 150-180 min compared to 210-360 min.

(4) The rate of dispersion and degree of dispersion are directly related to interaction among resin, solvent, and dispersing agent with iron oxide, without which an acceptable coating cannot be formed.

(5) The dispersion mechanism follows a nonlinear rheological trend which must be monitored through a pattern of events rather than relying on a single measurement.

The % gloss and magnetic skewness of the dried coating are plotted in *Figure 14* showing a scattered, but converging set of points reaching an asymptotic zone after 75% gloss. The magnetic skewness continues to increase with little change in gloss indicating the more sensitive measurement of particle size and distribution.

Using the knowledge gained from the flow of liquid dispersion during the milling operation, the flow rate of dispersion and magnetic skewness of dried coating was plotted with dispersing time in *Figure 15*. The Disperse Ayd #7 agent was added at 0.5% of total weight. Following the familiar curve of initial peaks and valleys and reaching a constant slope from 180 min to 210 min, the experimental curve eventually stabilizes. However, by plotting flow rate for an already well-dispersed material

corrected for % nonvolatile (see *Figure 12*), a control curve develops. Correcting the experimental curve for % nonvolatile and plotting with time produces a curve which converges with the theoretical curve asymptotically. So, by adjusting flow rate values for % nonvolatile at 25°C, the degree of dispersion can be determined in the liquid state. The magnetic skewness values of dried coatings from 180 min to 210 min dispersions confirm this observation as shown in *Figure 15*. Again, using a constant pumping viscometer eliminated the manual "filling and cleaning" of the capillary manual viscometer, and the fluctuations in % nonvolatile content.

In summary, the overall optimization of parameters including addition of dispersing agent demonstrates the usefulness of the former methods.

## ACKNOWLEDGMENTS

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## References

- (1) Magnetic Materials—"A Glossary," Pfizer Corp., Easton, PA, 1981.
- (2) Livesay, B.R., Gooch, J.W., and Larson, J.W., "Studies of Magnetic Particle Dispersion Mechanisms, and the Physical Behavior of Recording Tape Composites," Final Report, Georgia Institute of Technology, Atlanta, GA, 1983.
- (3) Patton, T.C., "Paint Flow and Pigment Dispersion," Interscience Publishers, New York, NY, 1964, pp. 10-11, 200.
- (4) Fowkes, F.M., "Acid-Base Interactions in Polymer Adsorption," *I&EC Product Research & Development*, 17, 3, March (1978).
- (5) Barton, F.M. (Ed.), "Handbook of Solubility Parameters," CRC Press, Inc., Boca Raton, FL, 1983, pp. 139-190.
- (6) Lueck, L.B., "Wetting Agents and the Preparation of Magnetic Pigment for Effective Dispersion," Symposium on Magnetic Media Manufacturing Methods, Honolulu, HI, 1983.
- (7) Montgomery, D.C., "Design and Analysis of Experiments," John Wiley & Sons, New York, NY, 1976, pp. 121-159.
- (8) Perry, J.H. (Ed.), "Chemical Engineers' Handbook," 7th Ed., McGraw-Hill Book Company, New York, NY, 1980, Section 3.
- (9) Parfitt, G.D., "Dispersion of Powders in Liquids," 3rd. Ed., Applied Science Publishers, Englewood, NJ, 1981, pp. 376-377.
- (10) Mitschka, P., "Simple Conversion of Brookfield RVT Readings into Viscosity Functions," *Rheol. Acta*, 21, 207-209 (1982).
- (11) Wazer, R.R., "Viscosity and Flow Measurement," Interscience Publishers, 1963, pp. 190-191, pp. 207-220, 268.
- (12) Isobe, Y., Okuyama, K., Hosaka, A., and Kubota, Y., "Effect of the Pigment Vehicle Interaction on the Properties of Magnetic Coatings," *JOURNAL OF COATINGS TECHNOLOGY*, 55, No. 698, 23 (1983).

# Cathodic Blistering of Two Alkyd Paints

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The blistering of two alkyd coatings during the application of a cathodic potential while immersed in alkali chloride solutions has been studied. Factors that affected the rate of cathodic blistering include applied potential, temperature, nature of the electrolyte, type of coating, and the presence of soluble salt beneath the coating. In the case of a zinc chromate alkyd, the rate of blistering increased as the potential was more negative (cathodic), as the temperature was increased, as the coating thickness was decreased, and when soluble salt was present beneath the coating. The rate of blistering of the zinc chromate alkyd under comparable conditions decreased in 1.0M solutions in the order: KCl > NaCl > LiCl. The rate of cathodic blistering of a lead oxide alkyd coating was greater than that of the zinc chromate alkyd coating.

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## INTRODUCTION

Blistering of paint films on a metallic substrate in the absence of an applied potential is a common phenomenon and a large amount of literature exists on this subject. The phenomenon is complex because it involves processes such as diffusion of water, oxygen, and ions and loss of adhesion as well as the mechanical properties of the film. Reviews of the causes and the mechanism of blistering have been given by Funke<sup>1</sup> and by Kresse.<sup>2</sup>

Blistering of the coating is often the first visible indication of the loss of the protective character of a coating. These blisters indicate areas where the coating has disbonded from the substrate and where localized corrosion beneath the organic coating may originate. The principal reactions involved in the corrosion process that follows the blistering are the anodic oxidation of the substrate metal and cathodic reduction of oxygen.<sup>3</sup> These two half-reactions may be summarized as follows:



which occurs when an aqueous medium is present to accept ions, and



which occurs when an aqueous medium is present to accept hydroxyl ions. Cations must also be present to provide charge balance for the hydroxyl ions and dissolved oxygen must be available to be reduced.<sup>4</sup> If a sufficient potential is applied, hydrogen formation also may occur at cathodic sites according to the equation



The cathodic reaction may occur under the coating when coated steel is subjected to cathodic protection and cathodic blistering develops. Blistering is possible because some coatings are more permeable to cations that carry charge through the coating than the cathodically-produced hydroxyl ions diffusing in the opposite direction. The production of alkali and the subsequent loss of the interfacial bond occurs beneath the coating by reaction (2).

The diffusion of mobile species through the paint may be described by a set of equations proposed by Newman<sup>5</sup> and by Ruggeri and Beck.<sup>6</sup>

$$J = P\Delta C/l = (zFPC/RT)\Delta B/l \quad (4)$$

where P is the permeability coefficient,  $\Delta C$  is the difference between the external solution concentration (thermodynamic activity) and that under the coating, l is the film thickness, J is the flux of the species, z is the ion charge, F is the Faraday constant, R is the gas constant, T is the absolute temperature, and  $\Delta B$  is the potential.

Blister formation is caused principally by the osmotic pressure resulting from the different thermodynamic activities of water on the two sides of the coating.<sup>7-10</sup> Experimental evidence that the cathodic process under the coating is the reduction of oxygen has been reported.<sup>11, 12</sup> It is generally accepted that, in the absence of an applied potential, the center of the blister is anodic and

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the periphery is cathodic<sup>13, 14</sup> and that it is the cathodic process which is involved in the progressive outward delamination of the coating from the metal substrate.

The purpose of this research was to study the blistering phenomena when a cathodic potential was applied in the case of two representative primers, a lead oxide alkyd and a zinc chromate alkyd. The survey included a study of the following parameters: applied potential, temperature, the presence of salt contaminant beneath the coating, thickness of the coating, and type of electrolyte.

### EXPERIMENTAL

Two different primer paints were supplied by The Naval Ship Research and Development Center, Annapolis, MD. One paint consisted of zinc chromate alkyd (TT-P-645A) and the other one consisted of lead oxide alkyd (DOD-P-17545D, Type 1, form 1/6D red lead No. 32169). Steel panels (ASTM A-366) were cut into small pieces (5 cm in width and 7 cm in length) and were coated with the paints using a spin coater. In order to obtain the desired thickness, paint was placed on the metal surface and the velocity of spinning and spin time were controlled. The thickness of the coating was measured with a Minictor Thickness Gauge, Model 150, which operates on electromagnetic principles.

All measurements were made in 1M alkali metal chloride solutions. Cathodic potentials between -900 mV and -1,100 mV vs SCE were applied and maintained constant by means of the potentiostat described by Baboian, et al.<sup>15</sup> Two different temperatures were used: room temperature and 60°C. The specimen served as the working electrode and a carbon rod served as the counter electrode. A commercial saturated calomel electrode was

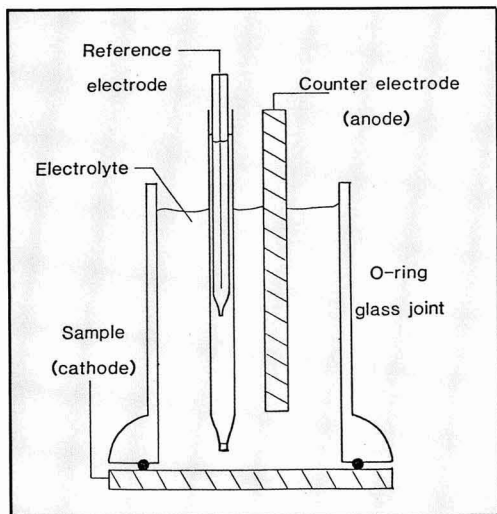


Figure 1—Schematic illustration of the cell used in the formation of blisters

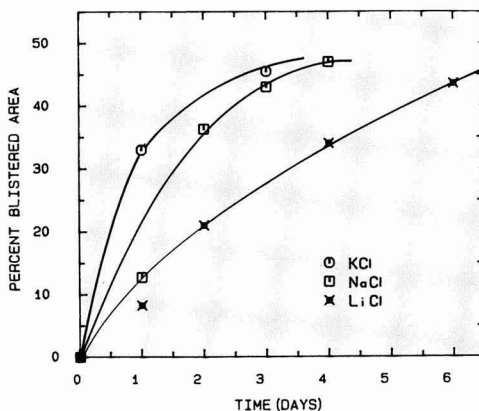


Figure 2—Percentage of area blistered as a function of time for 2.5 μm thick lead oxide alkyd coating at room temperature and an applied potential of -1,000 mV (vs SCE)

used as the reference electrode at room temperature, while a silver-silver chloride electrode was used as the reference electrode in the experiments run at 60°C. A vertically positioned remote junction filled with a solution of 1M NaSO<sub>4</sub>, was used as a salt bridge.

The following procedure was used at both temperatures. A glass cylinder and rubber O-ring were affixed to the specimen with a No. 35 ball and socket clamp. A polymer sheet backing was also clamped beneath the specimen to prevent flexing of the steel panel by the clamps. Figure 1 gives a schematic illustration of the arrangement. The cell was placed in an oven in those experiments carried out at 60°C. The temperature of the oven was kept constant by means of a thermostat.

The applied potential was temporarily suspended occasionally in order to take photographs of the samples so that the area of the blisters could be determined. A Carl Zeiss Mop-3-apparatus was used to measure the blistered area. The blistering measurements were made within 30 min after removal from the solution.

An adhesion test was performed on some specimens before application of the cathodic potential. The measurements were made by pulling the coating off the substrate and measuring the force required in the manner previously described by White and Leidheiser.<sup>16</sup>

Specimens contaminated with salt were prepared as follows: a solution of methanol saturated with salt was prepared. The panels were covered with this solution and the solution was allowed to evaporate. This contaminated surface was coated with the paint by the procedure previously described.

### RESULTS AND DISCUSSION

#### Measurements at Room Temperature

Figures 2 and 3 show representative plots of the growth of the blistered area vs time at -1,000 mV and -1,100 mV, respectively, for the lead oxide alkyd coating using



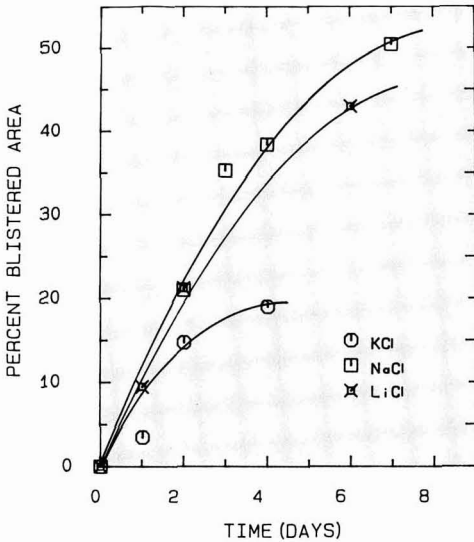


Figure 3—Percentage of area blistered as a function of time for 2.5 μm thick lead oxide alkyd coating at room temperature and an applied potential of -1,100 mV (vs SCE)

1M electrolyte solutions. The blistered area increased with time and approached an asymptotic value.

The rate of growth of the blisters at an applied potential of -1,000 mV was in the order  $K^+ > Na^+ > Li^+$ , but at an applied potential of -1,100 mV, the order follows the sequence  $Na^+ > Li^+ > K^+$ .

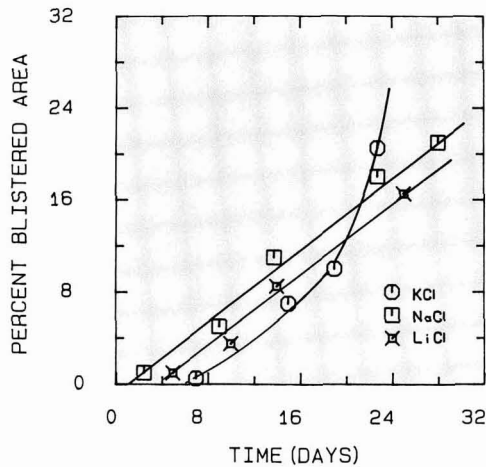


Figure 4—Percentage of area blistered as a function of time for 2.5 μm thick zinc chromate alkyd coating at room temperature and an applied potential of -1,000 mV (vs SCE)

Figure 4 shows the rate of growth of the blisters in a zinc chromate alkyd coating at an applied potential of -1,000 mV. The results indicate that the blistered area obeys the sequence  $K^+ > Na^+ > Li^+$  at longer times. It is interesting to point out that, for this coating, there is a delay time before the formation of blisters and this delay time is in the order  $Na^+ < Li^+ < K^+$ .

It may be noted in a comparison of Figures 2 and 4 that the rate of blistering of the zinc chromate alkyd coating was much less than the rate of blistering of the lead oxide alkyd coating.

### Measurements at a Temperature of 60°C

Figures 5 and 6 show the rate of growth of the blisters for the 2.5 μm thick lead oxide alkyd coating at applied potentials of -900 and 1,000 mV, respectively. At an applied potential of 900 mV, the blistered area follows the sequence  $K^+ > Na^+ > Li^+$ . At an applied potential of -1,000 mV, the same sequence was obtained as for an applied potential of -1,100 mV and room temperature,  $Na^+ > Li^+ > K^+$ .

The asymptotic value for the blistered area is greater at the higher potential at both temperatures.

Figures 7 and 8 show the rate of growth of the blisters for the 2.5 μm zinc chromate alkyd coating in the different electrolyte solutions. These plots show the same relative behaviors of the cations as at room temperature, namely,  $K^+ > Na^+ > Li^+$ . No delay time was observed for blistering of the zinc chromate alkyd coating at 60°.

The pH within the blisters was measured in several experiments at the end of the blistering time and it was always approximately 9.5.

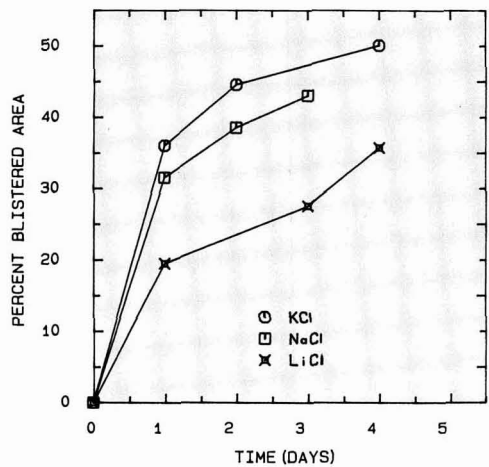


Figure 5—Percentage of area blistered as a function of time for 2.5 μm thick lead oxide alkyd coating at 60°C and an applied potential of -900 mV (vs SCE)

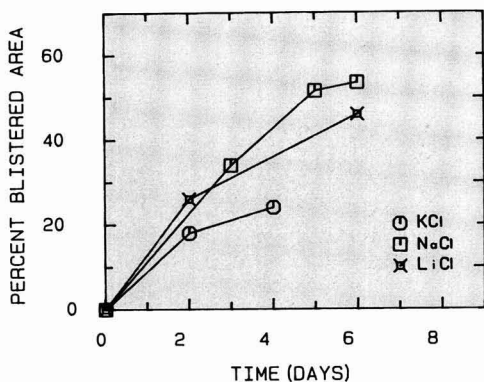


Figure 6—Percentage of area blistered as a function of time for 2.5 μm thick lead oxide alkyd coating at 60°C and an applied potential of -1,000 mV (vs SCE)

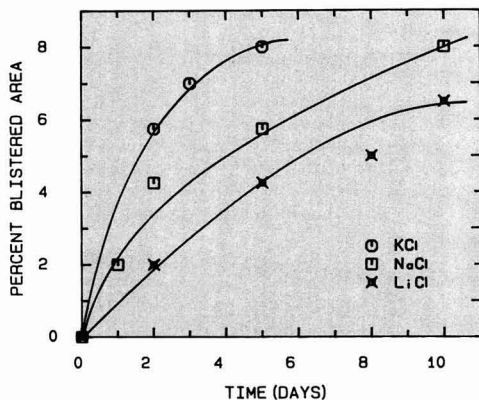


Figure 7—Percentage of area blistered as a function of time for 2.5 μm thick zinc chromate alkyd coating at 60°C and an applied potential of -900 mV (vs SCE)

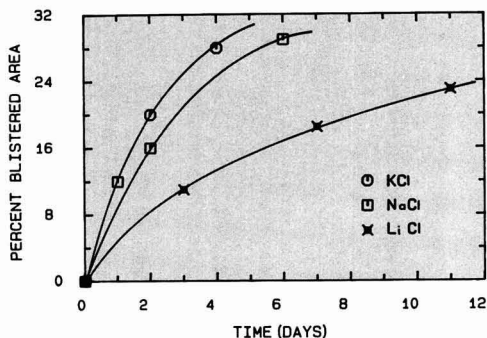


Figure 8—Percentage of area blistered as a function of time for 2.5 μm thick zinc chromate alkyd coating at 60°C and an applied potential of -1,000 mV (vs SCE)

### Blistering in the Absence Of an Applied Potential

All experiments were carried out at 60°C.

Figures 9 and 10 show rates of blistering of the lead oxide alkyd coating and the zinc chromate coating, respectively, for both contaminated and uncontaminated surfaces. The results indicate that the zinc chromate alkyd paint has better resistance to blister formation than the lead oxide alkyd paint. The effect of a contaminated surface is shown in Figure 10. The blistering rate for this type of surface was a function of thickness of the coating over the range studied. Figure 9 indicates that in the early stage, the blistered area is greater for the contaminated than for the noncontaminated surface and reaches the asymptotic value in a shorter time than the noncontaminated surface. The effect of the cation is noted again in Figures 9 and 10, where the blistered area follows the order  $K^+ > Na^+ > Li^+$ .

Figure 10 shows that the delay time is a function of the cation in the electrolyte.

### Shape of the Blisters

Figures 11-13 show pictures taken during the formation of blisters when a potential was applied. Those pictures show the growth of blistering as a function of time. Furthermore, they indicate that the shapes of the blisters are dependent on the type of coating used. Figure 11 represents the chronological behavior of the blistering using lead oxide alkyd as coating and Figures 12 and 13 represent data for the zinc chromate alkyd. Those figures help to visualize the results presented in previous plots.

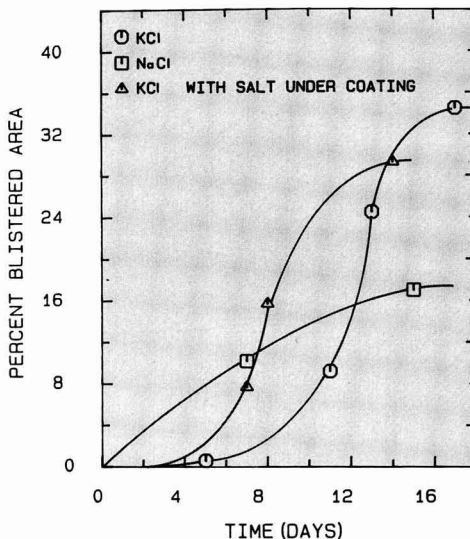


Figure 9—Percentage of area blistered as a function of time for 2.5 μm thick lead oxide alkyd coating at 60°C and no applied potential

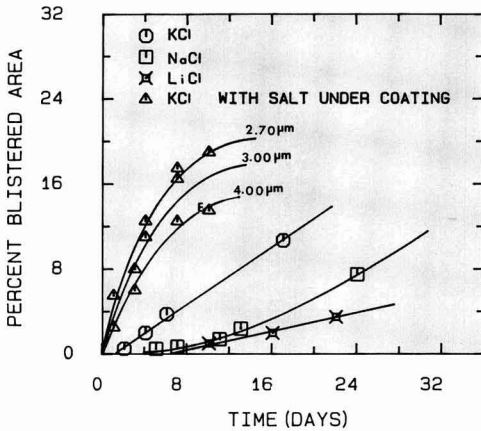


Figure 10—Percentage of area blistered as a function of time for zinc chromate alkyd coating at 60°C and no applied potential

It will be noted that for the lead oxide alkyd coating the shapes of the blisters are different than those obtained with the zinc chromate alkyd coating. Figure 13 shows rust taking place in the blisters. This rust appeared after the blisters collapsed following removal from solution. This collapse occurred only in the case of the zinc chromate alkyd at a temperature of 60°C. These blisters also

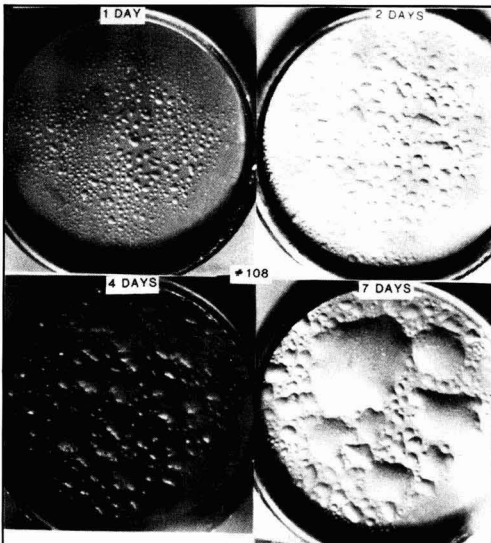


Figure 11—Formation of blisters as a function of time for lead oxide alkyd coating at room temperature, applied potential of  $-1,100$  mV using 1.0M NaCl as electrolyte

showed that the active area (anode) was in the center of the blister.

### Adhesive Strength

Table 1 reports the data obtained during the tensile adhesion test of the coating before exposure to the electrolyte solution. These data suggest that there is no relationship among the presence of surface contaminant, coating thickness, and adhesion force. Tensile adhesion tests were performed during blister formation but the adhesion force was too small and could not be measured.

The average value of the adhesion for the zinc chromate coating was 620 kPa and for the lead oxide coating it was 480 kPa, although range of the values overlapped one another. It is readily apparent, however, that the value of the adhesion prior to exposure to the electrolyte bears no relationship to the blistering behavior. The rate of blistering of the lead oxide coating was significantly greater than that of the zinc chromate coating even though the initial adhesion was generally higher in the case of the lead oxide coating. The adhesion was small in comparison to the osmotic pressure which was in the range of 2,027-2,854 kPa.<sup>1,17</sup>

### DISCUSSION

The blistering behavior of the zinc chromate coating was typical of what might be expected on the basis of past experience in cathodic delamination studies in which a defect was made in the coating before the application of

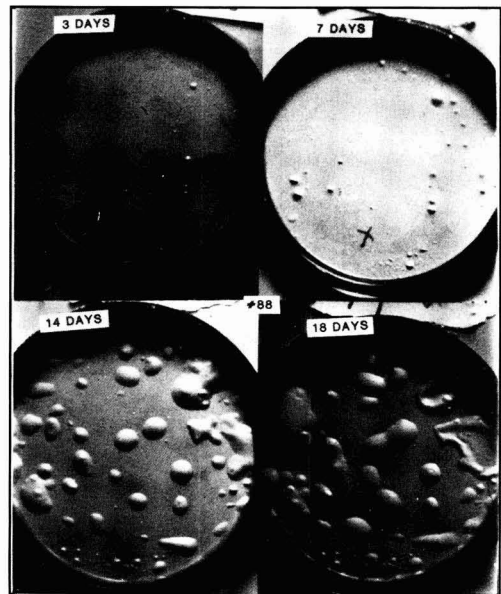


Figure 12—Formation of blisters as a function of time for zinc chromate alkyd coating at room temperature, applied potential of  $-1,000$  mV using 1.0M KCl as electrolyte

the potential.<sup>19,20</sup> The rate of blistering for equal concentration solutions decreased in the order: KCl, NaCl, LiCl, as is to be expected on the basis of the transference numbers of the alkali metal ions and the diffusion coefficients of the cations in chloride solutions. These relationships are a consequence of the fact that it is the cation that carries the majority of the charge through the coating. Both the transference numbers and the diffusion coefficients are reflections of the fact that the diffusing mass of the cation with its sheath of electrostatically held water molecules is greater in the case of the hydrated lithium ion, intermediate in the case of the hydrated sodium ion, and least in the case of the hydrated potassium ion.

The data in Figures 7 and 8 show that the rate of blister formation increases with increase in applied potential and the data in Figure 10 show that the rate of blister formation decreases with an increase in coating thickness. The data in Figure 10 also show that the rate of blister formation in the absence of an applied potential is greatly increased if a soluble salt is present beneath the coating before immersion in the electrolyte.

All of the above data are consistent with a blistering process that is dependent upon osmosis as the driving force for the migration of water through the coating and the formation of a liquid phase at the metal/coating interface. When contaminant is initially present, as exemplified by the data in Figure 10, the driving force for water migration is high since the thermodynamic activity of water in the external solution is much greater than that which initially forms as the soluble salt is dissolved to form a very concentrated solution at the metal/coating interface.

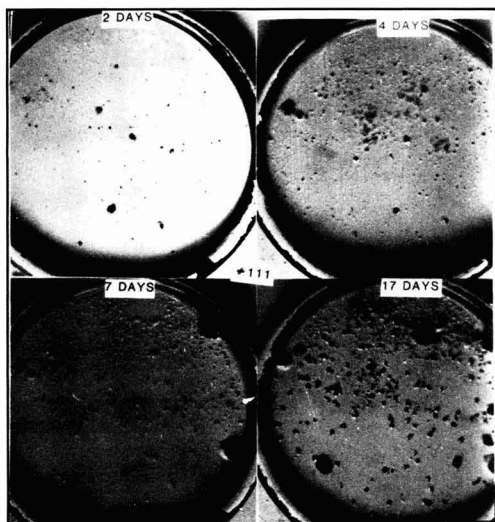


Figure 13—Formation of blisters as a function of time for zinc chromate alkyd coating at 60°C, no applied potential using 1.0M NaCl as electrolyte

Table 1—Tensile Adhesion of the Coating before Immersion in the Electrolyte.

Coating	Thickness	Adhesion	Contaminant
Lead oxide	μm	kPa	—
	2.75	470	—
	3.25	530	KCl
	4.50	610	—
	3.00	410	KCl
Zinc chromate	3.00	410	KCl
	3.50	430	KCl
	4.50	650	—
	3.50	470	KCl
	3.00	780	KCl
	2.50	770	—

In the case of an applied potential, hydroxide is formed at the metal/coating interface as a consequence of the cathodic reaction that generates the hydroxyl ions and the diffusion charge-carrying alkali metal cation. This concentrated solution results in a lowered thermodynamic activity of the water molecules and the diffusion inward of water molecules through the coating under the thermodynamic activity gradient. The pressure developed by the enlarging aqueous phase breaks the metal/coating bond and the blister grows in diameter and total mass. The blistering rate is also increased by the large number of water molecules associated with each diffusing cation as it arrives at the interfacial region and may also be increased by electroosmosis. The effect of the potential gradient through the coating on the migration of water molecules through the coating cannot be appraised in the present series of experiments.

The results with the lead oxide alkyd coating are much more difficult to interpret. There was no consistency in the relative rates of blistering in the LiCl, NaCl, and KCl solutions. Also, comparison of Figures 2 and 6 shows that the rate of blistering under similar applied potentials was greater at room temperature than at 60°. These anomalous behaviors are probably a consequence of the more active role that the lead ion plays within the coating matrix, but no firm statements can be made on the basis of the available data.

#### ACKNOWLEDGMENT

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#### References

- (1) Funke, W., "Corrosion Control by Organic Coatings," Leidheiser, H. Jr. (ed.), Natl. Assoc. Corros. Eng., Houston, TX, p. 97, 1981.
- (2) Kresse, P., *Farbe Lack*, 72, 1179 (1966).
- (3) Dickie, R.A. and Smith, A.G., *Chemtech* 1980, No. 10, p. 31.
- (4) Leidheiser, H. Jr., *Ind. Eng. Chem. Prod. Res. Dev.*, 20, 547 (1981).
- (5) Newman, J.S., "Electrochemical Systems," Prentice-Hall, Englewood Cliffs, NJ, 1973, 432 pp.



- (6) Ruggeri, R.T. and Beck, T.R., "Corrosion Control by Organic Coatings," Leidheiser, H. Jr. (ed.), Natl. Assoc. Corros. Eng., Houston, TX, p. 62, 1981.
- (7) Van Der Meer-Lerk, L.A. and Heertjes, P.M., *J. Oil & Colour Chemists' Assoc.*, 58, 79 (1975).
- (8) Kittelberger, W.W. and Elm, A.C., *Ind. Eng. Chem.*, 38, 695 (1946).
- (9) Brasher, D.M. and Nurse, T.J., *J. Appl. Chem.* (London), 9, 96 (1959).
- (10) Gowers, K.R. and Scantlebury, J.D., *Corros. Sci.*, 23, 935 (1983).
- (11) Schwenk, W., "Corrosion Control by Organic Coatings," Leidheiser, H. Jr. (ed.), Natl. Assoc. Corros. Eng., Houston, TX, p. 103, 1981.
- (12) Koehler, E.L., "Corrosion Control by Organic Coatings," Leidheiser, H. Jr. (ed.), Natl. Assoc. Corros. Eng., Houston, TX, p. 87, 1981.
- (13) Hepworth, M.T., Bhansali, K.J., and Cinkler, J., "Electrochemical Profiles on Bare Metals and Coated Steel Specimens," *JOURNAL OF COATINGS TECHNOLOGY*, 47, No. 605, 37 (1975).
- (14) Leidheiser, H. Jr. and Kendig, M.W., *Corrosion*, 32, 69 (1976).
- (15) Baboian, R., McBride, L., Langlais, R., and Haynes, G., *Materials Performance*, 18, No. 12, 40 (1979).
- (16) White, M.L. and Leidheiser, H. Jr., *Materials Performance*, 24, No. 11, 9 (1985).
- (17) Prosser, J.L. and Bullett, J.R., *J. Oil & Colour Chemists' Assoc.*, 45, 836 (1962).
- (18) Sykes, J.M. and McLeod, K., Unpublished presentation, Natl. Assoc. Corros. Eng., New Orleans, April 3, 1984.
- (19) Leidheiser, H. Jr. and Wang, W., "Some Substrate and Environmental Influences of the Delamination of Organic Coatings," *JOURNAL OF COATINGS TECHNOLOGY*, 53, No. 672, 77 (1981).
- (20) Leidheiser, H. Jr., *J. Adhesion Sci. Tech.*, 1, No. 1, 79 (1987).

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# Hydrophilic-Lipophilic Balance System And the Emulsification of Coatings Components

Robert C. Sonntag\*

Philadelphia Society for Coatings Technology  
Technical Committee

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The Technical Committee of the Philadelphia Society for Coatings Technology established a committee to apply the HLB system of detergent classification to hydrophobic coatings components. Such a classification has been applied to components such as oils and waxes useful to the pharmaceutical industry. The object of this study was to add to this list the HLB classification of various oils, resins, and vehicles that, when emulsified, would be useful in water-based coatings.

The technique followed for the HLB resin classification was developed from recommendation of ICI

Americas, Inc., in publications on the HLB system. A literature search was conducted and a bibliography of references is included.

The technique was applied to 14 oils, resins, and coatings vehicles, and a "Required HLB" value determined for them. The working procedure utilized solvents to pre-dissolve a component into a low viscosity solution. The influence of the solvent or solvents on the emulsification of a component was explored, especially the effect of water soluble solvents such as glycol ethers commonly used in coatings formulations as "coupler solvents."

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## INTRODUCTION

The concept of assigning a classification number value to a nonionic emulsifier was introduced in the late 1940's by ICI Americas, Inc. (then the Atlas Corp.). The classification scheme was called the HLB System—The hydrophile-lipophile balance. The classification scale is calibrated from 0-20 with lipophilic emulsifiers assigned in the 0-10 range and hydrophilic emulsifiers in the 10-20 range. A reference set of nonionic emulsifiers calculated for a range of HLB numbers from 2-20 was used to classify other emulsifiers and emulsifier mixtures.<sup>1</sup>

A given system or component was emulsified more efficiently by one of the 0-20 HLB classified emulsifiers. The HLB number of that emulsifier was designated the "Required HLB" value for the system. Other classified

families or mixtures of emulsifiers also have, at the same Required HLB value, the most efficient degree of emulsification for the specified systems. This allows a quick comparison of the relative efficiency of different families of emulsifiers when selecting an emulsifier having maximum emulsification properties for a given system.

Emulsification is the dispersing of mutually immiscible liquids in one another. An emulsion is defined as the stable mixture of two or more immiscible liquids and is comprised of a continuous phase and a dispersed phase; the dispersed phase being held in suspension in the continuous phase. A satisfactory stable emulsion is a dispersion meeting the requirements of the formulator/user as to its ease of preparation, cost, and storage stability, among other factors. For the purpose of evaluating the Required HLB of a system, a stable emulsion is not desired so that a more rapid evaluation can be made based on comparative degrees of emulsion stability.<sup>1,3,4</sup> (See *Figures 1-4*.)

The HLB number for a mixture of emulsifiers can be calculated as the numbers are additive. Theoretical HLB

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Figure 1—A display of the HLB evaluation of component G-H dehydrated castor oil with mineral spirits/66 as diluent, illustrating the degree of emulsification remaining at three separate time frames. The emulsification achieved immediately after agitation is illustrated by the top row set for a control (no emulsifier) and the HLB series 2-18. The second row set illustrates the degree of emulsification remaining one hr after agitation. The bottom row set illustrates the remaining degrees of emulsification for the HLB series after 24 hr

numbers have been calculated from the chemical composition of a potential emulsifier.<sup>1</sup>

The HLB system concept has resulted in the evaluation and classification of many emulsifiers by HLB number. Reference is made to ICI's booklets, "The HLB System—A Time-Saving Guide to Emulsifier Selection" and "General Characteristics of Surfactants" for the classification of many emulsifiers.<sup>1,2</sup>

**OBJECTIVE**

In a presentation to the Philadelphia Society's Technical Committee by an ICI representative on the HLB system, the extension of the HLB classification to components being emulsified was discussed. Those components classified were of interest to the pharmaceutical and drug industries for preparing emulsions, lotions, and creams.

A committee was formed to investigate classifying coatings components potentially useful in water-based

systems by the HLB system. The Required HLB number corresponding to the best oil-in-water phase emulsion for each component was to be our principal objective.

Components evaluated by the ICI method involved emulsifying the component with a mixer; and for solid components, elevated temperature. For this study, the components investigated were reduced in viscosity by dissolving them in a suitable solvent so that simple shaking would form an emulsion.

The introduction of solvents with the component in the emulsification procedure developed into a study of the Required HLB number for the solvent-component system and the effect of different types of solvents on the HLB classification.

**PROCEDURE**

An emulsification procedure was developed based on recommendations in the previous reference modified for our objectives.

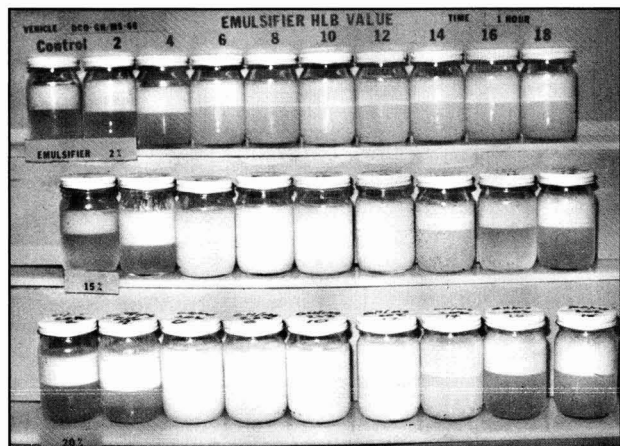


Figure 2—A display illustrating the variations in degrees of emulsification obtained by varying the amount of emulsifier in the G-H dehydrated castor oil-mineral spirits/66 system. The top row set was emulsified with 2% of emulsifier (based on oil), the second row set was emulsified with 15% of emulsifier, and the bottom row set was emulsified with 20% of emulsifier (the standard series contains 10% emulsifier). The sets are shown 1 hr after agitation



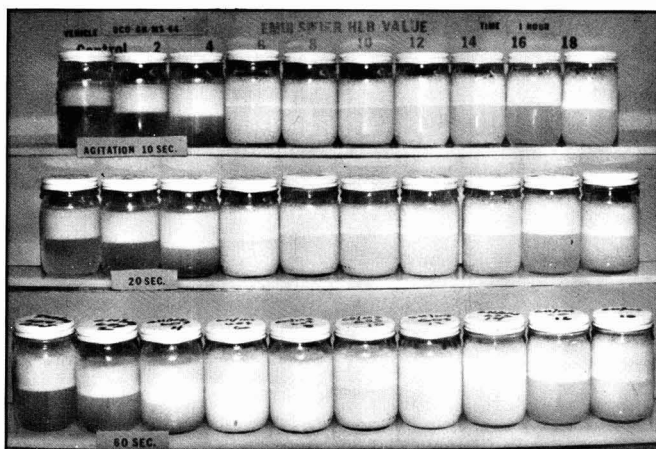


Figure 3—A display illustrating the variation in degrees of emulsification obtained by varying the time of emulsification. Each set was placed in a suitable container and hand agitated vigorously. The component system was GH dehydrated castor oil-mineral spirits/66 with 10% emulsifier (based on oil). The top row set was agitated for 10 sec, the second row set agitated for 20 sec (the standard time), and the bottom row set agitated for 60 sec. The sets are shown 1 hr after agitation

The standard HLB series of emulsifiers having HLB numbers of 2, 4, 6, 8, 10, 12, 14, 16, and 18 were prepared in quart quantities (Appendix E).

A standard mix was established as follows: component being evaluated (solids)—10 grams; solvent/solvents—10 grams or as needed; water (distilled)—60 grams; and emulsifier—1 gram.

The component was weighed into a four-ounce jar. If needed, solvent was also weighed into the jar and mixed with the component. In some cases, the component and solvent were warmed to facilitate mixing and then cooled. The water and emulsifier were weighed into the jar. The jar was vigorously agitated by hand for 20 sec. Sets of jars for an HLB series (2-18 emulsifiers) were agitated together in a suitable container, also vigorously by hand, for 20 sec.

Actual weights of the HLB mixes for 12 components are included on the "Comparison of Operator Data" tabulations (Appendixes B and C). The identity and

source of the "components" evaluated are listed in Appendix F.

## EVALUATION

Observations and measurements of the phases formed were made immediately; and at intervals of 1 hr, 6-8 hr, 24 hr, and 7 days. Photos were also taken for future comparison (Figures 1-4).

An intermediate rating system was developed to classify the samples and sets before assigning Required HLB values. From a combination of measurements of the phases and visual observation of emulsion density, the samples were rated on a scale of 0-10; a rating of 10 was given to a completely emulsified sample. The degree of emulsification for the oil-in-water phase changed rapidly with time, and a given samples' rating would decrease. After a time period of 24 hr/7 days, the HLB number or numbers of those samples having the highest ratings were

Figure 4—A display illustrating the HLB evaluation of three components (standard mix ratios). The components are oils at 100% (no diluent solvent used). The top row set contains linseed oil, the second row set contains china-wood oil, and the bottom row set contains GH dehydrated castor oil. The sets are shown 1 hr after agitation



**Table 1—Required HLB Values for Component-Solvent Systems**

Component	Operator	Solvent Diluent		
		MS/66	Butyl Ether E.G.	t-Butyl Ether P.G.
GH dehydrated castor oil	1	6-8	8-10	8-10
	2	6-8-10-12	6-8-10-12	6-8
	3	8-10	—	—
	4	—	—	—
Polymerized rosin Solution (60% MS/66)	1	14	6-8-10-12	16-18
	2	—	6-8-10-12	16-18 (2-6)
	3	(4)	—	—
	4	10	—	—

then assigned to that component or component-solvent system as the Required HLB value or values.

## PROCEDURE VARIATIONS

Some variables in the procedure were examined by varying the components and procedure of the standard mix. An emulsion set was made with dehydrated castor oil GH and MS/66 varying the amount of emulsifier from 2 to 20% on the oil (the standard mix contains 10% on oil). A visual observation of the degree of emulsification indicated a change as expected. The HLB number was rated as 8 for all the sets; but with increased emulsifier, the degree of emulsification increased, and time to separate increased (*Figure 2* and Appendix A).

Another set was made, varying the emulsion time, with all samples prepared following the standard mix recipe. One set was agitated for 10 sec, another for 20 sec, and a third for 60 sec. Increased agitation increased the degree of emulsification; the assigned Required HLB value was unchanged at 8 for each set (*Figure 3* and Appendix A).

## RESULTS

### Comparison of Operator Data

Four operators investigated the Required HLB value for 12 oil and resin coatings components with dilution by four solvents. Appendixes B and C are the complete tabulations of all data developed. Not all components and component-solvent systems were evaluated by all operators because of time limitations.

Good agreement of Required HLB values was achieved for some components, while other component system results were in less agreement. In general, the simpler, lower molecular weight components gave better agreement than those components having higher molecular weights or wider molecular weight distribution. A source of data inconsistency was, perhaps, the method employed to evaluate the emulsions for stability (visual comparison and measurement of the phases obtained). Using a method such as phase-inversion titration<sup>5,6</sup> might develop a Required HLB number for a given system more quickly and with better accuracy.

As examples of the comparative results obtained by different operators, data in *Table 1* indicates good agreement for GH dehydrated castor oil. The polymerized

rosin-mineral spirits system gave less than good agreement, but better agreement for polymerized rosin diluted with other solvents.

Results were reported only for the number of the actual HLB surfactants evaluated, and surfactants with in-between values would be included in a more refined evaluation (this also reduced the bulk of data reported). A spread of HLB numbers reported for a given component-solvent system indicates the need for a longer time frame to separate the more stable emulsion mixes. Values below 6 indicate a strong water-in-oil emulsion that were reported in some instances as the Required HLB value. (Values are indicated in the data in parentheses.) The values desired for this evaluation were of those corresponding to the best oil-in-water emulsion, but the values below 6 are of interest where a water-in-oil emulsion is desired.

## Combined Data

In addition to the systems evaluated by the participating operators, the author generated data for two additional resins and for some different component-solvent systems. The operator data averages and author-generated data were combined and tabulated in Appendix D.

*Table 2* is a summary of the "assigned" Required HLB values as tabulated in Appendix D. For the components evaluated, some values were obtained directly for the 100% component; most values were "calculated," allowing for the effect of solvent on the value.

For simple systems with a nonpolar solvent, good agreement was obtained for a calculated value and actual observed value. For example, the GH dehydrated castor oil-MS/66 system had an observed Required HLB value of 8. The calculated value of GH dehydrated castor oil would be obtained by allowing for the Required HLB value of 10 obtained for the MS/66 solvent. For the 50/50 oil-solvent mix, the solvent would contribute 5 HLB points (50% of the HLB value of 10). For the oil to contribute the remaining 3 HLB points, the oil would, in this system, have a base HLB value of 6 (50% of the HLB value of 6). The observed Required HLB value for 100% GH dehydrated castor oil was found to be 6-8.

In a similar manner, assuming the same relationship, a value was calculated for the long oil alkyd. The Required HLB value for the alkyd MS/66 system was 8. The contributing HLB value of the MS/66 solvent would be 5 HLB points (50% of the Required HLB of 10 for the MS/66 solvent in the 50% solution). The Required HLB value of the alkyd would be 6 to contribute 3 HLB points

**Table 2—Summary of the Assigned Required HLB Values**

Component	Assigned HLB Number For 100% Component	Component	Assigned HLB Number For 100% Component
Mineral spirits	10	Epoxy resin	8
Xylene	14	Hydrocarbon resin	18
China-wood oil	6	Maleic modified rosin ester	18
Linseed oil	6	Polymerized rosin	18
Dehydrated castor oil (GH)	6	Pure phenolic resin	8
Long oil alkyd	6	Rosin modified phenolic	10
Oil modified urethane	10	EHEC resin	8
Epoxy ester	10	SMA S2625 resin	8

(50% of the assumed Required HLB value of 6 for the alkyd). Care must be taken in using this technique as the numerical relationship probably does not hold for different solvents and for more complex components.

Mixed results were obtained for the effect on Required HLB values of systems containing the glycol ether solvents and for systems containing mixtures of the nonpolar petroleum solvents and the polar glycol ethers. Some differences would be expected between the butyl ether of ethylene glycol and the t-butyl ether of propylene glycol evaluated in this study because of differences in water solubility and resin solubility of the two solvents.

The butyl ethylene glycol ether solvent decreased the HLB value of some systems and increased that of others. The Required HLB values for the GH DCO, urethane, and polymerized rosin-solvent systems all decreased 1-4 HLB units while the values for the alkyd, epoxy ester, epoxy resin, hydrocarbon resin, and phenolic resin-solvent systems remained the same or increased 1-2 HLB units.

The t-butyl propylene glycol ether solvent increased the HLB value for all systems. The GH DCO, alkyd, urethane, epoxy ester, epoxy resin, hydrocarbon resin, modified maleic rosin resin, polymerized rosin, phenolic resin, and rosin modified phenolic resin-solvent systems had slight increases to increases of four HLB units in the Required HLB values. An interesting observed difference between the two glycol ethers occurred with the polymerized rosin ester solvent system; the butyl ethylene glycol ether lowered the Required HLB value by four HLB units, while the propylene glycol ether increased the value by four units.

One observed property of those solvent systems containing glycol ether solvents was the increased stability of the emulsions obtained (in comparison to the other solvent mixes). The combined water solubility, resin solubility, and polarity of the glycol ethers gives them properties of emulsifiers, increasing the effective emulsifier content of the mix.

Some miscellaneous solvents evaluated in mixed solvent systems were two acetates and a ketone. These solvents lowered the Required HLB values by approximately two units compared to the petroleum solvents, in a limited evaluation, with one to two resins.

## SUMMARY AND CONCLUSIONS

Results of this evaluation indicate that components such as coatings, vehicles, and resins can be classified by the HLB system. Preliminary results did not give as precise a classification as emulsifiers, but the systems investigated are also more complex. The recommended Required HLB values for the components evaluated developed from the generated data are listed in the results.

A better method for evaluating the degree of emulsification would, perhaps, give more precise classification. Such a method as determining the inversion point, as reported in the literature<sup>5,6</sup> will be investigated in future work.

Solvents in the emulsion mix with a resin component gave somewhat different HLB numbers, and the relative change from one system to another did not result in the same change with another resin in more complex component-solvent systems. One observation that needs more evaluation is that the water soluble solvents, such as the glycol ethers, shift markedly the overall degree of emulsion as well as shifting the HLB value somewhat. In two comparative systems, less emulsifier should be needed in the system containing a glycol ether.

The object of evaluating a component for a Required HLB value is to shorten the formulation time in selecting the most efficient emulsifier for a given component. With a Required HLB classification known for a component, selection of an emulsifier giving the best formulation properties can be made more quickly by evaluating emulsifiers of different chemical types having the same HLB value.

With the possibility in mind that the emulsifier would remain in the dried/cured coatings film having an effect on the water resistance of the coating, the level of the emulsifier and its HLB value would be important. Using the HLB system to determine the most efficient type of emulsifiers, a refinement of the coatings formulator's final formulation could be made by making up a series of emulsions with the selected class of emulsifiers and a re-evaluation made with and without modifying solvents, such as the glycol ethers, across the wider range of HLB emulsifiers. The object would be to develop a compromise formulation balancing emulsion stability, film properties, and economics for the water-based coatings system with the assistance of the HLB system concept.

Most useful coatings, vehicles, and resins have a high molecular weight and are extremely viscous or solid at 100% solids. Their incorporation into an emulsion is difficult. By utilizing a solvent to reduce the component's viscosity, emulsions can be made more easily. Many of the coatings, vehicles, and resins evaluated in this study were in a solvent solution and the Required HLB value was determined for a solution of the component with one or two solvents.

An attempt was made to define the effect of the solvent on the Required HLB value of a coatings component value by studying and comparing the Required HLB of components diluted with different types of solvents. From this comparison and the Required HLB value defined for some of the solvents, a 100% component Required HLB value was approximated. Tabulated results and assigned Required HLB values for the components evaluated are found in the Results section and Appendix D. Again, the assumption of a numerical relationship of the Required HLB values of a component and solvent may not hold true for all systems.

The petroleum solvents and the miscellaneous solvents had a more predictable effect on the Required HLB value of the systems evaluated than the more polar glycol ether solvents. The glycol ether solvents exhibit some emulsification ability, and emulsions were more stable than those of comparative systems containing the nonpolar solvents.

Future work will include the evaluation of other vehicle components, other (and more comparative) resin-solvent

systems, and the modification of our evaluation procedure. We hope this study of the emulsification of solvent-based vehicle components will prove useful to the coatings formulator in addition to having generated interesting, comparative emulsification (Required HLB values) data.

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## References

- "The HLB System—A Time-Saving Guide to Emulsifier Selection," 103-3, ICI Americas, Inc., Wilmington, DE.
- "General Characteristics of ICI Surfactants," 0-1, ICI Americas, Inc., Wilmington, DE.
- Federation of Societies for Coatings Technology, "Paint/Coatings Dictionary," Philadelphia, PA, 1978.
- Hampel, C. A. and Hawley, G. C., "The Encyclopedia of Chemistry," Van Nostrand Reinhold, NY, 3rd Edition.
- Marszall, L., "Emulsion Inversion Point and Required HLB of Oil-in-Water Emulsions," *Cosmet. Toiletries*, 91(8), 21-2, 24-6, 28 (1976).
- Marszall, L., "Study on the Required HLB (Hydrophilic-Lipophilic Balance) of Oil-in-Water Emulsions By a Simple Phase-Inversion Titration," *Cosmet. Perfum.*, 90(2), 37-9 (1975).
- Bagalkote, B.B., "Emulsifiers," *Chemical Process Eng.* (Bombay), 4(5), S65-S72 (1970).
- Ben-El, G. and Tatarsky, D., "Application of NMR for the Determination of HLB (Hydrophilic-Lipophilic Balance) Values of Nonionic Surfactants," *J. Amer. Oil Chemists' Soc.*, 49(8), 499-500 (1972).
- Bottiglieri, P., "Formulation of Aqueous Three-Phase Aerosols with Aliphatic Hydrocarbons," *Aerosol Rep.*, 16(10), 359-68 (1977).
- Boyd, J., Parkinson, C., and Sherman, P., "Factors Affecting Emulsion Stability, and the HLB (Hydrophilic-Lipophilic Balance) Concept," *J. Colloid Interface Sci.*, 41(2), 359-70 (1972).
- Cajkovic, M. and Stivic, I., "Formulation of Amphiphilic W-O Emulsions," *Acta Pharm. Jugoslav.*, 31(4), 253-8 (1981).
- Cianchini, V., "Predicting Perfume Oil Solubilization by the HLB (Hydrophilic-Lipophilic Balance) Principle," *Soap, Perfum., and Cosmet.*, 46(12), 687-90, 710 (1973).
- Cianchini, V., "Predicting Perfume Oil Solubilization with the HLB Principle," *East and Pharm.*, 16(188), 43-7 (1973).
- Courtney, D.L., "Monomolecular Film Bath Oils," *Cosmet. Perfum.*, 88(3), 55-9 (1973).
- Depraetere, P., Florence, A.T., Puisieux, F., and Seiller, M., "Some Properties of Oil-in-Water Emulsions Stabilized with Mixed Nonionic Surfactants (Brij 92 and Brij 96)," *Int. J. Pharm.*, 5(4), 291-304 (1980).
- Harusawa, F., Nakajima, H., and Tanaka, M., "The Hydrophilic-Lipophilic Balance of Mixed Nonionic Surfactants," *J. Soc. Cosmetic Chemists*, 33(3), 115-29 (1982).
- Johnson, G.C. and Sabia, A.J., "Structure-Performance Relationship of Silicone Finishes," Book Pap., Natl. Tech. Conf.—AATCC, 163-8 (1980).
- Kunieda, H. and Shinoda, K., "Evaluation of the Hydrophilic-Lipophilic Balance (HLB) of Nonionic Surfactants. I. Multisurfactant Systems," *J. Colloid Interface Sci.*, 107(1), 107-21 (1985).
- Leca, Minodora, Perez, H., and Rafael, J., "Relation Between Hydrophilic-Lipophilic Balance and Polarity Determined by Reverse Gas-Liquid Chromatography for Nonionic Surfactants," *Rev. Roum. Chim.*, 22(8), 1117-23 (1977).
- Lin, I.J. and Marszall, L., "Partition Coefficient, HLB and Effective Chain Length of Surface-Active Agents," *Prog. Colloid Polym. Sci.*, 63, 99-104 (1978).
- Marszall, L., "A Titration Method for the Determination of the Effective HLB of Nonionic Surfactants," *Pharm. Ind.*, 42(4), 416-19 (1980).
- Marszall, L., "The Effect of Some Additives on the Emulsion Inversion Point," *Riv. Ital., Essenze Deriv. Agrumari, Profumi Piante Off., Aromi, Saponi, Cosmet. and Aerosol*, 57(11), 639-42 (1975).
- Marszall, L., "HLB (Hydrophilic-Lipophilic Balance) of Polysorbates," *Riv. Ital., Essenze Deriv. Agrumari, Profumi Piante Off., Aromi, Saponi, Cosmet. and Aerosol*, 56(1), 18-20 (1974).
- Marszall, L., "Hydrophilic-Lipophilic Balance and Partial Molar Volume of Non-Ionic Surfactants," *J. Pharm. Pharmacol.*, 25(3), 254-5 (1973).
- McCutcheon, J.W., "Detergents and Emulsifiers—North America," "Detergents and Emulsifiers—International," and "Detergents and Emulsifiers—Functional Material," McCutcheon Div., MC Publishing Co., Glen Rock, NJ.
- McDonald, C., "Hydrophilic-Lipophilic Balance Values and Solubility Parameters," *Can. J. Pharm. Sci.*, 5(3), 81-2 (1970).
- Mitchell, D.J. and Ninham, B.W., "Micelles, Vesicles, and Microemulsions," *J. Chem. Soc., Faraday Trans.*, 2, 77(4), 601-29 (1981).
- Rimlinger, G., "Mixed Theory of Emulsions," *Amer. Perfum. Cosmet.*, 85(8), 29-30 (1970).
- Rodriguez, M.N., Geczy, I., and Ares, M., "Gas-Liquid Chromatographic Determination of the Hydrophilic-Lipophilic Balance of Nonionic Surfactants Containing Carbamate Groups," *Kolor Ert.*, 25(4-5), 191-8 (1983).
- Schott, H., "Hydrophilic-Lipophilic Balance and Distribution Coefficients of Nonionic Surfactants," *J. Pharm. Sci.*, 60(4), 648-9 (1971).
- Schott, H., "Solubility Parameter and Hydrophilic-Lipophilic Balance of Nonionic Surfactants," *J. Pharm. Sci.*, 73(6), 790(2) (1984).
- Szymanowski, J. and Prochaska, K., "Estimation of the Average Structure of Ethylene and  $\alpha$ -Butylene Copolymers of EBE Type by Means of the Parameters Characterizing Their State of Hydrophilic-Lipophilic Balance," *Fette, Seifen, Anstrichmittel*, 83(5), 172-6 (1981).
- Szymanowski, J., Pietrzak, E., Prochaska, K., and Atamanczuk, B., "Influence of the Hydrophilic-Lipophilic Balance Upon the Surface Activity of Ethylene Oxide and Butylene Oxide Block Copolymers of Type EBE," *Tenside Deterg.*, 20(1), 18-23 (1983).
- Turai, L.L. and Williams, L.D., "Effects of HLB (Hydrophilic-Lipophilic Balance) Factor of Nonionic Surfactants on Deinking Efficiency," *Tappi*, 60(11), 167-8 (1977).
- Wan, L. and Lee, P., "Solubilization of Liquid Paraffin by Mixed Nonionic Surfactant System," *Indian J. Pharm.*, 35(4), 121-2 (1973).

## Bibliography

**APPENDIX A**

**Results: Procedure Variations**

**Effect of Emulsifier Concentration:**

**System: GH dehydrated castor oil + MS/66 solvent**

Required HLB values observed

% Emulsifier On oil	1 Hr Observation	7 Day Observation
2	4-6-8-10-12	6-8-10
10	6-8-10	6-8-10
15	4-6-8-10-12	6-8-10
20	<b>6-8-10</b>	<b>6-8-10</b>

Ratings: HLB numbers recorded for each set and time frame for samples having the densest oil-in-water emulsion with the Required HLB best observed value highlighted.

**Effect of Emulsification Time:**

**System: GH dehydrated castor oil + MS/66 solvent with 10% emulsifier on oil**

Required HLB values observed

Time of emulsification (vigorous hand shaking)	1 Hr Observation	7 Day Observation
10 sec	6-8-10	<b>8</b>
20 sec	6-8-10	6-8-10
60 sec	4-6-8-10-12-14	<b>6-8-10</b>

Ratings: Same as previously mentioned.

**APPENDIX B**

**Comparison of Operator Data**

**Required HLB Values for Component/Solvent Systems**

Solvent Diluent

Component	Operator	Solvent Diluent			
		MS/66	Xylene	Butyl Ether E.G.	t-Butyl Ether P.G.
China-wood oil	1	6	—	—	—
HLB mix <sup>a</sup> —10.0 oil	2	—	—	2-4	4-6
10.0 solvent	3	8	—	—	—
	4	4-6	—	—	—
Linseed oil	1	6	—	—	—
HLB mix <sup>a</sup> —10.0 oil	2	—	—	2-4	4-6
10.0 solvent	3	8	—	—	—
	4	6	—	—	—
Long oil alkyd	1	6-8	8	6-8 (18)	8-10
HLB mix <sup>a</sup> —10.0 alkyd	2	—	—	8-10-12	6-8
10.0 solvent	3	8	—	—	—
	4	8 (4)	—	—	—
Oil modified urethane resin	1	10	—	6-8	—
Solution (60% MS/66)	2	—	8-10-12-14	8-10-12	8-10-12
HLB mix <sup>a</sup> —16.7 urethane	3	—	—	—	—
10.0 solvent	4	—	—	—	—
Polymerized rosin	1	14	—	6-8-10-12	16-18
Solution (60% MS/66)	2	—	—	6-8-10-12	16-18 (2-6)
HLB mix <sup>a</sup> —16.7 vehicle	3	(4)	—	—	—
10.0 solvent	4	10	—	—	—
GH dehydrated castor oil	1	6-8	—	8-10	8-10
HLB mix <sup>a</sup> —10.0 oil	2	6-8-10-12	—	6-8-10-12	6-8
10.0 solvent	3	8-10	—	—	—
	4	—	—	—	—
Phenolic resin solution	1	—	8	8	—
(50% xylene)	2	—	8-10-12	8-10-12	8-10-12-14-16
HLB mix <sup>a</sup> —20.0 solution	3	—	—	—	—
10.0 solvent	4	—	—	—	—
Rosin modified phenolic	1	—	—	—	—
resin solution	2	—	8-10-12	6-8-10-12	8-10-12
(60% xylene)	3	—	—	—	—
HLB mix <sup>a</sup> —16.7 vehicle	4	—	—	—	—
10.0 solvent					

(a) All HLB mixes contained 60 parts water plus one part of emulsifier.



**APPENDIX C**

**Comparison of Operator Data**

**Required HLB Values for Component/Solvent Systems**

Component	Operator	Solvent Diluent			
		MS/66	Xylene	Butyl Ether E.G.	t-Butyl Ether P.G.
Hydrocarbon resin	1	14-16-18	—	14-16	18
Solution (60% MS/66)	2	—	—	14-16	8 & 18
HLB mix <sup>a</sup> —16.7 solution	3	—	—	—	—
10.0 solvent	4	10-12-14	—	—	—
Maleic modified rosin	1	12-14	—	14	18
Ester resin solution (60% MS/66)	2	—	—	10-12-14-16	18
HLB mix <sup>a</sup> —16.7 solution	3	10-12-14-16	—	—	—
10.0 solvent	4	10-12-14	—	—	—
Epoxy resin solution	1	—	10	—	—
(50% xylene/t-butyl ether E.G.)	2	—	8-10-12	8-10-12-14	8-10-12
HLB mix <sup>a</sup> —20.0 solution	3	—	10	—	—
10.0 solvent	4	—	—	—	—
Epoxy resin solution	1	—	—	—	—
(53% xylene/t-butyl ether P.G.)	2	—	8-10-12	8-10-12	10-12-14
HLB mix <sup>a</sup> —18.9 solution					
10.0 solvent					
Epoxy ester solution	1	10	6-8	—	—
(60% xylene)	2	—	8-10-12-14	12-14-16	8-10-12
HLB mix <sup>a</sup> —16.7 solution	3	—	10	—	—
10.0 solvent	4	—	—	—	—

(a) In addition, the HLB mix contained 60 parts water plus one part of emulsifier.

**APPENDIX D**

**Required HLB Values for Component/Solvent Systems**

Component	Solvent Diluent									Assigned HLB No. for 100% component
	100%	MS/66	Xylene	Butyl Ether Ethylene Glycol	t-Butyl Ether Prop. Glycol	Methyl Ether P.G. Acetate	n-Propyl Acetate	MIBK		
Mineral spirits/66	8-10	—	—	8-10	—	—	—	—	—	10
Xylene	12-14	—	—	10-12	—	—	—	—	—	14
China-wood oil	6-8	8	—	—	—	—	—	—	—	6
Linseed oil	6-8	6-8	—	—	—	—	—	—	—	6
Dehydrated castor oil	6-8	8	—	6-8	6-8-10	6-8-10	6-8-10	—	—	6
GH viscosity										
Long oil alkyd (100% N.V.) (linseed-isophthalic)	—	6-8	8	8-10	8-10	—	—	—	—	6
Oil mod. urethane resin sol. (60% MS/66)	—	10	8-10-12-14	6-8-10-12	8-10-12	—	—	—	—	10
Epoxy ester solution (60% xylene)	—	10	6-8-10-12-14	12-14-16	8-10-12	—	—	—	—	10
Epoxy resin solutions										
(50% butyl ether E.G. + xylene)	—	—	8-10-12	8-10-12-14	8-10-12	—	6-8	6-8-10	—	8
(53% t-butyl ether P.G. + xylene)	—	—	8-10-12	8-10-12	10-12-14	—	—	—	—	8
Hydrocarbon resin solution (60% MS/66)	—	14-16-18	—	14-16	16-18	—	—	—	—	18
Maleic modified rosin ester Resin solution (60% MS/66)	—	12-14	—	14	18	—	—	—	—	18
Polymerized rosin (60% MS/66)	—	14	—	6-8-10-12	16-18	—	—	—	—	18
Pure phenolic resin solution (60% xylene)	—	—	8	8-10-12	8-10-12-14-16	—	—	—	—	8

APPENDIX D (cont'd)

Required HLB Values for Component/Solvent Systems

Component	Solvent Diluent								Assigned HLB No. for 100% component
	100%	MS/66	Xylene	Butyl Ether Ethylene Glycol	t-Butyl Ether Prop. Glycol	Methyl Ether P.G. Acetate	n-Propyl Acetate	MIBK	
Rosin modified phenolic Resin solution (60% xylene)	—	—	8-10-12	6-8-10-12	8-10-12	—	—	—	10
Ethyl hydroxy ethyl Cellulose resin solution 25% in butyl ether E.G. + n-propyl acetate	—	—	—	8	—	8-10	—	—	8
SMA S2625 resin solution 30% in butyl ether E.G.	—	—	—	8-10	—	—	—	—	8

APPENDIX E  
Composition of Surfactants in HLB Evaluation

HLB	HLB
2	16
4	18
6	Span 80
8	Span 85
10	Tween 20
12	Tween 80
14	G-7596DD

(a) Span and Tween surfactants are products of the Specialty Chemicals Division, ICI Americas, Inc., Wilmington, DE.

APPENDIX F

Components Evaluated	Source	Components Evaluated	Source
Linseed oil	Commercial alkali refined linseed oil	Epoxy ester solution	#06-3166 (60% xylene) (C.J. Osborn)
China-wood oil	Commercial china-wood oil	Epoxy resin	Dow 664 Epoxy resin (Dow Chemical Co., Midland, MI)
GH dehydrated castor oil	Castung 103-dehydrated castor oil GH viscosity (CasChem, Inc., Bayonne, NJ)	Hydrocarbon resin	Picco 5140 (Hercules, Incorporated)
Long oil alkyd	#3503 Isophthalic Alkyd (linseed) Z3 Vis. @ 100% NV (Superior Varnish & Drier, Div. of Suvar Corp., Merchantville, NJ)	Pure phenolic resin	CKM 2400 Bakelite Resin (Union Carbide Corp., Danbury, CT)
Oil modified urethane	#08-0139 (60% NV MS/66) (C.J. Osborn, Div. of Suvar Corp., Merchantville, NJ)	Rosin modified phenolic resin	Pentalyn 802A (Hercules, Incorporated)
Polymerized rosin	Polypale (Hercules, Incorporated, Wilmington, DE)	EHEC resin	Ethyl Hydroxy Ethyl Cellulose—low viscosity (Hercules, Incorporated)
Maleic modified rosin ester resin	#7059 Resin (Union Camp Corporation, Savannah, GA)	SMA S2625 resin	(Arco Chemical Co., R & E., Newtown Square, PA)
		Water	Commercial steam distilled (pH 6)
		Emulsifiers	Spans & Tweens (ICI Americas, Inc., Wilmington, DE)



## Federation of Societies for Coatings Technology

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*Produced by the Manufacturing Committee, Toronto Society for Coatings Technology*

This presentation has been developed to assist in the selection and training of resin plant operators, and focuses on basic concepts of manufacture and the role of a resin operator. 12 minutes (58 slides) . . . . . **\$65**

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*Produced by the Manufacturing Committee, New York Society for Coatings Technology*

This presentation describes the design and operation of a batch operated mini-media mill, and was developed to assist in the training of plant personnel to operate such equipment. 8½ minutes (51 slides) . . . . . **\$60**

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# Society Meetings

## **BIRMINGHAM . . . . . NOV.** **"Computer Color Match Prediction"**

P.F.M. Coverdale, retired, was presented a 50-Year Pin and pen.

The meeting's speaker was G. Pausch, of Pacific Scientific Ltd. His topic was "PRACTICAL APPLICATIONS OF COMPUTER COLOR MATCH PREDICTION."

According to Dr. Pausch, using a color match computer should provide the following advantages: lower cost, higher accuracy, speed, quality control, and simplicity of operation.

The speaker stated that in the U.S., after initial hostile reactions, the market share of D.I.Y. products where a point-of-sale computer is used has increased. Improvement in software, which is user friendly, and the greater reliability of hardware have contributed to the increase.

Dr. Pausch said that the following features should be considered when purchasing a computer: speed, memory, reliability, service, and software availability.

Software should have an extensive database analysis (lead free formulations, tag fields for colorants, etc.), be simple to use, have the ability to check for existing matches, and give color formulations for marketable quantities, explained the speaker. In addition, each software package should be custom-built and include color matching, batch correction, formula files, and utilities.

The procedure for matching is by color information, file search, batch correction, matching existing formulas, checking customer decisions, and hard copy, stated Dr. Pausch.

He also suggested that can size, color tolerances, fill requirements, special match

parameters (i.e., metamerism), and labels should be defined.

In conclusion, Dr. Pausch stressed the importance of service of hardware and software packages.

D.A.A. WALLINGTON, *Secretary*

## **CDIC . . . . . OCT.** **"Accelerated Testing"**

Douglas M. Grossman, of the Q-Panel Co., was the evening's speaker. The Cleveland Society member's presentation was on "THE TRUTH ABOUT ACCELERATED WEATHERING: IT'S SIMPLER THAN YOU THINK."

The question that the speaker is most often asked is "How many hours in a weathering tester equals a year in the outdoors?" According to Mr. Grossman, "this is just not the real world. The data is not for comparison with the variable weather that is experienced outdoors."

The speaker presented data which showed the monthly variability of the solar dosage in Arizona and the dramatic changes from winter to summer. He stressed the fact that laboratory data gained from accelerated testing was indeed valuable for improving formulas. The "feedback loop" process, as he termed it, entails formulating and testing, and then repeating the process.

Mr. Grossman felt that three points must be stressed: (1) To simulate the effects of sunlight, the UV portion of sunlight is needed—not the entire spectrum; (2) To simulate rain and dew condensation must be used; and (3) To control the acceleration rate, temperature must be controlled.

*Q. Is the only way to predict service life to work against a known formula?*

A. Yes. If you know a formula lasts for three years, and you run a test formula, and it exceeds the control formula, then you have an improvement. But I would still be cautious as to trying to assign a length of service to the new formula.

*Q. Would wood and printed paper run in chamber?*

A. Yes. The wood is only a problem if it exceeds 3/4-inch thick. The cooling may not cause condensation. This can be solved if the temperature of the cabinet is raised. The printing inks that were mentioned are a different story. If they are silk screen inks they test well, but lithograph inks respond to visible light and therefore do not test well. This is a testing method problem that I assure you we are trying to solve.

N. JAY HUBER, JR., *Secretary*

## **CHICAGO . . . . . NOV.** **"Zirco Aluminate Coupling Agents"**

In a special election to fill the vacated Society Representative position, Richard M. Hille, of General Paint & Chemical Co., was unanimously elected.

The MMA plaque, awarded by the Federation to the Chicago Society at the Annual Meeting in Dallas, TX, was presented by Society Membership Chairman Theodore J. Fuhs, of General Paint & Chemical Co., to President Raymond J. Czicz, of Reliance-Universal, Inc., and Gregory E. McWright, of U.S.G. Corporation. Also recognized for their work were: Lori M. Friedman, of Sherwin-Williams Co.; David P. Kuehner, A. Frank Leo, and Kevin P. Murray, of DeSoto, Inc.; Natu C. Patel, of Ace Paint Division, Ace Hard-



**CLASS A MMA COMPETITION WINNER—**Members of the Chicago Society Educational Committee, winners of the Class A Competition in the Material Marketing Associates Awards, are (l-r): Past-Educational Committee Chairman Theodore J. Fuhs, Natu C. Patel, David P. Kuehner, Lori Friedman, Kevin Murray, Gregory E. McWright, Walter Rexing, and President Raymond Czicz (holding the award). Chicago won the MMA Award for its comprehensive course in Coatings Technology at DePaul University

ware; Al Part and Walter Rexing, of U.S.G. Corporation. The First Place plaque recognized the Joint Educational Committee course on "Coatings Technology."

The meeting's first speaker was Lawrence B. Cohen, of Cavendon Chemical Co., Inc. The New England Society member spoke on "ZIRCO ALUMINATE COUPLING AGENTS IN HIGH SOLIDS AND WATER-BORNE COATINGS."

The speaker discussed the chemistry and use of the novel compounds in high solids and water-borne coatings. A comparison of adhesion promotion and pigment dispersion against silane type materials was presented. Mr. Cohen noted the superior reaction selectivity and controllable rate.

The second speaker was Agit Tamhane, of Northwestern University. Dr. Tamhane's topic was "STATISTICAL PROCESS CONTROL."

The speaker's talk focused on statistical process and quality control and quality improvement. Representative case studies were used to illustrate the techniques.

KEVIN P. MURRAY, *Secretary*

## GOLDEN GATE ..... NOV.

### "Industrial Latexes"

President Timothy Donlin, of Pacific Coast Chemicals, awarded 25-Year Pins to Robert T. Miller, of Frank W. Dunne Co.; Fred Gueverra, of The Fleteo Co.; Leon Persson, of Harrisons and Crosfield Pacific, Inc.; and Zoltan Saary, of Chevron Research Co.

Mr. Donlin presented Robert D. Athey, Jr., of Athey Technologies, a plaque and certificate of merit for the Technical Committee paper presented at the 1987 Annual Meeting in Dallas, TX.

Mr. Athey, Technical Committee Chairman, announced that the Committee's 1988 paper will be "Room Temperature Crosslinking Latex Systems."

Manufacturing Committee Chairman Louis F. Sanguinetti, of Jasco Chemical Corp., reported that the June 15 program, "In Step with the Times—Are You?," will contain talks on computers and computer programs, regulations, Proposition 65, and Right-to-Know labeling.

Dennis H. Guthrie, of The Dow Chemical Co., was the evening's speaker. Mr. Guthrie spoke on "EVALUATION OF COALESCENT AGENTS FOR INDUSTRIAL LATEXES."

Historically, solvent-based systems were preferred over water-borne systems because of their performance advantages, stated the speaker. Recent advancements in emulsion technology, however, have bridged the gap between the two. A prime example of this is the currently evolving water-borne automotive basecoat technology.

According to Mr. Guthrie, the emulsion system used in the OEM/industrial marketplace are latexes with very high glass transition temperatures. Although coalescents are usually used to aid film formation in emulsion systems, the efficiency or strength of a coalescent has become a more important consideration when dealing with these new industrial latexes.

The speaker discussed the properties an emulsion formulator must consider when selecting a coalescent, including evaporation rate and the overall efficiency of the coalescent. Mr. Guthrie explained that in the past, one property was often sacrificed at the expense of the other; however, this need not always be the case with the newer coalescents under development.

The speaker said that, to gain a more complete picture of the available coalescents on the present market, studies were



**GUEST SPEAKER—Dennis H. Guthrie, of The Dow Chemical Co., speaks to the Los Angeles Society at its November meeting**

carried out on nine coalescents. The ability to lower the minimum film formation and glass transition temperature, the evaporation rate of the pure coalescent, and the hardness development rate of full paint formulations properties were evaluated.

GORDON N. PIOCH, *Secretary*

## HOUSTON ..... NOV.

### "Water-Borne Polyurethanes"

The meeting's technical presentation was given by Lynn A. Murr, of Mobay Corp. Ms. Murr's talk was on "WATER-BORNE POLYURETHANES."

According to Ms. Murr, all the government regulations on emissions and escalating solvent prices have led to increased emphasis on water-borne polyurethanes. The speaker presented the basic chemistry of polyurethane dispersions, including a discussion of the different types of internal emulsifiers used and their relation to physical properties.

In addition, Mr. Murr described several processes for the preparation of water-borne polyurethanes and reviewed applications areas such as adhesives and coatings for textiles, leather, glass, wood, and plastics.

SANDRA SWIFT GIDLEY, *Secretary*

## LOS ANGELES ..... NOV.

### "Coalescent Agents for Industrial Latexes"

A moment of silence was observed for Joseph A. Vasta, of DuPont Co., who died recently.

Environmental Committee Chairman Bobbi Stover, of Major Paint Co., reported



**1987-88 GOLDEN GATE SOCIETY OFFICERS: President—Timothy Donlin; Treasurer—Ernest Soldavini; Secretary—Gordon N. Pioch; Vice-President—David Filson; and Society Representative—Barry Adler**



on several of the current regulations and their effect on the industry. Assembly Bill 2588 on toxic air contaminants, which proposes to have the Air Resources Board rate all manufacturers according to potency, toxicity, volume, and proximity of receptors, is pending.

The Texas Air Control Board recently held public hearings and proposed regulations limiting VOC with regard to automotive finishes and architectural coatings. The Board is attempting to restrict all sales in Texas of aerosols containing any VOC propellant.

El Rap will be establishing position papers on Rule 1113 in anticipation of further reduction of VOC levels in architectural coatings.

In addition, Ms. Stover reported that the NPCA has requested a variance on San Diego's Rule 67 with regard to sale of specialty coatings in that district. NPCA has requested a six month extension to sell products manufactured prior to September 1, 1987.

Jean Jackson, of Commerce Public Library, explained the services, resources, and facilities available to members of the coatings industry.

Dennis H. Guthrie, of The Dow Chemical Co., was the guest speaker for the evening. Mr. Guthrie presented a talk on "EVALUATION OF COALESCENT AGENTS FOR INDUSTRIAL LATEXES."

Water-borne coatings are projected to be one of the highest future growth areas within the coatings industry, stated the speaker. Recent advancements in emulsion technology have bridged the gap that once existed between solvent-based systems and water-borne systems.

According to Mr. Guthrie, emulsions systems used in the OEM/industrial marketplace are latexes with very high glass transition temperatures. The efficiency or strength of a coalescent has become a more



**PITTSBURGH SOCIETY OFFICERS FOR 1987-88: Secretary—James Lore; Society Representative—Raymond C. Uhlig; Treasurer—Carol Storme; and Vice-President—Richard Marci**

important consideration when dealing with the new industrial latexes.

The speaker discussed the fact that a variety of properties must be considered when the OEM/industrial emulsion formulator selects a coalescent. The most important properties are the evaporation rate and the overall efficiency of the coalescent. In the past, one property was often sacrificed at the expense of the other; however, with the newer coalescents under development, this need not always be the case.

Mr. Guthrie explained that studies were carried out on nine coalescents to gain a more complete picture of the coalescents available on today's market. Properties such as the ability to lower the minimum film formation and glass transition temperature, the evaporation rate of the pure coalescent, and the hardness development rate of full paint formulations were developed.

*Q. Regarding the softening of the acrylic after 24 hours with EB, could this be ex-*

*plained by taking EB vapor pressure into consideration as balanced against the force due to capillary action of the water in the air?*

A. Probably, I do not know for sure, but it sounds like a very reasonable way of thinking about it.

*Q. Due to different solubilities of different acrylic polymers, how confidently can we conclude that one good cosolvent for a certain acrylic will be equally good for another?*

A. Not very well, there is no such thing as a universal coalescent. You must try and see which works the best for your resin system.

JAMES F. CALKIN, *Secretary*

## NEW ENGLAND . . . . . NOV.

### "UV/EB Curing"

The evening's speaker, Byron K. Christmas, of Interez, Inc., presented "UV/EB CURING: A TECHNOLOGY FOR THE 80'S AND BEYOND."

Dr. Byron described how ultraviolet (UV) and electron beam (EB) curable coatings, inks, and adhesives have grown in popularity over the last 20 years. The speaker outlined the history of these technologies, listed their advantages and disadvantages, and gave an overview of their chemistry. Also discussed were the components (oligomers, monomers, additives, and initiators) and key formulating principles.

Dr. Byron explained that new developments in research have addressed many of the difficulties formerly encountered with the systems. In conclusion, the speaker stated that new types of monomers and oligomers which possess unique properties and new curing approaches follow the ap-



**MEXICO SOCIETY OFFICERS FOR 1987-88: Seated: Manuel Gutierrez; Vice-President—Arturo Ita; President—Cuahtemoc Pereda; Treasurer—Juan Irazabal; and Angel Ruiz. Standing: Educational Committee Chairman—Tomas Arcos; Secretary—Gerardo del Rio; Membership Committee Chairman—Sergio Alvarado; Program Committee Chairman—Jose Antonio Herrera; and Publicity Committee Chairman—Agustin Herrera**

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BALTIMORE (Third Thursday—Snyder's Willow Grove, Linthicum, MD). DONALD HILLIARD, Unocal, 1500 Carbon Ave., Baltimore, MD 21226. VIRGINIA SECTION (Fourth Wednesday—Ramada Inn-East, Williamsburg, VA).

BIRMINGHAM (First Thursday—Strathallan Hotel, Birmingham, England). D.A.A. WALLINGTON, Macpherson Drynamels Ltd., Westgate, Aldridge, West Midlands WS9 8YH England.

CDIC (Second Monday—Sept., Jan., Apr., June in Columbus; Oct., Dec., Mar., May in Cincinnati; and Nov., Feb. in Dayton). N. JAY HUBER, JR., Paint America Co., 1501 Webster St., Dayton, OH 45404.

CHICAGO (First Monday—meetings alternate between Como Inn in Chicago, IL and Sharko's West in Villa Park, IL). KEVIN P. MURRAY, DeSoto, Inc., 1700 S. Mt. Prospect Rd., Des Plaines, IL 60018.

CLEVELAND (Third Tuesday—meeting sites vary). ILONA NEMES-NEMETH, Sherwin-Williams Co., Cleveland Technical Center, 601 Canal Rd., Cleveland, OH 44113.

DALLAS (Thursday following second Wednesday—Harvey Hotel, North Dallas, TX). STEVE STEPHENS, Ribelin Sales, Inc., P.O. Box 461673, 3857 Miller Park Dr., Garland, TX 75046.

DETROIT (Second Tuesday—Ukrainian Cultural Center, Warren, MI). LIANA CALLAS ROBERTS, A.T. Callas Co., 1985 W. Big Beaver, Suite 308, Troy, MI 48043.

GOLDEN GATE (Monday before third Wednesday—Alternate between Francesco's in Oakland, CA and Holiday Inn in S. San Francisco). GORDON PROCH, Triangle Coatings, Inc., 1930 Fairway Dr., San Leandro, CA 94577.

HOUSTON (Second Wednesday—Look's Sir-Loin Inn, Houston, TX). SANDRA SWIFT, Cron Chemical Corp., P.O. Box 14042, Houston, TX 77221.

KANSAS CITY (Second Thursday—Cascone's Restaurant, Kansas City, MO). NICK DISPENSA, Davis Paint Co., P.O. Box 7589, N. Kansas City, MO 64116.

LOS ANGELES (Second Wednesday—Steven's Steak House, Commerce, CA). JAMES F. CALKIN, E.T. Horn Co., 16141 Herron Ave., La Mirada, CA 90638.

LOUISVILLE (Third Wednesday—Executive West Motor Hotel, Louisville, KY). RAYMOND L. MUDD, Porter Paint Co., Coatings Div., P.O. Box 1439, 400 S. 13th St., Louisville, KY 40201-0439.

MEXICO (Fourth Thursday—meeting sites vary). ARTURO ITA, Pinturas Auro- lin, S.A. De C.V., Poniente 150 No. 750, Nueva Industrial Vallejo, 02300 Mexico, D.F.

MONTREAL (First Wednesday—Bill Wong's Restaurant, Montreal). ROBERT BENOIT, NL Chemicals Canada Inc., 4 Place Ville-Marie, Ste. 500, Montreal, Que., Canada H3B 4M5.

NEW ENGLAND (Third Thursday—LeChateau Restaurant, Waltham, MA). JOSEPH T. SCHRODY, Unocal Chemicals Div., 90 Cumberland Rd., Leominster, MA 01453.

NEW YORK (Second Tuesday—Landmark II, East Rutherford, NJ). ARTHUR A. TRACTON, Hempel Coatings, Inc., Foot of Curie Ave., Wallington, NJ 07057.

NORTHWESTERN (Tuesday after first Monday—Jax Cafe, Minneapolis, MN). MARK W. UGLEM, Hirschfield's Paint Mfg., Inc., 4450 Lyndale Ave., N., Minneapolis, MN 55412. WINNIPEG SECTION (Third Tuesday—Marigold Restaurant, Winnipeg). NEIL WEBB, Phillips Paint Products Ltd., 95 Paquin Rd., Winnipeg, MB, Canada R2J 3V9.

PACIFIC NORTHWEST (PORTLAND SECTION—Tuesday following second Wednesday; SEATTLE SECTION—the day after Portland; BRITISH COLUMBIA SECTION—the day after Seattle). EMIL IRAOLA, Olympic Home Care Products Co., 1141 N.W. 50th, Seattle, WA 98107.

PHILADELPHIA (Second Thursday—Williamson's, GSB Bldg., Philadelphia, PA). ORVILLE E. BROWN, M.A. Bruder & Sons Inc., 52nd & Grays Ave., Philadelphia, PA 19143.

PIEDMONT (Third Wednesday—Americana Inn, Greensboro, NC). FOREST G. FLEMING, Reliance Universal, Inc., P.O. Box 2124, High Point, NC 27261.

PITTSBURGH (Second Monday—Montemurro's, Sharpsburg, PA). JAMES LORE, Watson Standard Co., P.O. Box 11250, Pittsburgh, PA 15238.

ROCKY MOUNTAIN (Monday following first Wednesday—Holiday Inn North, Denver, CO). PAUL D. SILVA, Kwal Paints, Inc., 3900 Joliet St., P.O. Box 39485, Denver CO 80239.

ST. LOUIS (Third Tuesday—Salad Bowl, St. Louis, MO). HOWARD JEROME, Mozel Equipment Co., 4003 Park Ave., St. Louis, MO 63110.

SOUTHERN (GULF COAST SECTION—Third Thursday; CENTRAL FLORIDA SECTION—Third Thursday after first Monday; ATLANTA SECTION—Third Thursday; MEMPHIS SECTION—bi-monthly on Second Tuesday; MIAMI SECTION—Tuesday prior to Central Florida Section). KENNETH W. ESPEUT, Jim Walter Research, 10301 9th St. N., St. Petersburg, FL 33702.

TORONTO (Second Monday—Cambridge Motor Hotel, Toronto). ROY A. DONNELLY, St. Lawrence Chemical Co. Ltd., 321 Humberline Dr., Rexdale, Ont., Canada M9W 5T6.

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

plication of this technology to new end uses.

*Q. Can these coatings be heavily filled?*  
A. Yes, if they are applied in thin film.

*Q. What, if any, large volume uses exist for this technology?*

A. Current uses described are large volume.

JOSEPH T. SCHRODY, *Secretary*

## NORTHWESTERN . . . . . NOV.

### "Low VOC Coatings for Plastics"

The meeting's first speaker was Society member Richard Johnson, of Cargill, Inc. Mr. Johnson's topic was "Low VOC COATINGS FOR PLASTICS."

The speaker described the three major families of plastics: thermosetting, thermoplastics, and plastics. He explained that these plastics are coated for appearance sake, to improve exterior durability, for increased chemical resistance, for better abrasion resistance, and to reduce static electric charges.

According to Mr. Johnson, coating plastics can be very difficult. He stated that substrates may vary widely, temperature bake is limited, and most plastic films are hydroscopic on aging. Many plastics also have barrier coats that can interfere with coating adhesion, he explained.

In conclusion, the speaker stated: high solids formulations can provide good service life on plastics; more functional groups should provide better adhesion; and the use of the wrong solvent can cause embrittlement of the plastic and hence the failure of the system.

Society member Edward C. Ferlauto, of Valspar Corp., presented "COMPARISON OF VOC AND VOLATILES RELEASED FROM A MELAMINE CROSSLINKED HIGH SOLIDS POLYESTER." Mr. Ferlauto's paper was awarded the Third Prize in the A.F. Voss/American Paint & Coatings Journal Award competition at the Annual Meeting in Dallas, TX.

The speaker demonstrated that the current standard of measurement, a modified version of ASTM 2369-81, is not entirely accurate. Mr. Ferlauto observed differences in measured VOC as high as 16% depending on the temperature and cure time (20, 40, and 60 minutes). Temperature played an important part, and upper limits of around 200°C demonstrated a decomposition of the coating film.

In conclusion, Mr. Ferlauto found that the theoretical VOC levels did not correspond to real measured VOC levels. He explained that to determine the correct

VOC, it must be measured under the same time and temperature conditions specified for that application. Mr. Ferlauto found that there is a definite need to develop a better ASTM procedure to measure VOC, especially in melamine crosslinked coatings.

MARK W. UGLEM, *Secretary*

**ROCKY MOUNTAIN..... NOV.**

**"Coalescent Agents"**

President Marcy S. Baugh, of Sunburst Paint and Coatings, Inc., nominated J. Vincent Brown, of Kwal Paints, Inc., for the position of Treasurer. A final vote will be taken at the December meeting.

The meeting's technical presentation was given by Dennis H. Guthrie, of Dow Chemical Co. Mr. Guthrie spoke on the "EVALUATION OF COALESCENT AGENTS FOR INDUSTRIAL LATEXES."

CRAIG SCHWEIGER, *Secretary*

**ST. LOUIS ..... NOV.**

**"High Solids"**

The meeting was attended by Federation President-Elect James E. Geiger, of Sun Coatings, Inc. and Executive Vice-President Robert F. Ziegler.

Mr. Geiger spoke briefly on the direction the Federation will be taking in the years ahead and urged members to get involved in the Federation.

Mr. Ziegler gave an update on Federation activities and outlined the progress of Federation committees.



**1987-88 OFFICERS OF THE NORTHWESTERN SOCIETY—WINNIPEG SECTION: Social Committee Chairman—Larry E. Juskow; Program Committee Chairman—Sandra Madray; President—Stephen Schultz; Secretary—Neil E. Webb; and Treasurer—V. Jay Sharma**

A moment of silence was observed for Joseph A. Vasta, of DuPont Co., who died recently.

President James N. McDerby, Jr., of F.R. Hall, Inc., presented Al E. Zanardi, of Thermal Science, Inc., a 25-Year Pin.

Regulatory Affairs Committee member Frank Giles, of U.S. Paint Div., cautioned that even though methylene chloride regulations have not been effected in Missouri, restrictions on its use are getting tighter in other parts of the country. In addition, labeling regulations are changing and becoming stricter.

Richard M. Benton, of NL Chemicals, spoke on "CLOSING THE GAP WITH HIGH SOLIDS."

Mr. Benton discussed the systems the industry has available for high solid coatings use including polyesters, baking al-

kyds, air-dry alkyds (short, medium, and long), VT alkyds, phenolics (rosin modified alkyds), and two-component urethanes.

The speaker said the challenge is to meet VOC requirement with both bake and air-dry systems.

Mr. Benton compared VOC levels determined from a paint formula to VOC levels of the coating obtained by using Method 24 of the Federal EPA. The difference between the two results was labeled "VOC surprise."

To avoid VOC surprise, Mr. Benton suggested formulators consider the potential for VOC of the crosslinker and the backbone resin, determine the solids on the backbone resin, and do some testing.

The speaker said that transfer efficiency is used by some states in connection with VOC regulations and that, in electrostatic applications, 0.3-1.0 megohms is an ideal range.

Mr. Benton stated that with air-dry systems the molecular weight must be lowered to keep the viscosity down and that blending of resins works well to keep the VOC in line with regulations.

In conclusion, the speaker briefly examined various air-dry systems, a high-solids black enamel, a medium alkyd with a urethane additive, an alkyd blend, a medium alkyd enamel reduced with 1,1,1-trichloroethane, a high-solids nitrocellulose lacquer, and a lift resistant primer.

*Q. You have only discussed solvent systems. What happened to the water reducible approach?*

*A. Those are still available. With water systems you can go lower in VOC than with high-solids solvent systems. A range of 1.2-1.6 megohms can be obtained but those products are restricted to specific application techniques.*

HOWARD JEROME, *Secretary*



**ROCKY MOUNTAIN SOCIETY OFFICERS FOR 1987-88: Secretary—Craig Schweiger; President—Marcy S. Baugh; Paul Silva; and Vice-President—Jeffrey B. Johnson**

# Future Society Meetings

## Birmingham

(Mar. 3)—"FUNDAMENTALS OF WATER-BASED TECHNOLOGY"—G. Brown, Harlow Chemical Co.

(Apr. 7)—"IMPROVING DISPERSION OF PIGMENTS"—Allen Cowley, ICI Chemicals and Polymers Ltd.

(May 5)—59th ANNUAL GENERAL MEETING.

(May 12)—"BRITISH STANDARD BS 5750 QUALITY ASSURANCE AND THE PAINT INDUSTRY"—J. Cauthorpe, Sonneborn & Rieck Ltd.

## C-D-I-C

(Mar. 14)—"IMPROVING OPACITY AND FLOW PROPERTIES WITH ORGANIC PIGMENTS"—Gary Jordan, Hoechst Corp.

(Apr. 11)—"EVALUATING COATINGS FOR LONG TERM PROTECTION"—Bernard Appleman, Steel Structures Painting Council.

## Chicago

(Mar. 7)—"MEDIA SELECTION"—Ivan Quackenbush, Quackenbush Co. and "DRIERS AND RELATED ADDITIVES"—Sam Bellettiere, Nuodex, Inc., Sharko's.

(Apr. 4)—"IMPROVED FLOW AND OPACITY WITH ORGANIC PIGMENTS"—Gary Jordan, Hoechst Corp. and "DISPERSION OF ORGANIC PIGMENTS"—Ted Vernardakis, Sun Chemical Corp. Sharko's.

(May)—AWARDS NIGHT.

## Cleveland

(Feb. 16)—"ACTIVITIES OF THE CENTER FOR ADHESIVES, SEALANTS, AND COATINGS (CASC)"—Charles Rogers, Case Western Reserve University. Independence Brown Derby.

(Mar. 15)—Speaker to be announced.

(Apr. 19)—AWARDS NIGHT. "PLASMA SURFACE TREATMENT FOR ENHANCED ADHESION OF COATINGS FOR PLASTICS"—Peter Rose, Plasma Science Inc. Independence Brown Derby.

(May 17)—"EFFECT OF COATINGS ON ACOUSTIC QUALITIES OF MUSICAL INSTRUMENTS"—Speaker to be announced. Harley Hotel.

MENTS"—Speaker to be announced. Harley Hotel.

## Golden Gate

(Mar. 14)—"PRODUCTION MANAGEMENT, FORMULA ANALYSIS AND COMPLIANCE USING THE PERSONAL COMPUTER"—Christy Ausman, Pacific Micro. Francesco's Restaurant.

(Apr. 18)—"MODERN TRENDS IN ORGANIC PIGMENT TECHNOLOGY"—Hugh M. Smith, Sun Chemical Corp. Holiday Inn.

(May 16)—"UNDER UTILIZED KAOLIN"—Dan Dixon, Engelhard Minerals & Chemicals Corp. Francesco's Restaurant.

(June 13)—MANUFACTURING COMMITTEE PROGRAM. Holiday Inn.

## Houston

(Mar. 16-18)—SOUTHWEST PAINT CONVENTION—Speaker to be announced. Hyatt Regency Hotel, Houston, TX.

(Apr. 13)—"ADVANTAGES OF PRE-DISPersed POLYETHERS AND WAXES IN HIGH PERFORMANCE COATINGS"—Elio Cohen, Daniel Products Co.

(May 11)—Speaker to be announced.

## Los Angeles

(Apr. 13)—BOSSES' NIGHT. "MODERN TRENDS IN ORGANIC PIGMENT TECHNOLOGY"—Hugh M. Smith, Sun Chemical Corp.

(May 11)—AWARDS NIGHT. "UNDER UTILIZED KAOLIN"—Dan Dixon, Engelhard Minerals & Chemicals Corp.

(June 8)—ANNUAL MEETING AND ELECTION OF OFFICERS.

## Montreal

(Mar. 2)—"BREAKTHROUGH IN MAINTENANCE PAINT FOR STEEL"—Michael Bishop, ICI Mond Div.

(Apr. 6)—TECHNICAL COMMITTEE PRESENTATION—John E. Hall, Tioxide of Canada Ltd.

(May 4)—MANUFACTURING COMMITTEE PRESENTATION—Ladislav Krivanek, International Paints Ltd.

## New York

(Mar. 8)—"HIGH SOLIDS URETHANE COATINGS"—Bernard Talb, NL Chemicals.

(Apr. 12)—Speaker to be announced.

(May 10)—PAST-PRESIDENTS' AND PAVAC AWARDS NIGHT.

## Pacific Northwest—Portland, Seattle, & Vancouver Sections

(Mar. 15-17)—"PRODUCTION MANAGEMENT, FORMULA ANALYSIS AND COMPLIANCE USING THE PERSONAL COMPUTER"—Christy Ausman, Pacific Micro.

(Apr. 19-21)—"MODERN TRENDS IN ORGANIC PIGMENT TECHNOLOGY"—Hugh M. Smith, Sun Chemical Corp.

(May 17-19)—"UNDER UTILIZED KAOLIN"—Dan Dixon, Engelhard Minerals & Chemicals Corp.

## Philadelphia

(Mar. 10)—"COATINGS FOR PLASTIC SUBSTRATES"—Richard Johnson, Cargill, Inc.

(Apr. 8)—AWARDS NIGHT.

(May 12)—Speaker to be announced.

## Pittsburgh

(Apr. 11)—SYMPOSIUM ON HAZARDOUS WASTE LAWS—Speaker to be announced.

## Rocky Mountain

(Mar. 7)—"PRODUCTION MANAGEMENT, FORMULA ANALYSIS AND COMPLIANCE USING THE PERSONAL COMPUTER"—Christy Ausman, Pacific Micro.

(Apr. 11)—"MODERN TRENDS IN ORGANIC PIGMENT TECHNOLOGY"—Hugh M. Smith, Sun Chemical Corp.

(May 9)—"UNDER UTILIZED KAOLIN"—Dan Dixon, Engelhard Minerals & Chemicals Corp.

# Elections

## DETROIT

### Active

- CAREY, KIMBERLY ANN—BASF Inmont, Hamtramck, MI.  
HOOPFER, JOHN R.—Evech, Brighton, MI.  
HUGHES, LAWRENCE—BASF Inmont, Whitehouse, OH.  
KOEVENIG, BRIAN—Structural Coatings, Wayne, MI.  
SWINKO, RONALD J.—Advance Testing Laboratories, Hillsdale, MI.  
VALATKA, HENRY—Widger Chemical Co., Warren, MI.  
WILLIAM, ERWIN JAMES—Paint Systems Inc., Birmingham, MI.

### Associate

- OLIVER, J. ROBERT—Unocal Chemicals Div., Kalamazoo, MI.

### Educator/Student

- KUKKALA, PRAVIN K.—Eastern Michigan University, Ypsilanti, MI.

## GOLDEN GATE

### Active

- STANTON, D. THOMAS—Eureka Chemical Co., So. San Francisco, CA.

## KANSAS CITY

### Retired

- ACKERMAN, HERMAN D.—Kansas City, MO.  
MARTIN, WADE H.—Overland Park, KS.  
TERHERST, TED W.—Kansas City.

## NEW ENGLAND

### Active

- BECKER, MICHAEL J.—Dryvit System Inc., W. Warwick, RI.  
BENDER, HOWARD S.—Sannor Industries, Leominster, MA.  
CALHOUN, GARY D.—Polyvinyl Chemicals, Wilmington, MA.  
HENDERSON, RICHARD A.—Polyvinyl Chemicals, Wilmington.  
LOAR, DONALD F.—Whittaker Corp., Chicopee, MA.  
QUINN, FRANCIS X.—Dryvit System Inc., W. Warwick.  
WOOD, ANDREW C.—Dryvit System Inc., W. Warwick.

### Associate

- HUNT, GREGORY W.—Unocal Chemicals Div., Palmer, MA.  
KATZ, HERBERT N.—Northland Chemical, Warwick, RI.

## NORTHWESTERN

### Active

- CZAJKA, TED L.—Valspar Corp., Minneapolis, MN.  
JOHNSON, ERLIN J.—3M Co., St. Paul, MN.  
MCDONOUGH, JOHN M.—Valspar Corp., Minneapolis.  
PETERS, JOSEPH M.—Cargill, Inc., Minneapolis.  
REUTZ, BILLY G.—Cargill, Inc., Minneapolis.

### Associate

- BOERNER, THOMAS W.—Cary Co., Addison, IL.  
MEYER, G. WALLACE—McWhorter Inc., Carpentersville, IL.  
REZELL, JOSEPH M.—Polyvinyl Chemicals, Arlington Heights, IL.

## SOUTHERN

### Active

- BARA, ROBERT—Nationwide Chemical, Bradenton, FL.  
KISSEL, JOHN R.—Akzo Coatings, Norcross, GA.  
ROMER, RONALD L.—Sherwin-Williams, Morrow, GA.  
VENISKEY, TIMOTHY A.—Akzo Coatings, Norcross.

### Associate

- ABERNATHY, DONALD E.—Aqualon Co., Atlanta, GA.  
BALLEW, MELISSA A.—Union Carbide Corp., Tucker, GA.  
BURTON, PHILIP—Ameron, Enmar Inc., Jonesboro, AK.  
CARR, THOMAS G.—CL Industries, Orlando, FL.  
CASPER, FRED A.—Lomas Minerals & Chemicals, Tampa, FL.  
GOFF, LARRY N.—Milliken Chemical Co., Spartanburg, SC.  
GREEN, LYNNE E.—American Int'l Container Corp., Orlando.  
LAUGHRIDGE, W. NEIL—Process Materials & Engineering, Sylacauga, AL.  
MAHONEY, JAY—Sunshine State Products Corp., Riviera Beach, FL.  
MARSHALL, FREDERICK JR.—Letica Corp., Palm Harbor, FL.  
MEADOWS, W.D.—Cyprus Industrial Minerals, Cartersville, GA.  
MINER, RICK—Union Carbide Corp., Tucker.  
PHIPPS, SUSIE J.—Steeltin Can Corp., Baltimore, MD.

- POMP, PAUL R.—Growth International, Orange Park, FL.  
PRIDDY, DAVID C.—Kenrich Petrochemicals, Marietta, GA.  
PRISLAND, TONY J.—Raw Material Supply, Tampa.  
ROWDER, KENT A.—Daicolor/Pope, Marietta.  
SCHAFER, RUSSELL B.—Sunshine State Products Corp., Riviera Beach.  
SOUZA, JACK F.—Megachem Inc., Tucker.  
STEED, R. LOUIS—Ortec, Inc., Easley, SC.

## TORONTO

### Active

- COLANGELO, MICHAEL A.—Metal Koting, Rexdale, Ontario.  
MEEMINK, GARY—Ideal Paints, Oakville, Ontario.  
MISTRY, DHIRU C.—Continuous Color Coat Ltd., Rexdale.  
SANYAL, SUJIT C.—PPG Industries Canada, Ltd., Mississauga, Ontario.  
SCHTUNYK, STEVE—Metal Koting, Rexdale.  
STEGMANN, MICHAEL J.—PPG Industries Canada, Ltd., Mississauga.  
WILLIAM, RONALD C.—Continuous Color Coat Ltd., Rexdale.  
WILSON, ALAN—Ideal Paints, Oakville.

### Associate

- POPPE, RUSSELL E.—Anachemia Solvents Ltd., Mississauga, Ontario.

## AFFILIATED

- OLIVIERI, JOSE F.—Olivieri & Associates, San Juan, Puerto Rico.

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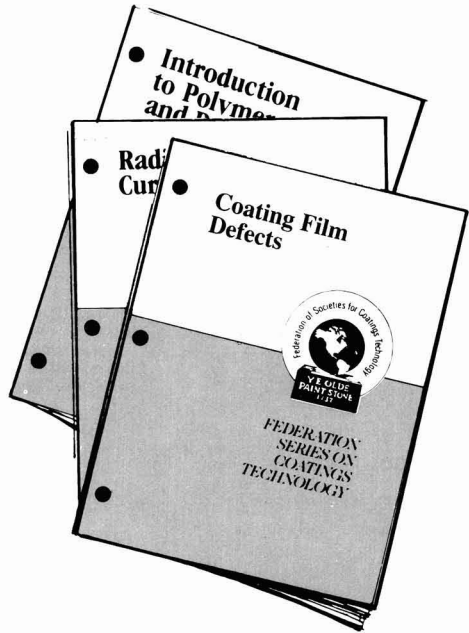
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# People

ASTM, Philadelphia, PA, has awarded its 1987 Award of Merit to **Allen W. Grobin, Jr.**, of IBM Corporation, Poughkeepsie, NY. The award, sponsored by ASTM Committee B-8, honors Mr. Grobin's outstanding work and contributions in the development of national and international standards covering metallic and inorganic coatings, and for extending the activities of the committee. Besides being a member of ASTM, he is also a member of the Electroplaters and Surface Finishers Society.



**A.W. Grobin**



**J.C. Hall**



**J.D. Downs**



**T. Stoffer**

Illinois Minerals Company, Cairo, IL, has appointed **James G. Goodman** National Sales Manager. He will be responsible for sales in the United States and Canada.

D.H. Litter Company, Inc., New York, NY, has announced the following sales appointments: **Thomas Kendzulak**—Senior Sales Representative, Andover, MA; **William Stowell**—Sales Representative, Andover; and **Stephen Holtzman**—Sales Representative, New York.

The Powder Coatings Group, Morton Chemical Division, Morton Thiokol, Inc., Chicago, IL, has announced the following appointments: **Walt Lindner**—Eastern Regional Sales Manager, New York, NY; **Donald W. McIntosh**—Development Specialist, Middletown, OH; and **Edward F. Lindberg**—Automotive Specialist.

In addition, **Ronald W. Williams** recently joined the Adhesives and Coatings Group as a Packaging Sales Representative.

Grow Group, Inc., New York, NY, has announced the retirement of **J. Robert Desjardins**, President of Devoe & Raynolds Division. Mr. Desjardins will continue as Consultant to the division, working on special assignments and acting as senior advisor to the new President, **Joseph M. Quinn**. Mr. Quinn will also retain his responsibilities as Group Vice-President of Grow's marine and maintenance coatings operations.

In addition, **Robert H. Osmer** has been promoted to Vice-President and General Manager of Devoe Marine Coatings Company, Louisville, KY.

**John C. Hall** has been named Sales Representative, Powder Coatings Division, Ferro Corporation, Cleveland, OH. Mr. Hall will be responsible for the sales and technical service of Vedoc® Powder Coatings in the Southern region of the United States, consisting of Kentucky, Tennessee, and Alabama.

**Treva L. Maxwell** and **Eric B. Schubert** have joined Union Carbide Corporation's UCAR Emulsion Systems Group, Cary, NC, as Technical Representatives. Ms. Maxwell's initial assignment will be at the company's Alsip, IL latex plant, and Mr. Schubert will receive his sales training at the firm's Somerset, NJ latex plant.

**Barry Radulski** has been named Manager of Market Development for the Chemicals Division of J.M. Huber Corporation, Havre de Grace, MD. In his new position, Mr. Radulski will coordinate a new product development program.

In addition, the following appointments have been announced by the Clay Division of J.M. Huber, Macon, GA: **Mack S. Duncan**—Project Geologist; **Tony Jones**—Project Engineer; **David E. George**—General Manager, Sales/Services; **Carl E. Kollmar**—Operation and Business Manager, Mica of the Kings Mountain and Spruce Pine, North Carolina locations; **Thad T. Broome**—Senior Section Leader, Paint Laboratory, Research and Development Department; **Janice H. Phillips**—Marketing Services Manager; and **Thomas D. Carlsen**—National Sales Manager.

Mr. Broome is a member of the Southern Society.

The appointment of **John D. Downs** to the position of Technical Director was announced by LanChem, E. St. Louis, MO. Mr. Downs will oversee the firm's technical research and quality control areas in the production of coatings resins and resins used for printing inks. He is a member of the Chicago Society.

In addition, **Thomas Stoffer** has been named to the position of Manager for Acrylic Resins Development. Previously, Dr. Stoffer was Group Leader for Synthese B.V., a division of Akzo Coatings, located in The Netherlands.

Interez, Inc., Louisville, KY, recently announced that **Richard Kemmerer** has been promoted to Technical Director. Among his responsibilities, Dr. Kemmerer will be responsible for the management of the monomer and oligomer synthesis labs, applications, and technical service in support of the UV/EB business segment.

**Jack E. Benham**, a member of the Southern Society, has announced the formation of a new company, J B Chemicals & Consulting Corporation, Pembroke Pines, FL. The firm will specialize in field inspections, product investigations, special sales assignments, quality control supervision, and other aspects in the chemical manufacturing, building, and coating manufacturing industries.

**Douglas R. Elliott** has been promoted to Manager, Editorial Services, and **Kathleen M. Tridante** has been promoted to Manager, Corporate Media Relations for ICI Americas, Inc., Wilmington, DE.

**Darwin A. Novak** has joined the staff of A.E. Staley Manufacturing Company, Decatur, IL, as Director for the Horizon Engineering Group. Prior to joining Staley, Mr. Novak was employed as Manager of the Detergent Chemicals Group of Monsanto Company, St. Louis, MO.

Also, two promotions have been announced by the Horizon Chemical Division of Staley: **Gary D. Lee**—Director, Chemical Intermediates Business Unit, and **Charles F. Putnik**—Director, Surfactants Business Unit.

**Cliff McCormick** has been appointed Manager of Statistical Process Control for the Organics Division of Witco Corporation, New York, NY. Based in Houston, TX, Mr. McCormick joins the division from Witco's Concarb Division where he most recently served as a Statistical Analyst.

In addition, **Gregory J. Dornstauder** has been named a Sales Representative, covering the Delaware, Maryland, and Virginia region. He will be based at the division's sales offices in Perth Amboy, NJ.

Ashland Chemical Company, Columbus, OH, a division of Ashland Oil, Inc., has announced the restructuring of its senior management group. Named in the reorganization were: **David J. D'Antoni**—Executive Vice-President; **Phillip D. Ashkettle**—Group Vice-President, General Polymers, Canadian, and Special Polymers and Adhesives Divisions; **Donald L. Coticchia**—Group Vice-President, IC&S, Petrochemical, and Electronic and Laboratory Products Divisions; **Anton Dorfmueller**—Group Vice-President, Drew Industrial, Drew Marine, Foundry Products, Carbon Black, and Composite Polymers Divisions; **S.B. Patrick**—Administrative Vice-President; **D.S. Boston**—Administrative Vice-President; and **T.F. David**—Administrative Vice-President and General Counsel.

In addition, **David H. Armstrong** has been named Manager, Chemical and Utilities Purchasing for Ashland. Mr. Armstrong joined Ashland in 1973 as a Process Engineer and most recently served as the firm's Compounding Business Manager in Detroit, MI.

**D. Brent McGinnis** has been appointed Director, Public Relations for Ashland Chemical Company. Mr. McGinnis will be responsible for all aspects of the company's national public relations program including product publicity and charitable contributions.

The 76 Polymers business unit of Unocal Chemicals Division, Unocal Corporation, Schaumburg, IL, has announced the following appointments: **Susan M. Adams**—Sales Representative, Schaumburg; **Shelli McCarthy**—Coatings Laboratory, Technical Service Center, Charlotte, NC; **R.E. (Bob) Rowan**—Senior Account Manager, Atlanta, GA; and **J.H. (Jay) Snyder**—Senior Accounts Manager, Atlanta.

## “When I Grow Up . . .”



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To find out how you can help, write to St. Jude, 505 N. Parkway, Memphis, TN 38105, or call 1-800-238-9100.

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*Danny Thomas, Founder*

## Obituary

**Aaron Yosef “Joe” Dworsky**, President of Consolidated Container Corporation, Minneapolis, MN, died on November 4, at the age of 65.

Mr. Dworsky worked at the firm established by his father in 1905 since he was 13. After graduating from North High School, he served in the Army during World War II. He then studied at the University of Minnesota.

A member of the Northwestern Society, Mr. Dworsky is survived by his wife, Marion; five sons; a daughter; two stepsons; and one stepdaughter.

## Pump & Pail System

A portable viscosity control system consisting of a stand holding standard five or 10 gallon ink pails, electric pump, solvent supply, and viscosity measuring element is being introduced in literature. The system includes a solenoid valve for solvent additions, an air valve for cycling the measuring element, a bypass flow control valve, and the hoses and fittings to and from the press. For complete information, write Norcross Corp., 225 Newtonville Ave., Newton, MA 02158.

## Industrial Microbicides

A technical bulletin covering many industrial uses for microbicides is now available. The microbicides are EPA-registered for use by manufacturers as preservatives in water-based paints and coatings, adhesives and tackifiers, building materials such as mastic and caulks, and metal-cleaning fluids. For more information on the Kathon® LX and LX 1.5% microbicides, request bulletin #CS-549 from Joan Macey, Rohm and Haas Co., Independence Mall West, Philadelphia, PA 19105.

## Nonseeding Additive

A 20-page brochure is available on a new nonseeding liquid organic rheological additive for solvent based systems. The additive offers easy handling, compatibility with a broad range of solvents, and sag resistance at low viscosity. Write NL Chemicals, Inc., P.O. Box 700, Hightstown, NJ 08520, for a copy of the brochure on Thixatrol® SR rheological additive.

## Spray Booth Treatment

Chemical treatment of water wash paint spray booths is the subject of a technical paper. The eight-page paper addresses the problems resulting from the increased use of base/clear coat, high solids enamels in the automotive industry, and discusses solutions that can minimize the far-reaching effects of these compliance coatings on production and overall plant operation. For a copy of the paper, write Betz Industrial, 4636 Somerton Rd., Trevose, PA 19047-6783.

## Texture Additive

Technical information highlights a new texture additive designed for powder coatings. The additive allows powder coatings manufacturers to create new textured coatings through post addition of the additive. Samples, application notes, and technical background information on Troykyd PTA are available by contacting Jim Joudrey, Troy Chemical Corp., One Avenue L, Newark, NJ 07105.

## Planning Subsystem

Information on an IBM PC compatible planning subsystem which will project material, container, production, equipment, and manpower requirements based on sales or production forecasts has been released. For more details on the BatchMaster Plus+ Planning Subsystem, contact Pacific Micro Software Engineering, 6511 Salt Lake Ave., Bell, CA 90201.

## Surfactants

A data sheet highlighting the typical properties and performance characteristics of surfactants which are used in the grinding and dispersing of pigments for water-based printing inks and coatings has been released. For a copy of the data sheet on Surfynol® surfactants for pigment grinding applications, contact Air Products and Chemicals, Inc., Performance Chemicals Div., Allentown, PA 18195.

## Environmental Services

A new service to help businesses meet their legal and ethical responsibilities for environmental protection is described in a brochure. The brochure provides a comprehensive service to help clients deal with such problems as plant emissions, ground-water protection, compliance with toxic materials and hazardous waste regulations, and compliance with other current environmental laws and regulations. Direct all inquiries for the Environmental Management Services brochure to: Environmental Management Services, the Du Pont Co., Barley Mill Plaza Bldg. 19, Wilmington, DE 19898.

## Copper Plating

Application briefs describing the analysis of copper plating baths by square wave voltammetry are available. The briefs provide detailed procedures for the determination of: Copper I in copper cyanide plating baths; Copper II in electroless copper plating baths; and formaldehyde in electroless copper plating baths. To receive copies of these briefs, write EG&G Princeton Applied Research, Electrochemical Instruments Div., CN 5206, Princeton, NJ 08543-5206.

## EPA Report

A nine-volume report covering in depth the subject of burning municipal wastes, the numbers and types of existing and projected waste combustion plants, the existence of potentially hazardous emissions, and how to monitor and control them and at what costs has been published. Contact the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161, for more information on the series on "Municipal Waste Combustion Study."

## Shopcoat Primers

Technical information is now available on two types of shopcoat primers designed to provide metal surfaces with corrosion resistance. The shopcoat primers are fast drying primers for iron and steel surfaces. Write to the Sherwin-Williams Stores Group, c/o Robert Silverman Co., 1375 Euclid Ave., Cleveland, OH 44115 for more information on its shopcoat primers.

## Rheometer

Details of a 90 torque rheometer are contained in a 12-page, full color brochure. The literature describes the applications of a rheometer which include the laboratory testing of thermoplastic, engineering thermoplastic, thermoset, ceramic, and rubber materials. In addition, complete specifications and available accessories that can be utilized have been included. For a copy of the brochure detailing the System 90 Torque Rheometer, contact Scott Krane or Barbara L. Naser, Haake Buchler Instruments, Inc., 244 Saddle River Rd., Saddle Brook, NJ 07662.

## Densitometer

A four-page brochure features a high performance scanning densitometer designed for rapid quantitative evaluation of electrophoretic separations as run on various types of media. The publication provides a complete product description including specifications and ordering information. For more information on the Joyce Loebel Densitometer, contact Loretta Scheel or Mary J. Greenway, Haake Buchler Instruments, Inc., 244 Saddle River Rd., Saddle Brook, NJ 07662-6001.

## Acrylic Polyols and Emulsions

Three technical brochures which describe acrylic polyols for urethane coatings, high-solids solvent-borne acrylic resins for melamine cured coatings, and rheology-controlled acrylic emulsions is available. The literature features product attributes, paint performance data, blending information, and formulating tips. For a copy of the Joncryl® polymer brochures, write Specialty Chemicals Group, M.S. 070, Johnson Wax, 1525 Howe St., Racine, WI 53403.

## Lead-Based Paint

Details on the services for field and laboratory testing of lead-based paint is the subject of a two-color brochure. The literature describes the company, staff, and techniques used for field and laboratory identification of lead-based paints. For a copy of the brochure, write KTA-Tator, Inc., 115 Technology Dr., Pittsburgh, PA 15275.

## Zirconium Silica

A nontoxic, anti-corrosive inhibitive zirconium-based silica is highlighted in a product bulletin. When the protector pigment is mixed with industrial-used white enamels, it shows little or no corrosion when subjected to 300 hours of water immersion, salt fog, and accelerated weather conditions. For data, contact Robert A. Paul or Dominick DeSantis, MMII Inc., Silica Products Group, Linden, NJ.

## Barrier Containers

Literature highlights a line of barrier containers in quart and 2½ gallon F-style designs. The containers are blow-molded of high-density polyethylene. A data sheet which provides complete specifications including capacity, weight, and dimensions on Airopak® barrier containers is available from Air Products and Chemicals, Inc., Box 538, Allentown, PA 18105.

## Health & Safety

A 12-page catalog which features a broad range of the latest products designed to protect health and safety is available. The publication contains up-to-date items that can be used in protecting health and safety in potentially dangerous situations. The "Health and Safety Products" catalog is available through American Labelmark Co., Labelmaster Div., 5724 N. Pulaski Rd., Chicago, IL 60646.

## Two-Component Air-Dry System

Literature describes a catalyst system for processing two-component air-dry urethane coatings. After a 24-hour dry time, coatings using the system exhibit 2H pencil hardness and 160-inch pounds reverse impact. For details on the Gemini A300, write Denomi Corp., P.O. Box 41535, Minneapolis, MN 55441.

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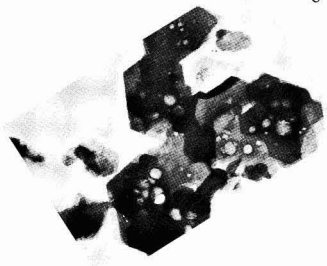
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## Testing Laboratories

The 1988 edition of the "ASTM Directory of Testing Laboratories" is now available. This directory contains information on over 1000 laboratories located in the United States, Canada, and eleven other countries. For ordering information, write ASTM, 1916 Race St., Philadelphia, PA 19103-1187.

## Test Strip Kits

Test strip kits which provide detection and measurement of five chemicals commonly used in the paint and pigments industry is the subject of a product bulletin. The paint and pigment test kits are a tool for performing semi-quantitative analysis for aluminum, calcium, copper, iron, and sulfate. For data on the EM Quant® test strip kits, contact Guenter Niessen, Product Manager, EM Science, 111 Woodcrest Rd., Cherry Hill, NJ 08034-0395.

## Microcrystalline Silica

A 12-page, four-color brochure on microcrystalline silica has been released. Included are charts, tables, characteristics, as well as a magnified photo of microcrystalline silica viewed through an electron microscope. Copies are available from Illinois Minerals, 2035 Washington Ave., Cairo, IL 62914.

## Microscope Camera

Information is now available on a microscope camera for the latest generation of light microscopes. The camera features automatic exposure control, automatic film transport, and motorized film return. Film speed range is ISO 25 to 6400 ASA. For further information on the Zeiss MC 100, write Microscopy Div., Carl Zeiss, Inc., One Zeiss Dr., Thornwood, NY 10594.

## Light Stabilizer

Recently released literature describes a hindered amine light stabilizer (HAL) specifically for use in high solids, acid-catalyzed coatings. The light stabilizer does not interfere with the curing process in high solids, acid-catalyzed thermosetting systems. HAL is designed for use with fully alkylated melamine crosslinking resins. For additional data on Tinuvin® 440 light stabilizer, contact Fred Vigeant, Additives Dept., CIBA-GEIGY Corp., Three Skyline Dr., Hawthorne, NY 10532.

## Curing Coatings

An eight-page formulation package has been published to assist coating formulators in the development of low temperature curing coatings for heat sensitive substrates. For more information on the K-FLEX® 188 resin, contact Richard J. Shain, King Industries, Inc., Science Rd., Norwalk, CT 06852.

## Safety Lid

A replacement safety lid for shipping containers with standard 55-gallon barrel openings has been introduced in literature. The lid features a special safety design which prevents the emergency vent from being knocked off during common forklift handling. Additional information is available from Clawson Tank Co., 4701 White Lake Rd., Clarkston, MI 48016-0350.

## Adhesion Promoting Resin

Technical data highlights a toluenesulfonamide/formaldehyde resin which is soluble in ketones, esters, alcohols, plasticizers, and aromatic solvents. The resin is used to promote adhesion, lower viscosity, increase gloss, and improve solvent release. For additional details on Sulfonox EST-100, write Estron Chemical, Inc., 1130 Rt. 46 W., Parsippany, NJ 07054.

## Adhesives Study

A multi-client, techno-economic marketing study on the current commercial developments, technological trends, and marketing shift affecting the adhesives industry has been completed. The study provides an analysis of markets, raw materials, technological advances, marketing trends, prices, major suppliers, and leading end users. For an "Adhesives V" brochure with Table of Contents, write Skeist Inc., 375 Rte. 10, Whippany, NJ 07981.

## Catalyst System

A catalyst system for processing two-component force-dry urethane coatings is introduced in literature. After 30 minutes at 140°F, coatings using the system exhibit 3H pencil hardness and 160-inch pounds reverse impact. For more information and product literature on Gemini A400, write Denomi Corp., P.O. Box 41535, Minneapolis, MN 55441.

## Lay Down Panels

A 24-page brochure which describes a complete line of lacquered paper charts, wood, plastic, and metal panels for laying down wet films of coating materials to be evaluated for gloss, color, hiding power, spreading rate, leveling, sagging, scrub testing, drying time, etc. is available. A number of test instruments designed to lay down wet films and other related devices, illustrations, descriptions, and current prices are included. For details, write Paul N. Gardner Co., Inc., P.O. Box 10688, Pompano Beach, FL 33061-6688.

## Color Matching

A four-page, full-color brochure which describes the procedures and factors taken into consideration to provide a precise color match for aerosol, bulk, or brush-in-cap touch-up coatings is available. The publication discusses color standards and the method of precise color matching using computerized color analysis. Write Raabe Corp., P.O. Box 23708, Milwaukee, WI 53223 for "The Art and Science of Color Matching" brochure.

## Colorimeter

A colorimeter system which offers color difference values and absolute readout is the subject of recently released literature. The system can display sample, standard, and color difference values simultaneously. For additional information on the D25-PC2Δ Colorimeter, write HunterLab, Hunter Associates Laboratory, Inc., 11491 Sunset Hill Rd., Reston, VA 22090.

## Glycol Ethers Overview

An overview brochure which discusses the applications and benefits of glycol ethers in water-based coatings is available. The brochure includes individual data sheets which provide information such as physical properties, resin solubility, and a chart of observed evaporation rates relative to other glycol ether products. The literature also contains details on an interactive computer service that offers a solvent modeling program to assist formulation chemists in formulating solvent blends to meet exact performance requirements. For a copy of "Advance Technology for Water-Based Coatings," write The Dow Chemical Co., 2020 Willard H. Dow Center, Midland, MI 48674.

## Book Review

### **ION PLATING TECHNOLOGY Developments and Applications**

By  
N.A.G. Ahmed

Published by  
John Wiley & Sons, Ltd.  
Great Britain (1987)  
171 pages, \$51.95

Reviewed by  
M.E. Graham  
Whirlpool Corporation  
Benton Harbor, MI 49022

Mr. Ahmed has produced a monograph on the subject of ion plating which is intended to introduce the subject to post graduate students or practicing engineers and scientists who have, at least, a basic knowledge of vacuum physics and vapor deposition methods. The book is quite readable with little dependence on mathematical relationships but, rather is a descriptive treatment of virtually every aspect of ion plating technology. Mr. Ahmed's thoroughness, including a comprehensive bibliography, will be much appreciated by those just getting started in the field.

The introduction sets ion plating in the context of other deposition processes, describing briefly its development over the past two decades. The central six chapters describe in some detail: (1) the physics of

ion plating; (2) system hardware; (3) process variables and considerations; (4) reactive ion plating applications; (5) coating characteristics; and (6) industrial applications of the technique. He concludes with a final chapter which summarizes the attributes of ion plating and discusses briefly the future of the technology and the economic considerations in choosing such a process.

The two chapters covering the physical apparatus and the other considerations relevant to the total process are especially useful to the experimentalist. Mr. Ahmed deals at length with the various options for evaporation sources, as well as other basic equipment and further considers everything from ionization enhancement techniques to substrate preparation to the effect and measurement of process control parameters.

For a description of potential uses of the technology, the treatments of coating characteristics (adhesion, wear, fatigue, etc.) and applications are quite good. The chapter on applications, in particular, looks at some of the most successful industrial applications and discusses in depth why the ion plated coatings were uniquely successful in certain circumstances.

As an introductory text on the subject of ion plating, Mr. Ahmed's monograph is a welcome and timely contribution in a still developing field. It condenses the major developments of the preceding two decades through concise descriptions of process technique and parameters, film characteristics and applications, and the probable directions of growth for the near future.

### **ENGINEERING WITH POLYMERS**

By  
Peter C. Powell

Published by  
Chapman and Hall Ltd.  
733 Third Ave.  
New York, NY 10017 (1983)  
318 pages, \$49.95

Reviewed by  
Daniel J. Horn  
Whirlpool Corp.  
Benton Harbor, MI 49022

Written by a lecturer in Polymer Engineering at Imperial College of Science and Technology in London, this book is designed to be an introduction to the broad field of polymer science. A text style format is used with problems listed at the end of each section and accompanying outlined answers in the back. Four main themes are addressed assuming the reader has a basic engineering background with little or no polymer experience. Chemical and environmental aspects of polymer engineering are touched upon only slightly.

The first section contains an introduction and information relevant to generic classifications and physics of polymers. Processing methods are also discussed. The next section deals with physical properties and includes some very well written sections on super-position principles, viscoelastic theory, and failure mechanics. The third section introduces polymer composites and discusses their anisotropic nature. The final section describes thermal and flow properties of polymer melts relevant to different processing methods. Some effects of processing on part properties are also listed.

Each chapter is well documented with references and a select list for further reading. An international flare is evident sighting only SI units, perhaps making it difficult for the English oriented engineer. Only a brief address to environmental and chemical effects on polymer aging is sighted. However, the book is an excellent mechanical engineering introduction to polymer science. It will be especially useful to individuals encountering polymer problems for the first time, those needing a quick fix of information, or individuals needing a refresher on the covered topics.

## **SPRING WEEK '88**

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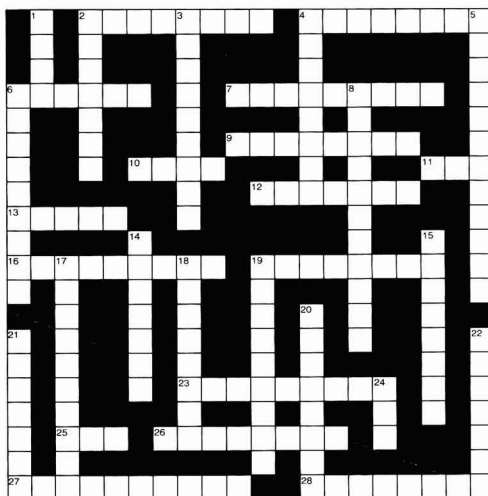
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"Coatings Defects: Prevention  
and Cure"

May 17-18

# CrossLinks

by Earl Hill



Solution  
to be  
published in  
March issue

No. 22

## ACROSS

2. Fungi science
4. Flow control agent, soya derived
6. Dicarboxylic acid bleaching agent
7. Excess paint from spraying
9. Gum adhesive
10. Agents of varnish film defects N\_\_\_\_\_
11. Moisture \_\_\_\_ (Abr.)
12. To cover over, as in painting
13. A cast
16. High build coating, usually PVC based
19. High unsaturation oil, native to Brazil. Relative of Tung oil
23. Containing >50% alcohol
25. To convert, as to air\_\_\_\_\_
26. Resin like
27. Attribute of resisting
28. Fine particle dispersion

## DOWN

1. Source of oil; a plant seed
2. Dividers for windows/glass panels
3. Emulsion technical term; lack of affinity
4. Petroleum solvent ("pet ether")
5. Non-n\_\_\_\_\_, rheological term
6. Being attacked by oxygen
8. Pearl-like finish, usually lacquer based
14. Volatile, liquid paint component
15. Accelerator of reactions, C\_\_\_\_\_
17. Glycerol esters
18. Masstone (Syn.), O\_\_\_\_\_
19. Multiple impression printing
20. To cure in excess
21. Single mers
22. A template (Syn.)
24. Federal bureau dealing with substances (Abr.)

# Coming Events

## FEDERATION MEETINGS

For information on FSCT meetings, contact FSCT, 1315 Walnut St., Philadelphia, PA 19107 (215-545-1506).

1988

(Mar.)—Federation Seminars on Statistical Process Control. Level I: Mar. 4-5, Mexico City, Mexico; Mar. 14-15, Philadelphia Airport Marriott, Philadelphia, PA; Mar. 21-22, Chicago O'Hare Marriott, Chicago, IL; and Mar. 28-29, Cleveland Airport Marriott, Cleveland, OH. Level II: Mar. 16-18, Philadelphia Airport Marriott; Mar. 23-25, Chicago O'Hare Marriott.

(May 17-20)—Federation "Spring Week." Seminar on the 17th and 18th; FSCT Society Officers Meeting on the 19th; FSCT Board of Directors Meeting on the 20th. Orlando Marriott Hotel, Orlando, FL.

(Oct. 19-21)—66th Annual Meeting and 53rd Paint Industries' Show. McCormick Place, Chicago, IL.

1989

(Nov. 8-10)—67th Annual Meeting and 54th Paint Industries' Show. Rivergate, New Orleans, LA.

1990

(Oct. 19-21)—68th Annual Meeting and 55th Paint Industries' Show. Convention Center, Washington, D.C.

## SPECIAL SOCIETY MEETINGS

1988

(Mar. 16-18)—Southwestern Paint Convention of Dallas and Houston Societies. Hyatt Regency Hotel, Houston, TX. (J. Harrell, Buckman Labs., 5127 Wightman Ct., Houston, TX 77069).

(Apr. 13-15)—Southern Society. Annual Meeting. Omni Hotel, Charleston, SC. (Scott McKenzie, Southern Coatings Co., P.O. Box 160, Sumter, SC 29150).

(Apr. 19)—Detroit Society. 13th Annual FOCUS Conference. "International Trends in Automotive Coatings." Management Education Center, Troy, MI.

(Apr. 28-30)—Pacific Northwest Society. Annual Symposium. Hotel Vancouver, Vancouver, B.C., Canada. (Yvon Poiras, General Paint Corp., 950 Raymur Ave., Vancouver, B.C., Canada V6A 3L5).

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(May 11-12)—New England Society. 1988 Tech Expo. Sheraton Boxborough Hotel, Boxborough, MA. (G. Pollano, Polyvinyl Chemicals, 730 Main St., Wilmington, MA 01887).

(June 1-2)—Cleveland Society. 31st Annual Conference on Advances in Coatings Technology. John Carroll University, Cleveland, OH.

(June 10-12)—Joint meeting of St. Louis and Kansas City Societies. Holiday Inn, Lake of the Ozarks, MO.

## 1989

(Mar. 13-15)—Western Coatings Societies Symposium and Show. Disneyland Hotel, Anaheim, CA. (Andy Ellis, NL Industries, Inc., 200 N. Berry St., Brea, CA 92621).

(Apr. 5-7)—Southern Society. Annual Meeting. Hyatt Regency Westshore, Tampa, FL.

## OTHER ORGANIZATIONS

### 1988

(Feb. 16-18)—"Process Safety Management" Seminar sponsored by Du Pont Co., Wilmington, DE. (Du Pont Safety Services, Barley Mill Plaza, P19-1104, Wilmington, DE 19898).

(Feb. 22-24)—"Maintenance Coatings for Contractors and Paint Inspectors." Course sponsored by the University of Missouri-Rolla, Rolla, MO. (Coatings and Polymer Science Program, Dept. of Chemistry, UMR, Rolla, MO 65401-0249).

(Feb. 25-26)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Stouffer Resorts Hotel, Orlando, FL. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Feb. 25-26)—"Introduction to Coating Inspection." Course sponsored by the National Association of Corrosion Engineers. New Orleans, LA. (NACE Education and Training Dept., P.O. Box 218340, Houston, TX 77218).

(Feb. 29-Mar. 1)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Dallas, TX. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Feb. 29-Mar. 2)—Finishing Technologies '88 sponsored by Coatings Magazine. Constellation Hotel, Toronto, Ont., Canada. (CM, 86 Wilson St., Oakville, Ont., Canada L6K 3G5).

(Feb. 29-Mar. 3)—"Removing Lead Paints from Industrial Structures" Seminar and Workshop co-sponsored by Federal Highway Administration, and Steel Structures Painting Council. Sheraton National Hotel, Arlington, VA. (Kitti Condiff, SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213).

(Feb. 29-Mar. 4)—"56th Introductory Short Course—The Basic Composition of Coatings." Course sponsored by the University of Missouri-Rolla, Rolla, MO. (Coatings and Polymer Science Program, Dept. of Chemistry, UMR, Rolla, MO 65401-0249).

(Mar. 1-3)—Electrocoat/88 Conference sponsored by Products Finishing Magazine. The Drawbridge Inn, Cincinnati, OH. (Julianne Hall, Electrocoat/88, c/o Products Finishing, 6600 Clough Pike, Cincinnati, OH 45244-4090).

(Mar. 5-6)—Canadian Decorating Products Show sponsored by the National Decorating Products Association. Constellation Hotel, Toronto, Ont., Canada. (Lillian Smyser, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Mar. 9-10)—"Professional Paint Foreman." Course sponsored by the National Association of Corrosion Engineers. Houston, TX. (NACE Education and Training Dept., P.O. Box 218340, Houston, TX 77218).

(Mar. 10-11)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Los Angeles, CA. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Mar. 14-17)—"Spray Applications for Furniture Finishing" Seminar followed by workshop, sponsored by Society of Manufacturing Engineers. High, N.C. (Jody Pickens, SME, Professional Education Dept., One SME Dr., P.O. Box 930, Dearborn, MI 48121).

(Mar. 14-18)—"16th Introductory—Paint Formulation." Course sponsored by the University of Missouri-Rolla, Rolla, MO. (Coatings and Polymer Science Program, Dept. of Chemistry, UMR, Rolla, MO 65401-0249).

(Mar. 16-17)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Dallas, TX. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Mar. 17-18)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Bloomington, MN. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Mar. 21-25)—Corrosion/88 sponsored by the National Association of Corrosion Engineers. Cervantes Convention & Exhibition Center, St. Louis, MO. (Allison Mayer, NACE Exhibits Dept., P.O. Box 218340, Houston, TX 77218).

(Mar. 26-27)—Western Decorating Products Show sponsored by the National Decorating Products Association. Brooks Hall, San Francisco, CA. (Lillian Smyser, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Mar. 28-29)—"New Specialty Polymer Products Through Interpenetrating Polymer Network (IPN) Technology" Seminar sponsored by Technomic Publishing Co., Inc. Colony Square Hotel, Atlanta, GA. (Lisa Shirk, Program Div., Technomic Publishing Co., Inc., 851 New Holland Ave., Box 3535, Lancaster, PA 17604).

(Mar. 30-31)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Denver, CO. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Apr. 4-5)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Grand Rapids, MI. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Apr. 6-7)—"Formulating Urethane Foams" Seminar sponsored by Technomic Publishing Co., Inc. Colony Square Hotel, Atlanta, GA. (Lisa Shirk, Program Div., Technomic Publishing Co., Inc., 851 New Holland Ave., Box 3535, Lancaster, PA 17604).

(Apr. 9-10)—Eastern Decorating Products Show sponsored by the National Decorating Products Association. World Trade Center, Boston, MA. (Lillian Smyser, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Apr. 9-13)—National Coil Coaters Association Annual Meeting. Marriott's Rancho Las Palmas, Palm Springs, CA. (NCCA, 1900 Arch St., Philadelphia, PA 19103).

(Apr. 11-12)—28th Annual Symposium sponsored by the Washington Paint Technical Group. Marriott Twin Bridges Hotel, Washington, D.C. (Mildred A. Post, Publicity Chairwoman, Washington Paint Technical Group, P.O. Box 12025, Washington, D.C. 20005).

(Apr. 11-12)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Neenah, WI. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Apr. 13-14)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Cleveland, OH. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Apr. 13-15)—"Radiation Curing." Course sponsored by The Center for Professional Advancement. San Mateo, CA. (The Center for Professional Advancement, 46 W. Ferris St., East Brunswick, NJ 08816).

(Apr. 18-20)—"Conformal Coatings." Course sponsored by the University of Missouri-Rolla, Rolla, MO. (Coatings and Polymer Science Program, Dept. of Chemistry, UMR, Rolla, MO 65401-0249).

(Apr. 20-21)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Minneapolis, MN. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Apr. 20-27)—Surface Treatment '88 at Hannover Fair Industry '88. Hannover Fairgrounds, Hannover, W. Germany. (Joachim Schafer, Hannover Fairs USA Inc., 103 Carnegie Center, P.O. Box 7066, Princeton, NJ 08540).

(Apr. 24-28)—RadTech '88. New Orleans Fairmont Hotel, New Orleans, LA. (John Waxman, Director of Conferences and Exhibits, RadTech International, 60 Revere Dr., Suite 500, Northbrook, IL 60062).

(Apr. 25-26)—"Advances in Polyurethanes—Elastomers & Coatings, Adhesives & Sealants" Seminar sponsored by Technomic



Publishing Co., Inc. Colony Square Hotel, Atlanta, GA. (Lisa Shirk, Program Div., Technomic Publishing Co., Inc., 851 New Holland Ave., Box 3535, Lancaster, PA 17604).

(Apr. 26-27)—"Innovations with Plastic Films Technology" Seminar sponsored by Technomic Publishing Co., Inc. Colony Square Hotel, Atlanta, GA. (Lisa Shirk, Program Div., Technomic Publishing Co., Inc., 851 New Holland Ave., Box 3535, Lancaster, PA 17604).

(Apr. 26-28)—Aluminum Finishing '88 Conference sponsored by Products Finishing Magazine. Drawbridge Inn, Greater Cincinnati Airport area, OH. (Aluminum Finishing '88, c/o Products Finishing, 6600 Clough Pike, Cincinnati, OH 45244-4090).

(May 2-4)—International Seminar sponsored by the Ford Motor Co. Dearborn, MI. (A. Golovoy, Ford Motor Co., Box 2053/SRL 3198, Dearborn, MI 48121).

(May 4-5)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Boston, MA. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(May 8-10)—Inter-Society Color Council Annual Meeting. Sheraton Inner Harbor Hotel, Baltimore, MD. (Paula J. Alessi, 10 Bay Park, Webster, NY 14580).

(May 9-11)—Federation of Scandinavian Paint and Varnish Technologists. 12th Congress, Helsinki, Finland. (Arja Saloranta, Tikkurila Oy, PB 53, SF 01301 Vanda, Finland).

(May 9-13)—"Dispersion of Pigments and Resins in Fluid Media." Course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, OH 44242).

(May 10-12)—"Process Safety Management" Seminar sponsored by Du Pont Co., Wilmington, DE. (Du Pont Safety Services, Barley Mill Plaza, P19-1104, Wilmington, DE 19898).

(May 11-13)—"Radiation Curing." Course sponsored by The Center for Professional Advancement. Chicago, IL. (The Center for

Professional Advancement, 46 W. Ferris St., East Brunswick, NJ 08816).

(May 16-17)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Cherry Hill, NJ. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(May 16-20)—"Physical Testing of Paints and Coatings." Course sponsored by the University of Missouri-Rolla, Rolla, MO. (Coatings and Polymer Science Program, Dept. of Chemistry, UMR, Rolla, MO 65401-0249).

(May 17-18)—"Markets and Technologies of Specialty High Performance Elastomers" Seminar sponsored by Technomic Publishing Co., Inc. Colony Square Hotel, Atlanta, GA. (Lisa Shirk, Program Div., Technomic Publishing Co., Inc., 851 New Holland Ave., Box 3535, Lancaster, PA 17604).

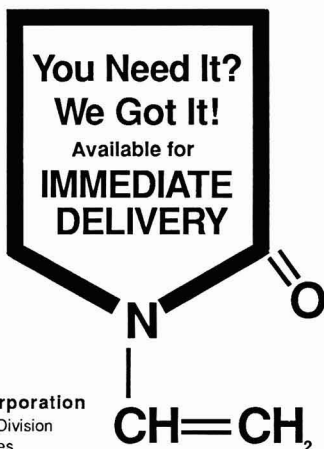
(May 17-19)—"Advances in Medical Plastics" Seminar sponsored by Technomic Publishing Co., Inc. Holiday Inn North, Newark International Airport, Newark, NJ. (Lisa Shirk, Program Div., Technomic Publishing Co., Inc., 851 New Holland Ave., Box 3535, Lancaster, PA 17604).

(May 18-19)—"Basic Principles: Polymeric Foams, Preparation, Processes and Properties" Seminar sponsored by Technomic Publishing Co., Inc. Colony Square Hotel, Atlanta, GA. (Lisa Shirk, Programs Div., Technomic Publishing Co., Inc., 851 New Holland Ave., Box 3535, Lancaster, PA 17604).

(May 18-20)—"Measurement of Appearance" Workshop sponsored by HunterLab. Sheraton Hotel, Tysons Corner, VA. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(May 19-20)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Boston, MA. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

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(May 23-25)—"Radiation Curing." Course sponsored by The Center for Professional Advancement, East Brunswick, NJ. (The Center for Professional Advancement, 46 W. Ferris St., East Brunswick, NJ 08816).

(May 23-27)—"Adhesion Principles and Practice for Coatings and Polymer Scientists." Course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, OH 44242).

(May 24-25)—Regional "Color and Appearance" Seminar sponsored by HunterLab, Charlotte, NC. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(May 25-27)—10th International Conference on "Advances in the Stabilization and Controlled Degradation of Polymers." Sponsored by the State University of New York, Luzern, Switzerland. (Angelos V. Patsis, Director, Materials Research Laboratory, CSB 209, State University of New York, New Paltz, NY 12561).

(May 30-June 1)—Second International Conference on "Cross-linked Polymers." Sponsored by the State University of New York, Luzern, Switzerland. (Angelos V. Patsis, Director, Materials Research Laboratory, CSB 209, State University of New York, New Paltz, NY 12561).

(June 1-2)—Regional "Color and Appearance" Seminar sponsored by HunterLab, Cherry Hill, NJ. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(June 5-11)—American Chemical Society, 195th National Meeting and Third Chemical Congress of North America, Toronto, Ont., Canada. (B.R. Hodson, ACS, 1155—16th St. NW, Washington, D.C. 20036).

(June 6-10)—19th Annual Short Course "Advances in Emulsion Polymerization and Latex Technology." Sponsored by Lehigh University, Bethlehem, PA. (Mohamed S. El-Aasser, Dept. of Chemical Engineering, Sinclair Lab #7, Lehigh University, Bethlehem, PA 18015).

(June 9-10)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Cincinnati, OH. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(June 13-14)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Rexdale, Ontario, Can. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(June 13-17)—International Conference on Composite Interfaces II. Case Western Reserve University, Cleveland, OH. (Professor H. Ishida, General Chairman, ICCI-II, Dept. of Macromolecular Science, Case Western Reserve University, 10900 Euclid Ave., Cleveland, OH 44106-1727).

(June 13-17)—"Applied Rheology for Industrial Chemists." Course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, OH 44242).

(June 15-16)—Surfex '88. Oil and Colour Chemists' Association. Harrogate International Conference Center, Yorkshire, England. (R.H. Hamblin, OCCA, Priory House, 967 Harrow Rd., Wembley, Middlesex HA0 2SF England).

(June 19-22)—62nd Colloid and Surface Science Symposium. Pennsylvania State University, State College, PA. (R. Nagarajan, 161 Fenske Laboratory, University Park, PA 16802).

(July 11-15)—14th International Conference on "Organic Coatings Science & Technology." Sponsored by the State University of New York, Athens, Greece. (Angelos V. Patsis, Director, Materials Research Laboratory, CSB 209, State University of New York, New Paltz, NY 12561).

(Aug. 8-11)—Color in Environmental Design Symposium sponsored by the International Color Association (AIC). Winterthur Polytechnic, Dept. of Architecture, Winterthur, Switzerland. (Allan Rodrigues, E.I. Du Pont de Nemours & Co., 945 Stephenson Highway, P.O. Box 2802, Troy, MI 48007-2802).

(Aug. 16-18)—"Process Safety Management" Seminar sponsored by Du Pont Co., Wilmington, DE. (Du Pont Safety Services, Barley Mill Plaza, P19-1104, Wilmington, DE 19898).

(Sept. 18-24)—XIXth Congress of FATIPEC. Aachen, Germany. (C. Bourgery, FATIPEC Secretary General, 76 Blvd. Pereire, 75017 Paris, France).

(Sept. 25-30)—"Polymers in Information Storage Technology" Symposium sponsored by the American Chemical Society. Los Angeles, CA. (K.L. Mittal, IBM-Corporate Technical Inst., 500 Columbus Ave., Thornwood, NY 10594).

(Oct. 1-4)—Canadian Paint and Coatings Association 1988 Convention. Hotel Newfoundland, St. John's, Newfoundland. (Harold Duffett, The Standard Manufacturing Co. Ltd., P.O. Box 6090, St. John's, Newfoundland, Canada).

(Oct. 2-4)—Canadian Paint and Coatings Association. 76th Annual Convention. Ottawa, Ontario. (CPCA, 515 St. Catherine St. W., Montreal, Que. H3B 1B4 Canada).

(Oct. 4-7)—12th World Congress on Metal Finishing, INTER-FINISH 88. Palais des Congres, Paris, France. (SEPIC INTERFINISH, 17 rue d'Uzes, 75002 Paris, France).

(Oct. 5-7)—Fall Meeting of the National Coil Coaters Association. Westin Hotel, O'Hare Airport, Chicago, IL. (NCCA, 1900 Arch St., Philadelphia, PA 19103).

(Oct. 10-13)—15th International Naval Stores Meeting. International Ritz and Meridien Hotels, Lisbon, Portugal. (Manco L. Snapp, Jr., Arizona Chemical Co., Panama City, FL).

(Nov. 4-6)—41st Annual Show and Convention of National Decorating Products Association. McCormick Place, Chicago, IL. (Lillian Smysor, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Nov. 7-9)—Paint Research Association. Eighth International Conference. Amsterdam, The Netherlands. (Mr. Dip Dasgupta, Head of Information Dept., Paint RA, Waldegrave Rd., Teddington, Middlesex TW11 8LD England).

(Nov. 8-10)—"Process Safety Management" Seminar sponsored by Du Pont Co., Wilmington, DE. (Du Pont Safety Services, Barley Mill Plaza, P19-1104, Wilmington, DE, 19898).

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## 'Humbug' from Hillman

Under the questionable auspices of Technical Editor Tom Miranda, this month Humbug celebrates(?) the return of the depressing philosophies of Bob Ahlf.

There is a risk, of course, that it will drive many of our readers to again start at the front of the book. To those fickle folk, Bob says:

- Most things get fouled up by people who think they know what they're doing.
- Flexibility is better than indecision.
- Make a Venetian blind with just two popsicle sticks.
- There's a lot to be said for beer, poker, and dirty jokes.
- Later, in the men's room, you'll hear the truth.
- Wives hide things and then pretend you lost them.
- After the kids leave home and you have a free weekend, you can go to visit the kids.
- Everything tastes more or less like Shinola.
- Dr. Jekyll isn't himself today.

It isn't Humbug who is responsible for the following bit of history but Clarke Boyce, who was our 1982-83 President. Humbug only takes credit for having the nerve to publish it.

The newly hired salesman wrote his first sales report to the home office. It stunned the brass in the sales department. Obviously, the new "hope" was a blithering illiterate, for here's what he had written:

"I seen this outfit which ain't never bought a dime's worth of nothing from us and I sold them a coupla hundred tousand dollars of guds. I am now going to Chicawgo."

Before the illiterate salesman could be given the heave ho by the sales manager, along came another letter:

"I cum hear and sole them haff a millyun."

Fearful if he did and fearful if he didn't fire the peddler, the sales manager decided to dump the problem in the lap of the President.

The following morning, the members of the ivory tower were flabbergasted to see the two letters and this letter FROM THE PRESIDENT tacked above:

"We bin spending to much time trying two spel instead of trying to sel. Lets wach those sails. I want everybody should read these letters from Gooch who is on the rode doing a grate job for us and you should go out and do like he done."

Dick Kiefer, who has a remarkable memory, remembers this from the July 2, 1984 issue of the *C&EN News*—

Leah Cooper, of Woodlawn, TX, saw a story in *World Wastes* for April 1983 that she thought others might find interesting. The magazine reported that papers filed in the U.S. District Court for the District of Columbia were titled "Plaintiffs' Motion for Leave to File a 'Last Word' Memorandum in Opposition to Defendants' 'Closing Memorandum' in Opposition to Plaintiffs' Reply to Plaintiffs' Opposition to Defendants' Motion to Dismiss the Second Amended Complaint."

U.S. District Judge June Green denied the motion. One of the plaintiffs' lawyers then filed a "Motion for Reconsideration of the Denial of Plaintiffs' Motion for Leave to File . . . . ."

As an antidote to Bob Ahlf's bright sayings, Roy Tasse has tapped the Book of Familiar Quotations, Ottenheimer Publications, Inc. 1913. After much deliberation, I think I'll take Bob's poisonous comments.

COMPLAINING—I will not be as those who spend the day in complaining of the headache, and the night in drinking the wine that gives the headache.

—Goethe

*Killjoy!*—Humbug

CORPULENCE—Let me have men about me that are fat, Sleek-headed men and such as sleep o' nights.

Yond Cassius has a lean and hungry look

He thinks too much; such men are dangerous.

—Shakespeare

*You tell 'em Willy!*—Humbug

PHYSICIANS—If you need a physician, employ these three—A cheerful mind, rest, and a temperate diet. The patient can often do without the doctor than the doctor without the patient.

—Zimmerman

*Hey Zimmie, that means I should be silly, do nothing, and have no fun. Nuts!*—Humbug

—Herb Hillman  
*Humbug's Nest*  
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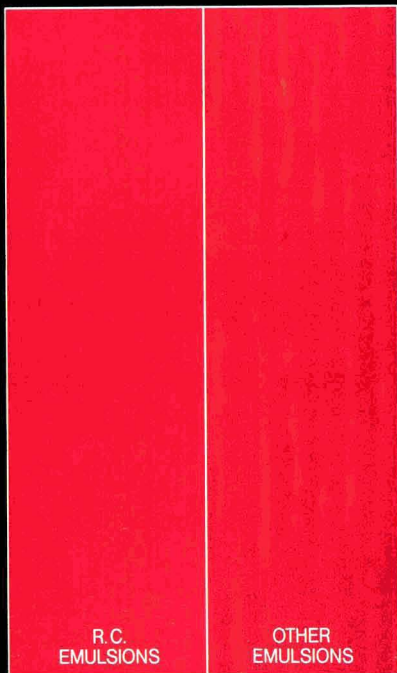
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Coatings Application	Desired Performance Qualities	PTFE Product
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Ultra-thin clears	abrasion resistance with clarity retention	SST-1MG
Coil, protective	corrosion inhibition and falling sand resistance	SST-2SP5
Coil, decorative	taber abrasion and metal-mark resistance	FluoroSLIP 515
Powder coating	durability	FluoroSLIP 525
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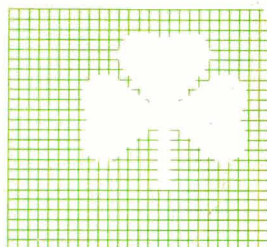
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