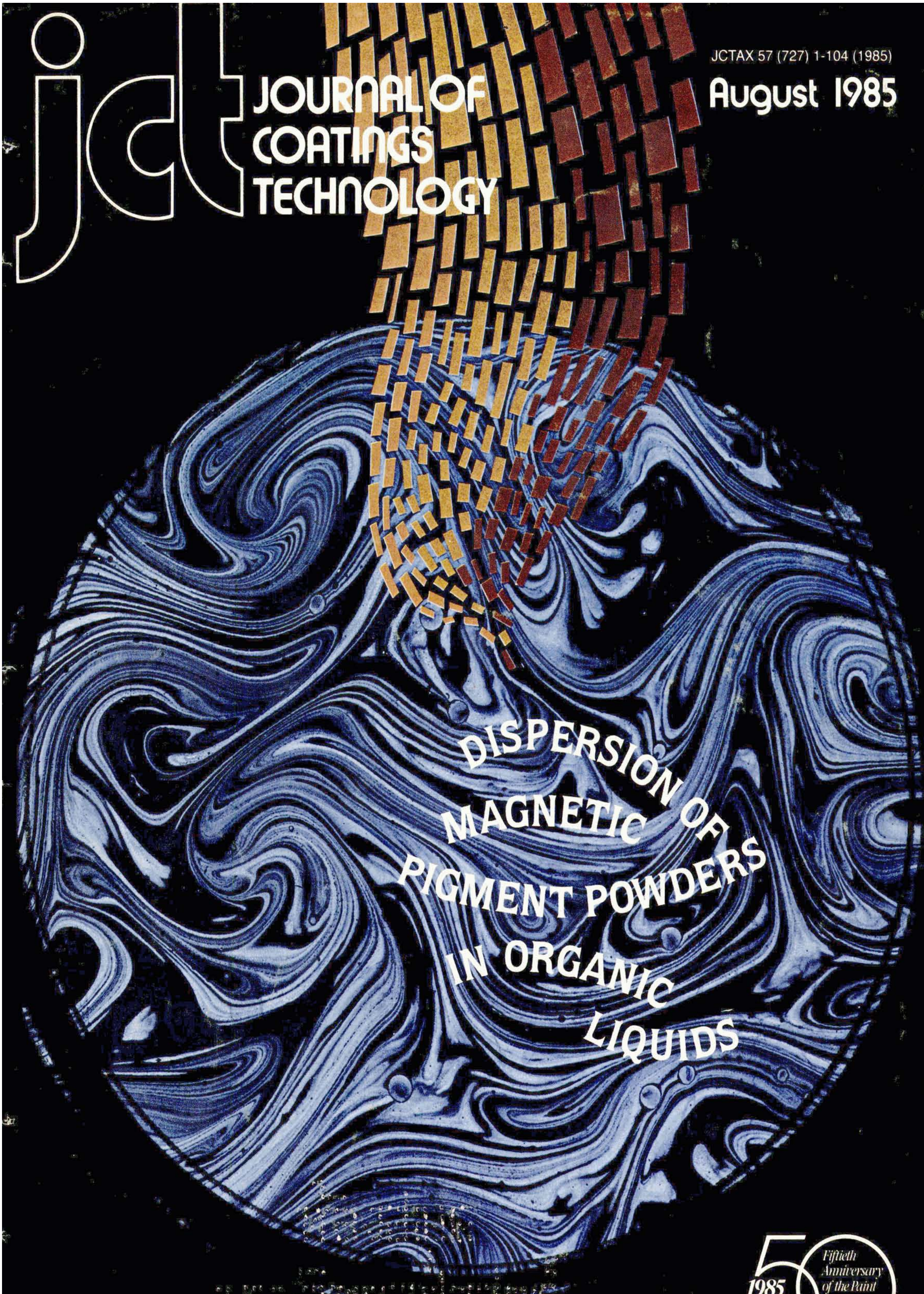
jct JOURNAL OF COATINGS TECHNOLOGY

JCTAX 57 (727) 1-104 (1985)

August 1985



DISPERSION OF MAGNETIC PIGMENT POWDERS IN ORGANIC LIQUIDS

1985 50 *Fiftieth Anniversary of the Paint Industries' Show*

and Sixty-Third Annual Meeting

CERVANTES CONVENTION CENTER
ST. LOUIS, MISSOURI OCTOBER 7–9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AUGUST 1985

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VOLUME 57 NUMBER 727

Technical Articles

Federation News

Departments

THE JOURNAL OF COATINGS TECHNOLOGY (ISSN 0361-8773) is published monthly by the Federation of Societies for Coatings Technology, 1315 Walnut St., Philadelphia, PA 19107. Phone: (215) 545-1507.

Second class postage paid at Philadelphia, PA and at additional mailing offices. POSTMASTER: *Send address changes to* JOURNAL OF COATINGS TECHNOLOGY, 1315 Walnut St., Philadelphia, PA 19107.

Subscriptions: U.S. and Canada—1 year, $27; 2 years, $51; 3 years, $73. Europe (Air Mail)—1 year, $50; 2 years, $97; 3 years, $142. Other countries—1 year, $37; 2 years, $71; 3 years, $103.


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

	U.S. and Canada	Europe (Air Mail)	Other Countries
1 Year	$27.00	$ 50.00	$ 37.00
2 Years	$51.00	$ 97.00	$ 71.00
3 Years	$73.00	$142.00	$103.00

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

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A Guide for Authors is published in each January issue.

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

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Comment

On Making the St. Louis Scene

With the summer doldrums upon us it may seem a bit premature to anticipate the events of autumn, but for those planning to attend the Federation Annual Meeting and Paint Industries' Show, the days are dwindling rapidly.

Theme for this year's AM&PS is "Coatings R&D: Today's Investment in Tomorrow," which stresses the need for innovative coatings science and technology to meet tomorrow's challenges, and Program Chairman Joe Vasta and his Committee members have lined up a solid three days of presentations dealing with a variety of coatings topics.

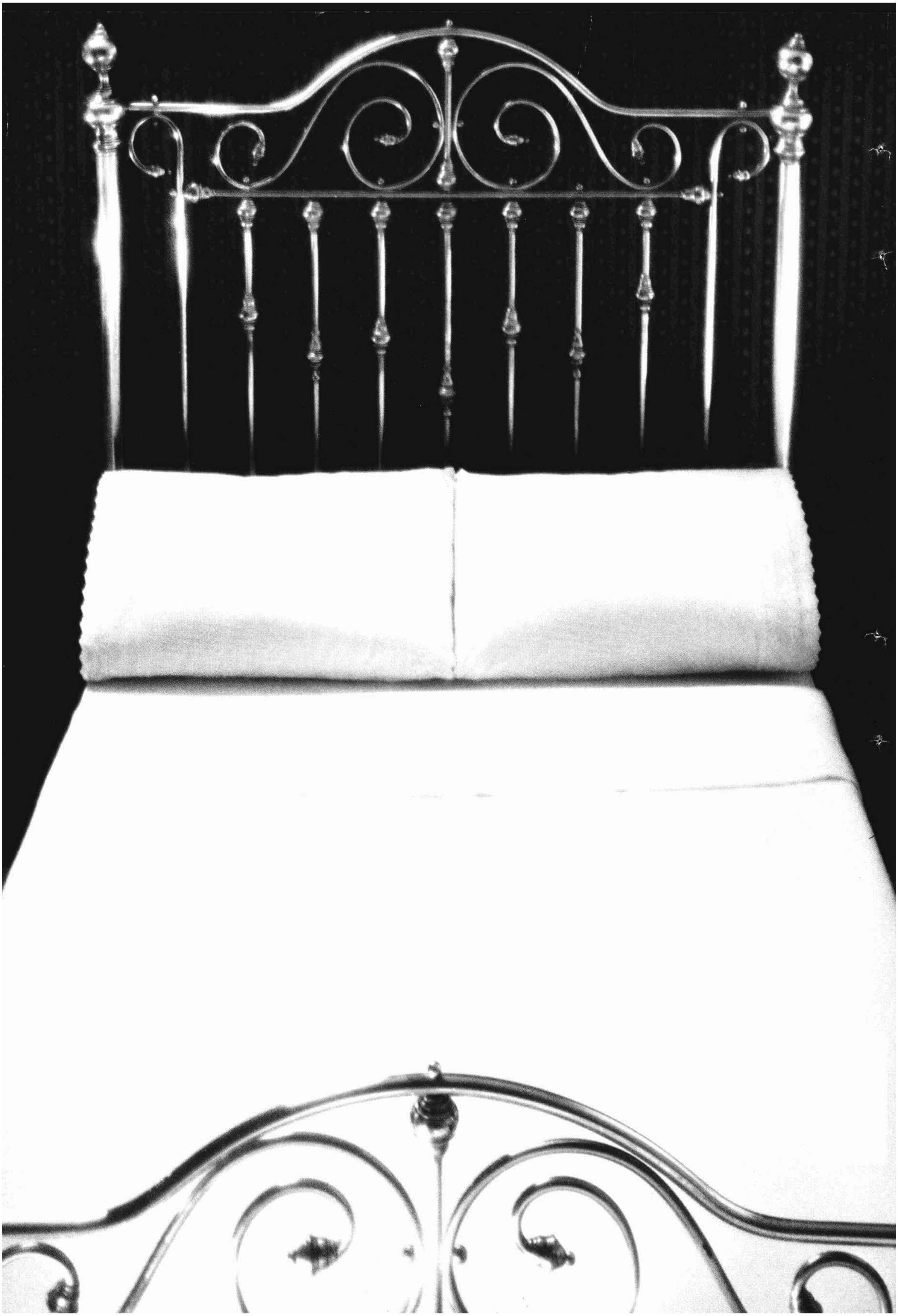
Kick-off session on opening day will focus on R&D management and will feature top coatings industry scientists who will offer perspectives on the research effort, from nurturing creativity to motivating and rewarding technical personnel. The closing program session features discussions on the effective use of computers in R&D. Accompanying these is a smorgasbord of technical helpings which should amply satisfy the appetites of coatings folks, including the Keynote Address by John P. McAndrews, Group Vice-President, F&FP Dept., E. I. du Pont de Nemours & Co., and the Mattiello Lecture by Ruth Johnston-Feller, Color Consultant, Mellon Institute.

Along with all that is the record-size Paint Show, which observes its 50th anniversary this year in St. Louis.

So, if you haven't made your arrangements yet, get to it pronto, then go back to enjoying what's left of the summer.

Thomas A. Kocis

Thomas A. Kocis,
Contributing Editor



A WHOLE NEW INDUSTRY WAS CONCEIVED HERE.

Over seven decades ago, an experimental coating made from phenolic resins was put on a brass bed to protect it from tarnish and corrosion, as well as to maintain the original lustre of the brass.

Needless to say, the experiment was a success. So much so that it started a whole new concept in high-performance coatings.

Today, our UCAR Phenolic Resins are used on everything from airplanes to zippers.

That's because they not only offer exceptional protection against corrosion, they also provide excellent abrasion resistance, outstanding chemical resistance, and good adhesive and electrical insulation properties. Plus, they're adaptable to a wide range of coatings technologies, such as high solids, powder, and waterborne. And, with most substrates, little or no surface preparation is required.

UCAR Phenolic Resins can also be used to upgrade the performance properties of alkyds, epoxies, and many other coatings resins.

To find out what UCAR Phenolic Resins can do for you, contact your local Union Carbide Sales Representative. Or write to Dept. K3442, Danbury, CT 06817.

Rest assured you'll like what we have to say.

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Abstracts of Papers in This Issue

DISPERSION OF (MAGNETIC) PIGMENT POWDERS IN ORGANIC LIQUIDS—H.F. Huisman

Journal of Coatings Technology, 57, No. 727, 49 (Aug. 1985)

The dispersion of a magnetic pigment in a liquid medium involves four distinct processes: (1) initial wetting of the pigment powder particles; (2) mechanical breaking down of the powder particles to a smaller size; (3) densifying the small but "aggregated" particles; and (4) displacement of air from the pigment particle surfaces and stabilization of the particles against flocculation.

The densification of the aggregates is a very important process in dispersing magnetic pigments, but there are strong indications that it occurs also in the dispersing process of nonmagnetic pigments. The densification process can be followed by determining the average effective particle density of the aggregates by means of mercury porosimetry measurements. If the pigment is dispersed in a high speed sand mill, the densification process follows kinetics, which are best described by a relation linear in log time. The initial part of the breakdown process can also be described by the same relation (linear in log time), but it slows down much earlier than the densification process. This indicates that the two processes are distinct.

The properties derived from flow curves, which were measured during the dispersion process, cannot be explained on the basis of pigment volume alone, as is done in most viscosity equations for semi-concentrated pigment dispersions. Also, the Mooney approach, which in some way takes into account the particle size, does not describe our flow data properly.

By introducing a particle size effect in the viscosity equation the change in properties, derived from the flow curves, can be understood. The effective pigment volume and the particle size are equally important for analysis of the flow data. The flow curve analysis can also be used to understand and optimize the dispersion process of inorganic pigments.

A NEW COMPUTATIONAL METHOD FOR DETERMINING THE SHEAR RATE DEPENDENT VISCOSITY OF COATINGS—H.H. Kuo

Journal of Coatings Technology, 57, No. 727, 57 (Aug. 1985)

A new mathematical model to determine coating viscosities over a wide range of shear rates has been developed. The method is based on a spring relaxation technique using a Brookfield viscometer to measure the drag forces in the coating material. The spring relaxation data was transformed into a three parameter mathematical model so that the data could be conveniently differentiated to obtain viscosity profiles. As a result, the viscosity profiles of a nonaqueous dispersion (NAD) lacquer at medium (10 sec-1) to ultra-low (0.001 sec-1) shear rates were determined. The general characteristics of these profiles are consistent with published data. In addition, this method has the capability of calculating the coating viscosity for both power law and Newtonian regions.

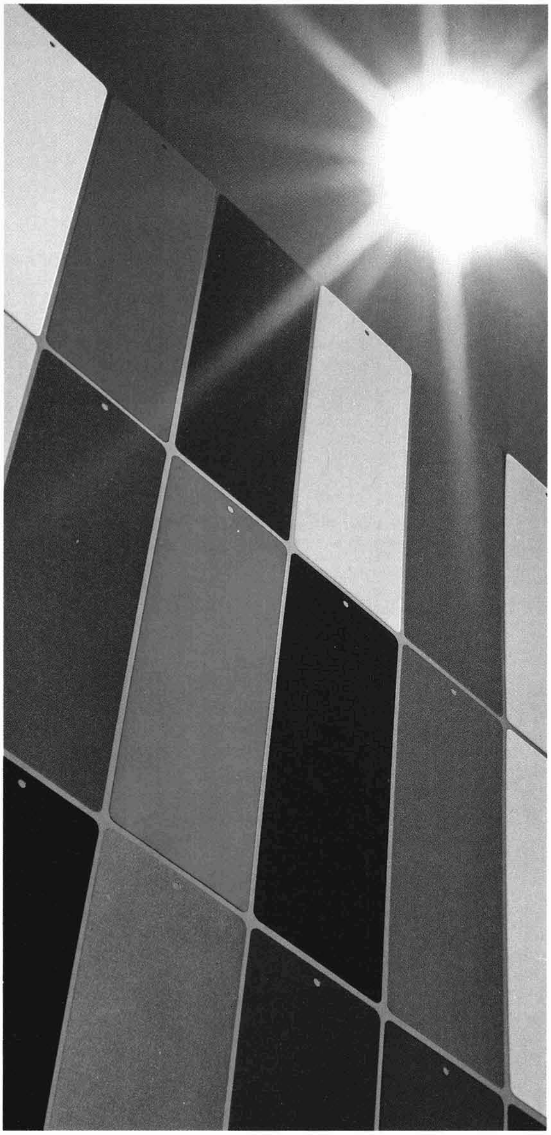
JCT September 1985

Official Convention Issue

On October 7-9, the Annual Meeting and Paint Industries' Show of the Federation of Societies for Coatings Technology will take place at the Cervantes Convention Center, in St. Louis, MO. Complete details covering this prestigious event will be announced in the September 1985 issue of the JOURNAL OF COATINGS TECHNOLOGY. Included in this feature issue will be Abstracts of Papers, expanded Exhibitor Listings, a detailed Floor Plan of the Exhibit Hall, plus more. Don't miss it!

In sunlight, coatings can die in months

With CIBA-GEIGY light stabilizers, they can live for years



Cracking, delamination and catastrophic failure often occur in coatings exposed to the sun. Consequently, the service life of both coating and substrate is shortened, and the cost of maintenance goes up.

Commercial use has shown that most types of coatings can be protected against photodegradation by two classes of CIBA-GEIGY light stabilizers.

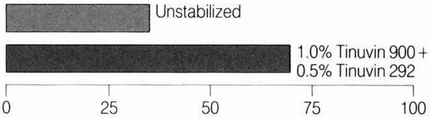
The first class is the hindered amine light stabilizers (HALS), such as Tinuvin® 292, Tinuvin 144 and Tinuvin 079L. They protect gloss and help prevent loss of physical properties that may result in chalking, erosion, water permeability and checking.

Ultraviolet light absorbers (UVA) such as Tinuvin 328, Tinuvin 900 and CGL-1130 are the other class. UVAs prevent UV light from degrading light-sensitive materials, especially primers, mildewcides and pigments. Thus, they protect performance characteristics, such as adhesion between primer and top coats. Depending on the pigment used, a UVA and HALS combination will improve color retention.

While a CIBA-GEIGY UVA or HALS by itself provides good protection for coatings, usage has shown that combinations of the two may give better results. This development is so important that CIBA-GEIGY has four patents* covering the use of HALS and combinations of HALS and UVAs in acrylic, polyester, alkyd and polyurethane coatings.

Percent 60° Gloss Retention After Two Years of Exposure

Sample: Two-Component Solid White Acrylic
Aliphatic Polyurethane Coating
Exposure: 5° South Florida Black Box



Manufacturers of maintenance, coil and powder coatings can now formulate their products to yield substantially longer service life.

For more information on light stabilization of coatings, call 800 431-1900 (in New York, 914 347-4700). Or write to: Additives Department, CIBA-GEIGY Corporation, Three Skyline Drive, Hawthorne, NY 10532.

U.S. Patent Nos. 4,314,933; 4,426,471; 4,426,472; and 4,344,876 assigned to CIBA-GEIGY Corporation.

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Abstracts of Papers in This Issue (Continued)

NEW CELLULOSIC POLYMERS FOR RHEOLOGY CONTROL OF LATEX PAINTS—K.G. Shaw and D.P. Leipold

Journal of Coatings Technology, 57, No. 727, 63 (Aug. 1985)

A process has been developed to enhance the rheological properties of cellulosics and other water-soluble polymers by chemically bonding small amounts of aliphatic hydrocarbon moities to the polymer backbone. This patented technology has created a new family of rheological modifiers. Hydrophobic modification of water-soluble polymers is exhibited in a number of macroscopic properties, such as increased solution viscosity, increased surface activity, and altered rheological properties.

Hydrophobically-modified hydroxyethylcellulose (HMHEC) has been designed for use in latex paints. These polymers have retained many of the desirable characteristics of cellulosic thickeners, and have superior rheological properties. This paper emphasizes the polymer's properties in solution and in a crowded, highly interactive system, such as a latex paint. Solution behavior and surfactant-interaction studies were used to discern the thickening mechanism. Sophisticated steady shear rheology analysis, over a wide shear rate, has been used to predict properties in a latex paint. Actual latex paint performance and application properties will also be discussed.

DISPERSION AND CLASSIFICATION EFFECTS IN A THREE-ROLL MILL—Y. Murakami, et al.

Journal of Coatings Technology, 57, No. 727, 73 (Aug. 1985)

Influence of the degree of particle dispersion on flow properties and the classification effect in the roll nip were investigated for roll milling of highly viscous suspensions. Seventeen kinds of commercial powders were dispersed into a linseed oil varnish with a three-roll mill, and the changes of the flow properties were measured. The rheological differences of these suspensions were classified into four groups and were discussed qualitatively in the light of the Casson's equation of viscosity.

Changes of densities and particle sizes of sample pastes which were scraped off the apron roll were measured to investigate the classification effect. It was found that low density samples having fine particles were scraped off at the beginning of scraping and that densities as well as particle sizes increased towards the end of scraping. The degree of classification could be correlated with the parameters obtained from the simulation.

STUDY OF INTERACTIONS BETWEEN WOOD AND WATER-SOLUBLE ORGANIC SOLVENTS—W.B. Smith, et al.

Journal of Coatings Technology, 57, No. 727, 83 (Aug. 1985)

Interactions between small cross-sectional wafers of basswood, eastern white pine, and radiata pine and several water-soluble organic solvents were investigated with the primary interest focused on the penetration and swelling of cell-wall capillaries. The water-soluble solvents used were ethylene glycol monobutyl ether (EGMBE), diethylene glycol monobutyl ether (DEGMBE), and ethylene glycol. Cell-wall capillary penetration was ascertained by measuring the residual volumetric swelling of the wood wafers after treatment and redrying.

Results have shown that these water-soluble organic solvents, when applied in aqueous solution, both penetrate and swell wood cell-wall capillaries, and can become entrapped to such an extent that prolonged oven drying does not remove them. The likelihood of this entrapment was found to increase with large molecular size and low evaporation rate of the solvent, and low relative humidity. The bulking is only temporary, however, because leaching with liquid water easily removes trapped solvent molecules.

'Big 50' Paint Show To Highlight St. Louis FSCT Meeting

The year was 1932 and America and the world were experiencing the crushing effects of the Great Depression. Businesses were fighting to survive and Franklin Roosevelt was elected to the first of his history-making four Presidential terms.

It was in this atmosphere that the leaders of the Federation decided to take a chance and experiment by bringing together at one place the suppliers to the coatings industry and their customers. The obvious time and place to hold such an event was at the Federation's annual gathering of members. That year, in Washington, D.C., twenty-five exhibitors took part in the first Paint Industries' Show.

The year is 1985 and, except for World War II (1942-45), the Paint Show has been a staple ingredient in the annual plans of both suppliers and coatings manufacturers for 50 years.

On October 7, 8, and 9, the Federation plans on celebrating the "Big 50" Paint Show in a big way. It will be the biggest in terms of exhibiting companies (240) and in exhibit area (56,200 sq. ft.) in its history. It will also be the biggest opportunity yet for all attending to gain information on the new materials, equipment, and services available to gain an edge in an increasingly complex marketplace.

Now for some interesting numbers:

- Of the 240 companies exhibiting, 184 exhibited in the 1984 Paint Show
- 47 have exhibited for 25 years or more
- 45 will be exhibiting for the first time.

The Federation is also pleased to note that Columbian Chemical Co., Rohm and Haas Co., and Union Carbide Corp. will be honored in St. Louis for their *fifty years* of participation in the Paint Industries' Show.

The current listing of exhibitors follows.

Aceto Chemical Co., Inc.
Advanced Coating Technologies; Inc.
Air Products and Chemicals, Inc.
Akzo Chemie America / Interstab Chemicals, Inc.
Alcan Powders & Chemicals
Allied Industrial Tank
C.M. Ambrose Co.
AMF Cuno, Gen. Filter Prod. Div.
Angus Chemical Co.
Anker Labelers Corp.
Applied Color Systems, Inc.
Arco Chemical Co.
Aries Software Corp.
Ashland Chemical Co., IC&S Div.
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Bowers Process Equipment, Inc.
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Cosan Chemical Corp.
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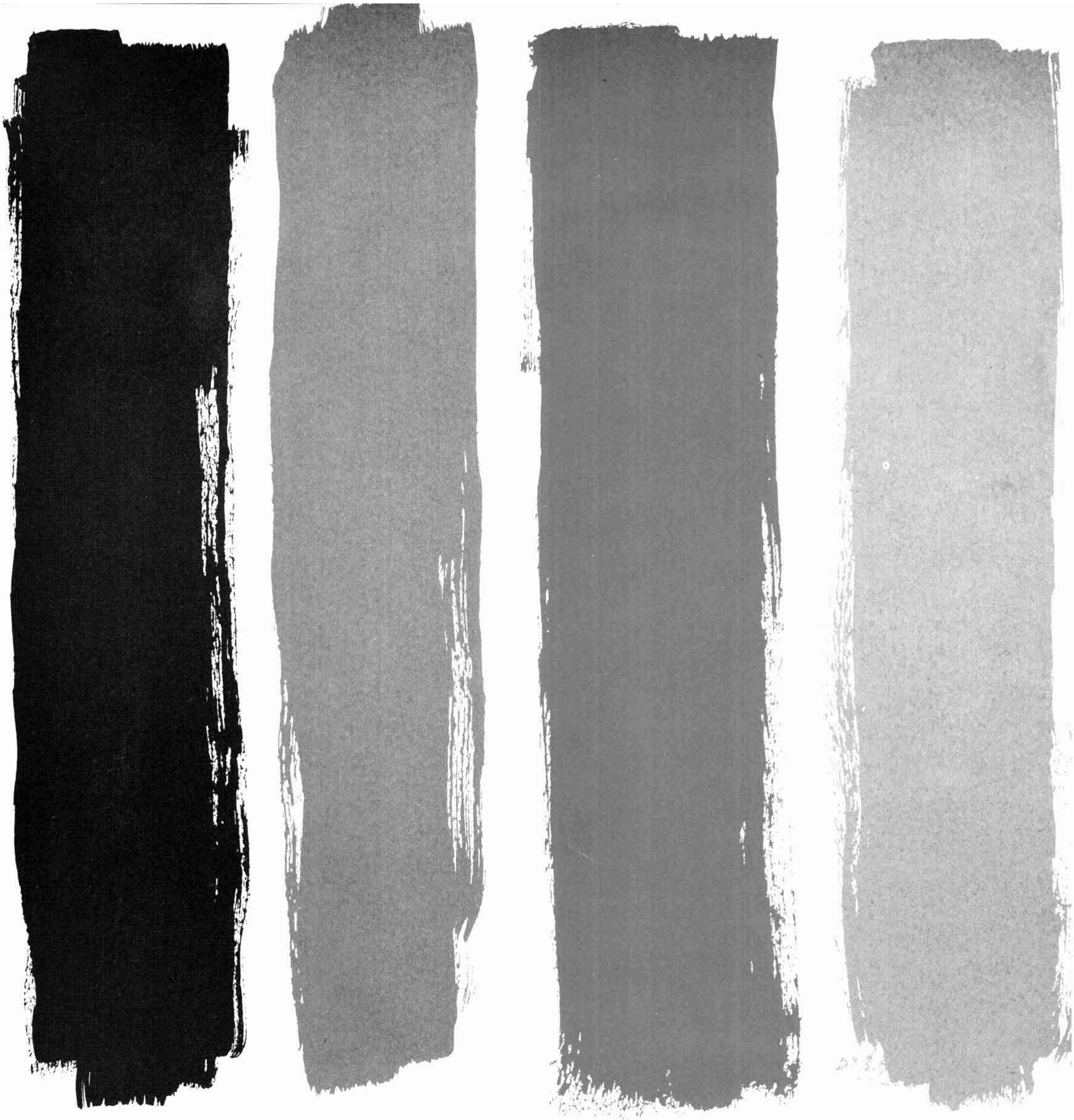
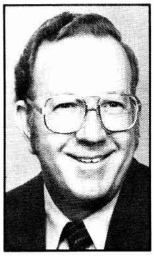
Wacker Chemical Co.
Warren Rupp-Houdaille, Inc.
Wilden Pump & Engineering Co.
Witco Chemical Co., Organics Div.

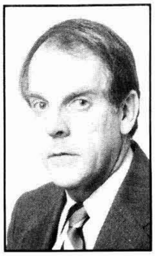
Zeelan Industries, Inc.



Carlos Dorris, of Dallas Society, and Deryk Pawsey of PNW, Are Nominated to Federation Officer Positions for 1985-86

Carlos E. Dorris, Plant Manager of Jones-Blair Co., Dallas, TX, has been nominated for the position of President-Elect of the Federation of Societies for Coatings Technology. Currently Treasurer of the Federation, Mr. Dorris is a Past-President of the Dallas Society and served as Society Representative to the Federation Board from 1977-1984. He was a member of the Paint Industries' Show Committee for five years and was also active on the Federation's Finance and Nominating Committees. Mr. Dorris is a graduate of the University of Texas, and has been employed with Jones-Blair for 22 years.


C.E. Dorris


D.R. Pawsey

Nominated for the position of Treasurer is Deryk R. Pawsey, of Rohm and Haas Canada, Vancouver, B.C. Mr. Pawsey is currently a member of the FSCT Executive Committee and a Trustee of the Paint Research Institute. In 1984 he received the George Baugh Heckel Award for his dedicated service to the Federation. A six-term Chairman of the Paint Industries' Show Committee, he also has served on the Federation's Finance, Technical Information Systems, and Corrosion Committees and was a member of the Editorial Review Board of the JOURNAL OF COATINGS TECHNOLOGY. Mr. Pawsey is a Past-President of the Pacific Northwest Society and has served as Society Representative to the Federation's Board since 1980. Educated in England, Mr. Pawsey is the British Columbia Area Manager for Rohm and Haas.

The current President-Elect, William Mirick, of Battelle Memorial Institute, Columbus, OH, will assume the Presidency at the close of the 1985 Annual Meeting, October 9, in St. Louis, MO.

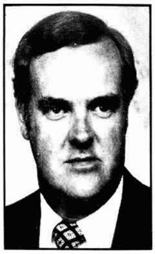
The Nominating Committee also submitted the names of the candidates for Board of Directors and Executive Committee positions.

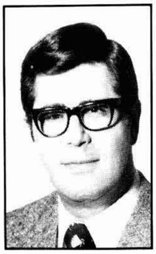
Executive Committee

Society Representatives to the Executive Committee:

Daniel Toombs, Vice-President of D.N. Lukens, Inc., Westboro, MA, has been nominated to serve a three-year term. Mr. Toombs has served on the Mattiello Lecture Committee and the Federation's Nominating Committee. Within the New England Society, he was elected twice as President and has served on various committees. Mr. Toombs is a graduate of Northeastern University.

Kurt F. Weitz, Product Manager for Extender and Filler Products at Indusmin, Ltd., Toronto, Ontario, has been nominated to serve a one-year term of office to fill the unexpired term of Deryk Pawsey. Active on the Roon Awards Committee for six years, Mr. Weitz also served on the Federation's Finance Committee. He is a Past-President of the Toronto Society, and since 1981, has served as the Society Representative to the Federation Board. A graduate of the University of Toronto, Mr. Weitz has been employed by Indusmin for 17 years.

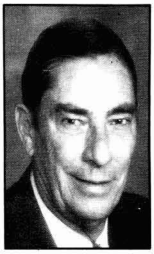

D. Toombs

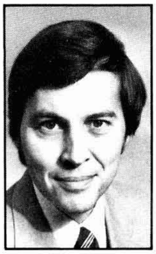

K.F. Weitz

Board of Directors

Board of Directors as Past-President Member—(Two-year term):

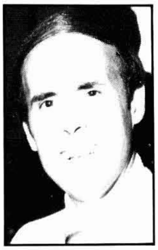
J.C. Leslie, Past-President of the Federation (1974-75) and the Kansas City Society (1957-58). From 1968-72, Mr. Leslie served as the Society's Representative to the Federation Board. He has also headed the Federation's Corrosion Committee and in 1984 was elected to Federation Honorary Membership. Employed with Tnemec Co., Kansas City, MO, for 22 years, Mr. Leslie retired as Vice-President of the firm in 1979.


J.C. Leslie


R.M. Hille

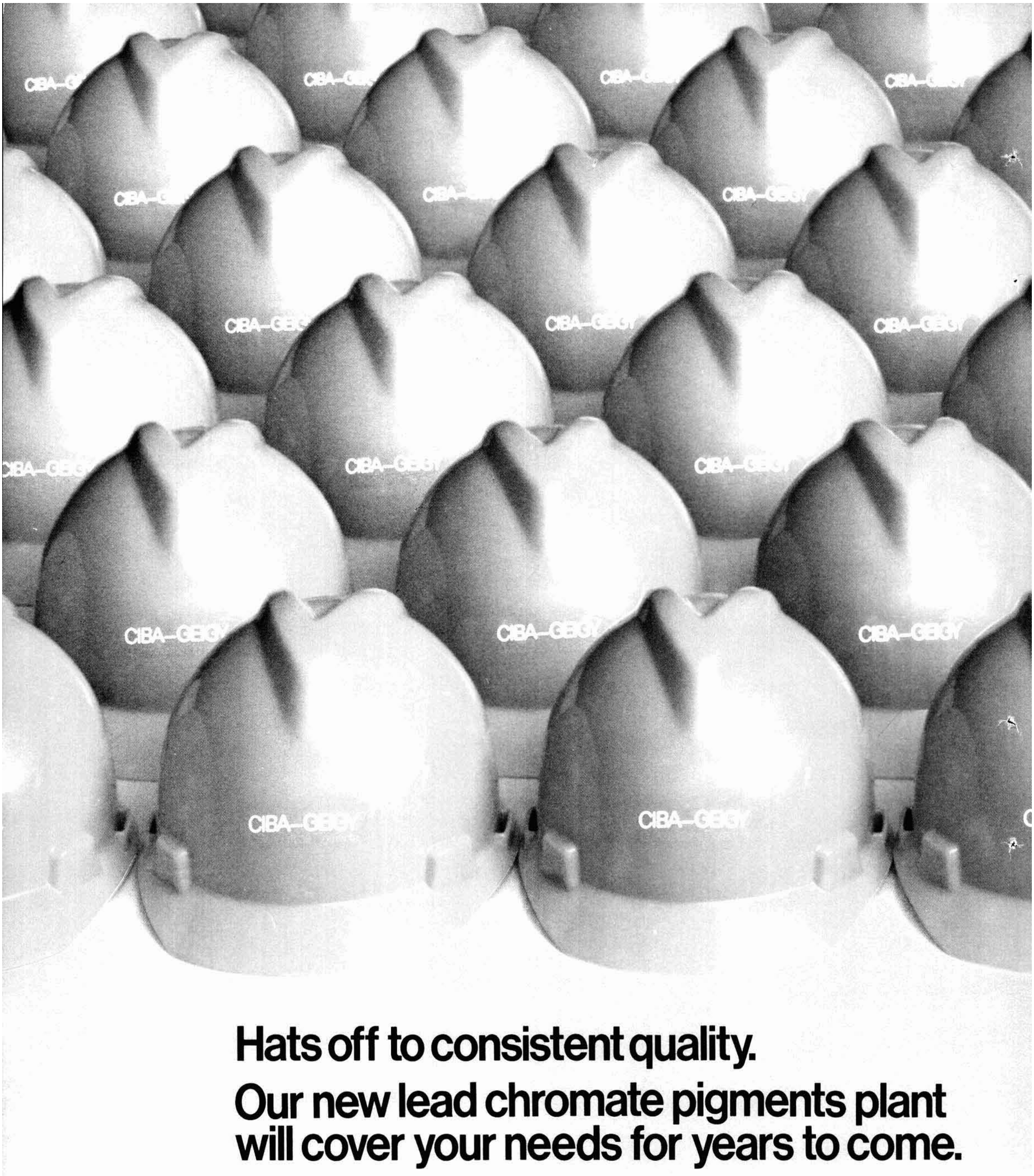
Board of Directors as Members-at-Large—(Two-year term; two to be elected):

Richard M. Hille, Manager of Manufacturing at General Paint and Chemical Co., Cary, IL. A Past-President of the Chicago Society, Mr. Hille chaired the 1984 Annual Meeting Host Committee and has served on the Federation's Professional Development and Membership Committees. Mr. Hille graduated from the University of Kansas and has worked for 17 years in the coatings industry.


J.A. Lanning

John A. Lanning, of Porter Paint Co., Louisville, KY. Mr. Lanning currently heads the Federation's Society Speaker Awards Committee and is a member of the Paint Show Committee. A Past-President of the Louisville Society (1983-84), he has also served on the Society's Membership and Technical Committees. Educated at the University of Louisville, Mr. Lanning is Product Quality Manager for Porter Paint, where he has been employed for seven years.

Elections will take place during the Board of Directors meeting on October 6 in St. Louis.


CIBA-GEIGY


CIBA-GEIGY

Preemption of State and Local Laws Upheld In Court's Decision on OSHA Hazard Communication Rule

In a decision handed down in the U.S. Court of Appeals for the Third Circuit recently, the court held that the OSHA Hazard Communication rule issued in November 1983 preempts all state and local worker right-to-know laws that operate in the manufacturing sector.

J. Andrew Doyle, Counsel for the National Paint and Coatings Association, which had intervened in the suit on behalf of OSHA, called the verdict "A major victory for the paint industry." The suit, United Steelworkers *v.* Auchter, had challenged several provisions of the standard, including its preemptive authority.

The court decision would require OSHA to expand application of the standard beyond Standard Industrial Codes 20-39 (those codes that represent the manufacturing sector) unless the agency can give the court good reasons not to do so. Mr. Doyle stated that expansion of the rule's authority could extend the standard to cover such related industries as painting contractors, auto body shops, and retail outlets, and that if so, the federal rule would presumably preempt state and local laws that currently apply to such establishments.

The decision also requires that the trade secrets provisions of the standard be revised to include access by non-health professionals, such as employees and their representatives, and that chemical identity would no longer be protected under those provisions.

Mr. Doyle predicted that some of the states will ignore the court's decision and proceed with implementation of their own worker right-to-know laws. In such cases, he said, NPCA is prepared to file motions to enjoin the states from enforcing such laws, since they are preempted under the federal standard.

The court decision upholding the preemptive powers of the OSHA rule, Mr. Doyle said, will facilitate full use of NPCA's Hazardous Materials Identification System in the manufacturing sector, since HMIS is specifically cited in the preamble to the rule as an acceptable means of compliance.

Inmont to Begin Construction of Paint Applications Lab

Inmont Corp., Clifton, NJ, recently broke ground for a $15 million, 55,000 sq ft Applications Laboratory in Southfield, MI. When completed in early 1986, the facility will become the world's only robotized auto paint applications laboratory that is fully associated with an automotive finishes research center.

According to J. Larry Jameson, Senior Vice-President, Inmont Worldwide Automotive Coatings, the plant is intended to provide a "real-world" testing environment for paint application techniques. It will house two full-sized paint lines, one for spray and the other for electrodeposition of paints and coatings.

In addition to its research uses, the new facility will serve as a paint applications training site for Inmont's technical service personnel, as well as for their customers' personnel.

NL Chemicals Purchases Victor Wolf Ltd.

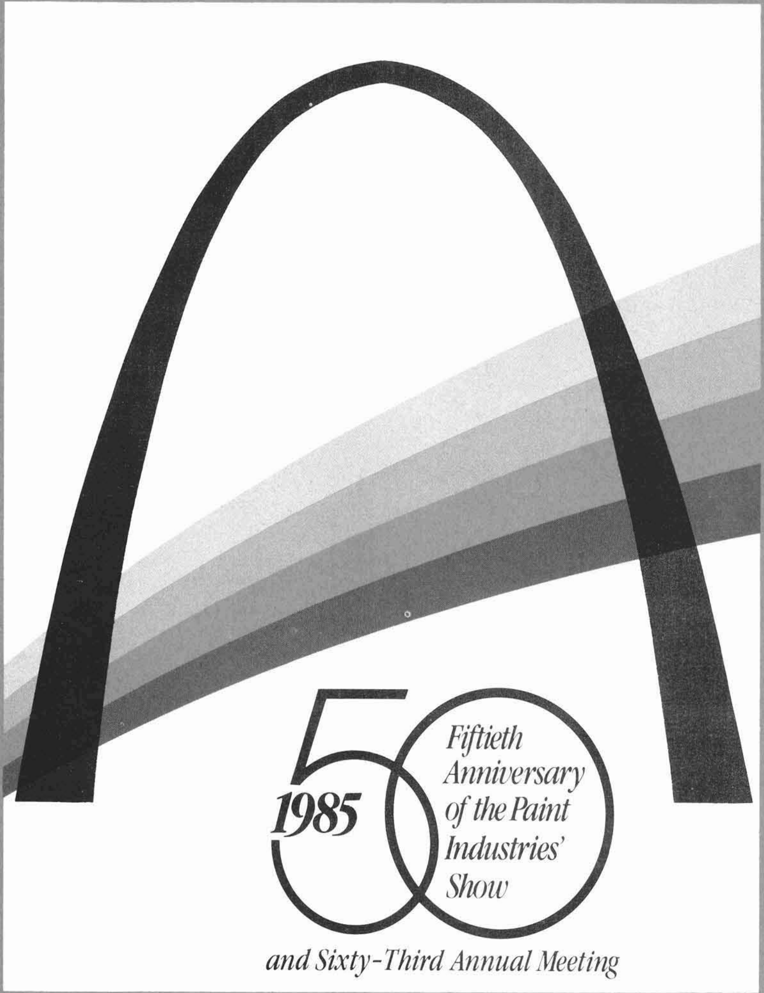
NL Chemicals/NL Industries, Inc., Hightstown, NJ, has announced the acquisition of Victor Wolf Industries Ltd., a United Kingdom-based producer of polyamide resins, plastics additives, and other specialty chemicals.

Victor Wolf's production facility, constructed in 1979, is located in Bedlington, on the northeast coast of England. Its polyamide resins are used as vehicles for packaging and flexogravure inks, in hot melt adhesives, and in the production of thixotropic alkyd resins. The company also produces epoxy resin curing agents, plasticizers, and heat stabilizers for PVC applications, polyols for the manufacture of polyurethane adhesives, and other specialty chemicals.

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY

Preliminary Program

"COATINGS R & D: TODAY'S INVESTMENT IN TOMORROW"



CERVANTES CONVENTION CENTER
ST. LOUIS, MISSOURI OCTOBER 7-9

Preliminary Program

MONDAY, OCTOBER 7

OPENING SESSION

(10:00)

Sixty-Third Annual Meeting of the Federation of Societies for Coatings Technology opened by President Joseph A. Bauer

Invocation: The Most Reverend George Gottwald, Auxiliary Bishop of St. Louis

Welcome: Charles L. Grubbs, President of St. Louis Society for Coatings Technology

Howard Jerome, Chairman of the Host Committee

Joseph A. Vasta, Chairman of the Program Committee

John C. Ballard, Chairman of the Paint Industries' Show Committee

Introduction of Distinguished Guests

A salute to raw material and equipment suppliers to the coatings industry.

E.W. FASIG KEYNOTE ADDRESS

(10:30-11:30)

TUNG OIL TO GROUP TRANSFER POLYMERIZATION—John P. McAndrews, Group Vice-President, Finishes and Fabricated Products Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, DE

R & D MANAGEMENT SYMPOSIUM

(2:00-5:00)

Often overlooked in industrial research is the importance of attendant factors which strongly influence the success or failure of the technical effort. This session examines some of these factors, ranging from techniques to start the creative juices flowing to the motivation and rewarding of technical personnel.

Moderator—Percy Pierce, Manager of Physical/Analytical Research, PPG Industries, Inc., R & D Center, Allison Park, PA

COATINGS TECHNOLOGY—HIGH TECH, LOW RESPECT—Marco Wismer, Vice-President of Science and Technology, PPG Industries, Inc., Pittsburgh, PA

THE PIONEERING RESEARCH EXPERIENCE AT ROHM AND HAAS—William D. Emmons, Director of Pioneering and Specialty Chemicals Research, Rohm and Haas Co., Spring House, PA

CREATIVE THINKING AND PROBLEM SOLVING—THEIR APPLICATION TO BUSINESS AND MANAGEMENT—John S. Ostrowski, Research Director, The Valspar Corp., Minneapolis, MN

MAKING THE DUAL LADDER WORK IN MONSANTO'S TECHNICAL COMMUNITY—William E. Koerner, Director, Physical and Environmental Sciences Centers, Central Research Laboratories, Monsanto Co., St. Louis, MO

PUTTING THE "R" INTO PRODUCT AND PROFIT—Peter V. Robinson, Associate Director, Polymer and Coatings Research, Glidden Coatings & Resins, Div. of SCM Corp., Strongsville, OH

MANUFACTURING THE NEXT GENERATION OF COATINGS

(2:00-5:00)

Panel of speakers will discuss various aspects of the manufacturing process, including automating the paint plant, trade sales and industrial water-bornes, and high-solids vs. conventional.

Registration Hours

Sunday, October 6 .... 1:00 pm-5:00 pm

Monday, October 7 .... 8:00 am-5:30 pm

Tuesday, October 8 .... 8:00 am-5:30 pm

Wednesday, October 9 .... 8:00 am-3:00 pm

TUESDAY, OCTOBER 8

PHYSICAL CHEMISTRY OF COATINGS

(9:00-11:00)

MECHANICS OF ELECTROSTATIC ATOMIZATION, TRANSPORT, AND DEPOSITION OF COATINGS—Guy C. Bell, Jr., Research Associate, E. I. du Pont de Nemours & Co., Inc., Marshall R & D Laboratory, Philadelphia, PA

THE INFLUENCE OF FINE-PARTICLE SIZE EXTENDERS ON THE OPTICAL PROPERTIES OF LATEX PAINTS—Luigi Cutrone, Supervisor, Application Development, Tioxide Canada Inc., Sorel, Quebec, Canada (A Roon Awards competition paper)

PHOTODEGRADATION OF MELAMINE-ACRYLIC COATINGS—Richard C. Wilson, Technical Leader, Fundamental Sciences Section, Specialty Resins R & D, Monsanto Polymer Products Co., Springfield, MA

DYNAMIC PROPERTIES AND PERFORMANCE OF THERMOSET FILMS—Loren W. Hill, Science Fellow, Monsanto Polymer Products Co., Springfield, MA

CORROSION AND ADDITIVES

(9:30-11:30)

ACCELERATED NATURAL CORROSION TESTING—Civilingenior Helge Meyer, NIFAB, Malmo, Sweden, and Civilingenior Ago Saarnak and Klaus Lampe, Scandinavian Paint and Printing Ink Research Institute, Horsholm, Denmark (Presented on behalf of SLF: Federation of Scandinavian Paint and Varnish Technologists)

CATIONIC ELECTRODEPOSITION PRIMERS OVER ZINC COATED STEELS (PART I): EFFECT OF VOLTAGE AND SUBSTRATE ON COATING QUALITY—Clifford K. Schoff, Scientist, Coatings and Resins, PPG Industries, Inc., R & D Center, Allison Park, PA

AN INVESTIGATION OF MICROENCAPSULATED FUNGICIDES FOR USE IN EXTERIOR TRADE SALES PAINTS—G. K. Noren, M. F. Clifton, and A. H. Migdal, DeSoto, Inc., Administrative and Research Center, Des Plaines, IL (A Roon Awards competition paper)

URETHANE-FUNCTIONAL ALKALI-SOLUBLE ASSOCIATIVE LATEX THICKENERS—G. D. Shay and A. F. Rich, DeSoto, Inc., Administrative and Research Center, Des Plaines, IL (A Roon Awards competition paper)

RHEOLOGY

(9:00-12:00)

PRINCIPLES AND RHEOLOGY OF ADHESION—A. N. Gent, The University of Akron, Akron, OH

PREDICTING PERFORMANCE OF COATINGS OPERATIONS WITH COMPUTER-ASSISTED FINITE ELEMENT MATHEMATICS—L. E. Scriven and C. W. Macosko, Dept. of Chemical Engineering and Materials Science, University of Minnesota, Minneapolis, MN

MODELING OF THERMOSET OVEN-CURING INCLUDING FLOW AND EVAPORATION EFFECTS USING FINITE ELEMENT ANALYSIS—R. L. Mullen and M. J. Braun, Dept. of Chemical Engineering, Case Western Reserve University, Cleveland, OH

POLYVINYLACETATE LATEX DESIGN AND RHEOLOGICAL PERFORMANCE IN LATEX PAINTS—A. Rudin, University of Waterloo, Waterloo, Ontario, Canada

EFFECT OF MOISTURE AGING ON DISPERSIBILITY OF CARBON BLACK, KAOLIN, AND TITANIUM DIOXIDE DISPERSED IN POLYBUTENE AND 1,2,6 HEXANETRIOL MEASURED BY SHEAR SENSITIVITY—Jen-Ten Kuo, Raymond R. Myers, Carl J. Knauss, and Richard J. Ruch, Kent State University, Kent, OH

THE CONTRIBUTIONS OF DYNAMIC UNIAXIAL EXTENSIONAL VISCOSITIES TO TRADE-SALES ROLL AND INDUSTRIAL ROLL AND SPRAY APPLICATION PERFORMANCE—R. H. Fernando and J. E. Glass, North Dakota State University, Fargo, ND (A Roon Awards competition paper)

SOCIETY PAPERS

(2:00-4:00)

THE CORRELATION OF RESULTS FROM "COLOR-MATCHING APTITUDE TEST" SCORES—Birmingham Paint, Varnish & Lacquer Club. Presented by B. J. Addenbrooke, Croda Paints Limited, Birmingham, England

IMPLEMENTATION OF LABORATORY PAINT FORMULA CALCULATIONS ON AN APPLE II MICROCOMPUTER—Los Angeles Society for Coatings Technology. Presented by James D. Hall, Sinclair Paint Co., Los Angeles, CA

CRYSTALLINE SILICA AS A GRINDING AID IN HIGH SPEED PIGMENT DISPERSION—Los Angeles Society for Coatings Technology. Presented by Kirke Aokes, Baldwin Park, CA

INFLUENCE OF RHEOLOGY MODIFIERS ON PERFORMANCE CHARACTERISTICS OF LATEX PAINTS—Montreal Society for Coatings Technology. Presented by John Hall, Tioxide of Canada Ltd., Montreal, Canada

COATING TECHNOLOGY

(2:00-4:30)

THE NEW PAINT TECHNOLOGY FOR THE 80'S AND BEYOND—Alan D. McInnes, Managing Director, Vapocure Limited, Sydney, Australia (Presented on behalf of Oil and Colour Chemists' Association—Australia)

EFFECT OF POLYESTER CARBOXYL AND HYDROXYL END GROUP BALANCE IN ISOCYANATE CURING POWDER COATINGS—Louis T. Camilleri, Vice-President for Technical Activities, Ruco Polymer Corp., Hicksville, NY

HIGH SOLIDS HYBRID THERMOSET COATINGS—Ellsworth E. Faust, Marketing-Technical Development Laboratory, Celanese Chemical Co., Inc., Summit, NJ

THE EFFECT OF α-METHYL GROUPS ON ROOM TEMPERATURE CROSSLINKING IN ACRYLIC POLYMERS CONTAINING MAGME MONOMERS—H. R. Lucas, Research Chemist, American Cyanamid Co., Stamford Research Laboratories, Stamford, CT (A Roon Awards competition paper)

THE EFFECT OF COBALT DRIERS ON THE DRYING AND THE POST-CURE EMBRITTLEMENT OF PALE BODIED VARNISH LINSEED OIL IN MINERAL SPIRITS AND 1,1,1-TRICHLOREOTHANE—Esin Gunay, Laboratory Assistant, The Sherwin-Williams Co., Cleveland, OH, and Harvest L. Collier, Assistant Professor, Dept. of Chemistry, University of Missouri—Rolla, Rolla, MO

WEDNESDAY, OCTOBER 9

PIGMENTS/DISPERSIONS

(9:00-10:30)

PIGMENT DISPERSIONS: RECENT DEVELOPMENTS IN THE USE OF A-B BLOCK POLYMERS AS DISPERSANTS FOR NON-AQUEOUS SYSTEMS—Henry L. Jakubauskas, Research Associate, E. I. du Pont de Nemours & Co., Inc., Marshall R & D Laboratory, Philadelphia, PA

STRUCTURE AND PROPERTIES OF AMORPHOUS SILICA GEL IN COATINGS APPLICATIONS—Leon Kutik, Davison Chemical Div., W. R. Grace & Co., Technical Center, Baltimore, MD

NATURAL SILICAS IN COATINGS—Walter J. Polestak, Group Leader, Paints and Polymers Laboratory, and Thomas D. Thompson, Director of Research, Specialty Applications, Georgia Kaolin Co., Springfield, NJ

SOLVENTS

(9:00-10:30)

SOLVENT FORMULATION FOR SAFETY IN TOMORROW'S WORLD—Harold L. Jackson, Research Associate, Intermediates Div., Petrochemicals Dept., E. I. du Pont de Nemours & Co., Inc., Experimental Station, Wilmington, DE

THE ROLE OF AZEOTROPY IN SPEEDING UP WATER/SOLVENT EVAPORATION IN HUMID AIR—Albert L. Rocklin, Senior Research Chemist, Shell Development Co., Westhollow Research Center, Houston, TX (A Roon Awards competition paper)

THE PREPARATION AND EVALUATION OF ALKYD RESINS THAT COMPLY WITH SOLVENT RESTRICTIVE REGULATIONS—James Stoffer, John Gordon, and Karen Beckmann, University of Missouri—Rolla, Rolla, MO

MATTIELLO MEMORIAL LECTURE

(10:30-11:30)

REFLECTIONS ON THE PHENOMENON OF FADING—Ruth Johnston-Feller, Consultant in Color Science, Research Center on the Materials of the Artist and Conservator, Mellon Institute, Pittsburgh, PA

AWARDS LUNCHEON

(11:45)

Grand Ballroom, Sheraton St. Louis Hotel

Presentation of these awards: George Baugh Heckel ... Paint Show ... Roon Foundation ... American Paint & Coatings Journal/A. F. Voss ... Materials Marketing Associates ... Program Committee ... Ernest T. Trigg

Featured Speaker: Jim Valvano, Head Basketball Coach, North Carolina State University

EFFECTIVE USE OF COMPUTERS IN R & D

(2:00-5:00)

Moderator—Theodore Provder, Principal Scientist, Polymer Research and Computer Science Group, Glidden Coatings & Resins, Div. of SCM Corp., Strongsville, OH

ON-LINE INFORMATION RETRIEVAL: A POWERFUL INTELLIGENCE GATHERING TOOL FOR THE COATINGS INDUSTRY—Joanne Witiak, Information Specialist, Research Div., Rohm and Haas Co., Spring House, PA

APPLICATIONS OF COMPUTER DATA BASE MANAGEMENT IN POLYMER AND COATINGS RESEARCH—Mark E. Koehler, Group Leader, Instrumentation and Computer Science, Glidden Coatings & Resins, Div. of SCM Corp., Strongsville, OH

THE NEXT STEP IN LABORATORY AUTOMATION—ROBOTICS—Steve Pull, Zymark Corp., Zymark Center, Hopkinton, MA

USE OF RS-1, "AN ELECTRONICS NOTEBOOK," IN A COATINGS LABORATORY—Timothy D. Costello, Research Chemist, Finishes & Fabricated Products Dept., E. I. du Pont de Nemours & Co., Inc., Experimental Station, Wilmington, DE

CAF-COMPUTER AIDED FORMULATION—Donald S. Andrade, President, DSA Consulting, Inc., Mission, KS

ANNUAL BUSINESS MEETING

(4:00-5:00)

Annual Business Meeting of the Federation

Installation of Officers, 1985-86

OTHER CONVENTION INFORMATION

PAINT INDUSTRIES' SHOW

The 50th Anniversary Paint Industries' Show will be held in conjunction with the Annual Meeting. The 1985 Paint Show is the largest, by far, in Federation history with 240 companies occupying over 56,000 sq. ft. of exhibit space at Cervantes Convention Center.

The Show is the only national exhibit of raw materials and equipment used in the manufacture of paints and related coatings, and participating firms will have their top technical personnel on hand to discuss the latest developments in coatings manufacturing technology.

Exhibit hours will be 12:00 to 5:30 pm on Monday, October 7; 9:30 am to 5:30 pm on Tuesday, October 8; and 9:30 am to 3:00 pm on Wednesday, October 9.

REGISTRATION FEES

Advance registration is available for $50 for members and $65 for non-members. Fee for spouses' activities is $35 in advance.

There will be a special registration fee of $25 each for retired members and their spouses. This applies to advance registration only.

On-site registration will be $60 for full time and $40 for one day for members. Non-member fees will be $75 for full time and $50 one day. Spouses registration will be $45 on-site.

Registration forms were mailed to all members in April and are included in this issue (see pages 27-31).

SPOUSES PROGRAM

Included in the spouses registration fee will be a get-acquainted social on Monday afternoon and continental breakfast on Tuesday and Wednesday at the Sheraton St. Louis Hotel. A tour of St. Louis' historic homes and of the spectacular St. Louis Cathedral will also be featured.

FEDERATION ANNUAL AWARDS LUNCHEON

The Federation Awards Luncheon will be held Wednesday at the Sheraton St. Louis Hotel.

Presentations will be made to the recipients of the George Baugh Heckel Award (outstanding individual who has contributed to the advancement of the Federation), the Flynn Awards (firms judged to have the best exhibit booths in the 1985 Paint Industries' Show), the Roon Awards Competition awards, other Annual Meeting awards, and special presentations.

Featured speaker at the Luncheon will be Jim Valvano, Head Coach of the North Carolina State University basketball team.

CO-HEADQUARTERS HOTELS

Co-headquarters for the Annual Meeting will be the Sheraton St. Louis Hotel and the Marriott Pavilion Hotel. Other hotels with blocks of rooms set aside for the Annual Meeting are: Bel Air Hilton, Best Western, Clarion, Embassy Suites, Holiday Inn Market St., Holiday Inn Riverfront, Mayfair, Omni-Union Station, Radisson St. Louis, Rodeway Inn, and University Plaza.

ROOM RESERVATIONS

All requests for rooms and suites must be sent to the Federation office on the official housing form which has been mailed to all members and is included in this issue (see pages 27-31.) Additional housing forms are available from the Federation headquarters office.

PROGRAM STEERING COMMITTEE

Joseph A. Vasta, of the DuPont Co., F&FP Dept., Wilmington, DE, is the Chairman of the Federation's Program Committee.

Assisting Chairman Vasta in development of the Annual Meeting program are: Percy Pierce (Vice-Chairman), PPG Industries, Inc., Allison Park, PA; Taki Anagnostou, Akzo Coatings America, Inc., Troy, MI; Richard Eley, Glidden Coatings & Resins Div., SCM Corp., Strongsville, OH; William H. Ellis, Chevron Research Co., El Segundo, CA; James Lee, Lanchem Corp., E. St. Louis, IL; Stanley LeSota, Rohm and Haas Co., Spring House, PA; John S. Ostrowski, Valspar Corp., Minneapolis, MN; and David Richie, Midland Div. of Dexter Corp., Waukegan, IL.

Shown above is the famous Gateway Arch. In the background is Busch Stadium.

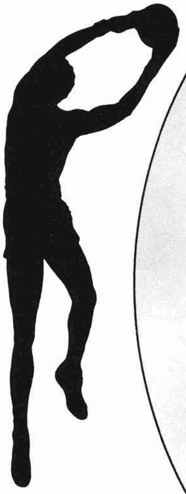
Plan to Attend the

Federation Annual Awards Luncheon

at the

Sheraton St. Louis Hotel • October 9th

Featuring Speaker



JIM VALVANO

Head Basketball Coach • North Carolina State University

Tickets — $20 per person

In advance or at Registration
during Annual Meeting

1985 ADVANCE REGISTRATION

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY

1315 Walnut St., Philadelphia, PA 19107

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V

Office Use Only

Date received ____________

Amount $ ____________

Check No. ____________

Please fill out this form and mail with a check in the correct amount (made payable to the FSCT) to the Federation address shown above. All checks must be payable in U.S. Funds. Any that are not will be returned. DEADLINE DATE FOR ADVANCE REGISTRATION IS SEPTEMBER 6. NONE WILL BE ACCEPTED AFTER THAT DATE.

A $10.00 charge will be made for cancellations received prior to September 6. No refunds will be made after that date.

INDUSTRY REGISTRATION FEES:

A ☐ MEMBER **$50.00**

Please name the Federation Society in which you are a paid-up member:

____

Federation Constituent Society

B ☐ NON-MEMBER **$65.00**

G ☐ SPECIAL FEE FOR RETIRED MEMBERS **$25.00**

____

Federation Constituent Society

INFORMATION FOR REGISTRATION BADGE:

NICKNAME

FIRST NAME

LAST NAME

BUSINESS AFFILIATION

STREET

CITY

STATE *(U.S. only)*

MAILING ZONE

COUNTRY (OTHER THAN U.S.)

BUSINESS CLASSIFICATION DATA FOR THE ABOVE REGISTRANT:

YOUR COMPANY (CHECK ONE BLOCK ONLY)

AA ☐ Manufacturers of Paints, Varnishes, Lacquers, Printing Inks, Sealants

BB ☐ Manufacturers of Raw Materials

CC ☐ Manufacturers of Equipment and Containers

DD ☐ Sales Agent for Raw Materials and Equipment

EE ☐ Government Agency

FF ☐ Research/Testing/Consulting

GG ☐ Educational Institution/Library

HH ☐ Paint Consumer

JJ ☐ Other

YOUR POSITION (CHECK ONE BLOCK ONLY)

KK ☐ Management/Administration

LL ☐ Manufacturing and Engineering

MM ☐ Quality Control

NN ☐ Research and Development

PP ☐ Technical Sales Service

QQ ☐ Sales and Marketing

RR ☐ Consultant

SS ☐ Educator/Student/Librarian

TT ☐ Other

SPOUSES REGISTRATION AND INFORMATION FOR REGISTRATION BADGE:

D ☐ SPOUSE **$35.00**

SPECIAL FEE FOR THE SPOUSES OF RETIRED MEMBERS ONLY:

H ☐ **$25.00**

NICKNAME

NAME

ADDRESS

CITY

STATE

MAILING ZONE

COUNTRY (OTHER THAN U.S.)

TICKETS FOR FEDERATION LUNCHEON, WEDNESDAY, OCTOBER 9 (@ $20.00)

Z ☐ NUMBER REQUIRED: ____________

$20.00 EACH.

A CHECK IN THE AMOUNT OF:

$ ____________

IS ENCLOSED

Federation of Societies for Coatings Technology

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PAINT STONE
1737

1985 Annual Meeting
Paint Industries' Show
October 7, 8, 9
Cervantes Convention Center
St. Louis, Missouri

TO OUR MEMBERS AND FRIENDS:

With much pleasure, I invite all those associated with the coatings manufacturing industry to attend the Federation's 63rd Annual Meeting and 50th Paint Industries' Show in St. Louis, October 7–9.

In 1972, the Federation marked the 50th Anniversary of its founding. In 1985, we reach another milestone with the Golden Jubilee of the Paint Show, the largest and finest exhibit of materials, equipment, and services for paint and coatings manufacturers.

The "Big 50" Paint Show will indeed be that—and another record-breaker.

Matching the Show in quality of content will be the Program Sessions under the chairmanship of Joseph A. Vasta. And how significant and timely is the theme: "Coatings R&D: Today's Investment in Tomorrow."

I am pleased that our 1985 convention will get underway on a high note with the Monday morning Keynote Address by John P. McAndrews, Group Vice-President, F&F Products Dept., DuPont Co.

Come join us in St. Louis for the Big Show, the Big Program, and a Learning Experience well worth your time.

Joseph a Bauer

Joseph A. Bauer
President, FSCT

FSCT 1985 ANNUAL MEETING AND PAINT INDUSTRIES' SHOW
CERVANTES CONVENTION CENTER, ST. LOUIS, MISSOURI
OCTOBER 7, 8, 9 (Monday, Tuesday, Wednesday)

APPLICATION FOR HOTEL ACCOMMODATIONS

THE BIG 50
1985
Fiftieth Anniversary of the Paint Industries' Show
and Sixty-Third Annual Meeting
CERVANTES CONVENTION CENTER
ST. LOUIS, MISSOURI OCTOBER 7–9

MAIL TO:
Fed. Socs. Coatings Tech.
1315 Walnut St.—Dept. H
Philadelphia, PA 19107

Please indicate below the type of accommodations requested and choice of hotels. All reservations will be processed by the Housing Bureau of the St. Louis Convention & Visitors Bureau. Hotel assignments will be made in accordance with prevailing availability. The Housing Bureau will send you an acknowledgment, noting the hotel to which you have been assigned. (Bureau telephone # 314-421-1166). The confirmation of your reservation will come to you directly from the hotel, to whom you must direct all inquiries (phone numbers in this brochure).

All reservations will be held until 6:00 p.m. and none can be guaranteed after September 6.

TYPE OF ACCOMMODATION	NUMBER	RATE REQUESTED
Single (1 person)		
Double (2 persons)		
Twin (2 persons)		
Suite (parlor and 1 bedroom)		
Suite (parlor and 2 bedrooms)		

CHOICE OF HOTELS:
1st
2nd
3rd
4th

NAMES OF ROOM OCCUPANTS AND DATES OF ARRIVAL DEPARTURE

Type of Room	Name	Dates Arrive	Depart

Please Type Additional Reservations on a Separate Sheet and Attach to This Form

SEND CONFIRMATION FOR ALL RESERVATIONS TO:

Name ____________________

Company ____________________

Address ____________________

City ____________________ State or Province ____________________

Country ____________________ Mailing Code ____________________

Telephone ____________________

Note: Requests for accommodations at the Marriott or Sheraton will be limited to five rooms per company. A parlor counts as one room.

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
1985 ANNUAL MEETING AND PAINT INDUSTRIES' SHOW
CERVANTES CONVENTION CENTER, ST. LOUIS, MISSOURI
MONDAY THROUGH WEDNESDAY, OCTOBER 7, 8, 9

The Combined Annual Meeting and Paint Industries' Show Is a Major Educational Activity of the Federation. This Significant Coatings Industry Event Consists of Three Days of Technical Program Sessions and Exhibits, Running Concurrently.

"COATINGS RESEARCH AND DEVELOPMENT: TODAY'S INVESTMENT IN TOMORROW"

The outstanding program presentations being arranged for the Annual Meeting Program will be centered about the theme—"Coatings R&D: Today's Investment in Tomorrow." The theme emphasizes the need to shape, guide, and protect the future through innovative coatings science and technology. Investments in coatings R&D will ensure continued ability to provide quality products to meet today's requirements and anticipate tomorrow's challenges.

"BIG 50" PAINT SHOW WILL FEATURE PRODUCTS/SERVICES OF 220 EXHIBITORS

The Paint Industries' Show—best known and largest exhibit of products and services used in the formulation, testing, and manufacture of paints and related coatings—will be another record-breaker in both size and number of exhibitors.

Exhibiting in the Show will be more than 220 companies which manufacture and supply a wide variety of raw materials, production equipment, laboratory apparatus & testing devices, containers, and a variety of services for the coatings manufacturing industry. The list of current exhibitors is included in this brochure.

Key personnel from coatings manufacturers in the U.S., Canada, and several other countries attend each year. The Paint Show gives them the opportunity to learn of the latest developments in the industry and to discuss them with the top technical/sales staffs of the exhibitors.

Show hours will be: Monday—12:00-5:30; Tuesday—9:30-5:30; Wednesday—9:30-3:00.

FEDERATION BOARD TO MEET ON SUNDAY

The Federation's Board of Directors meeting will be held on Sunday, October 6, in the Marriott Hotel.

HOTELS AND RESERVATIONS

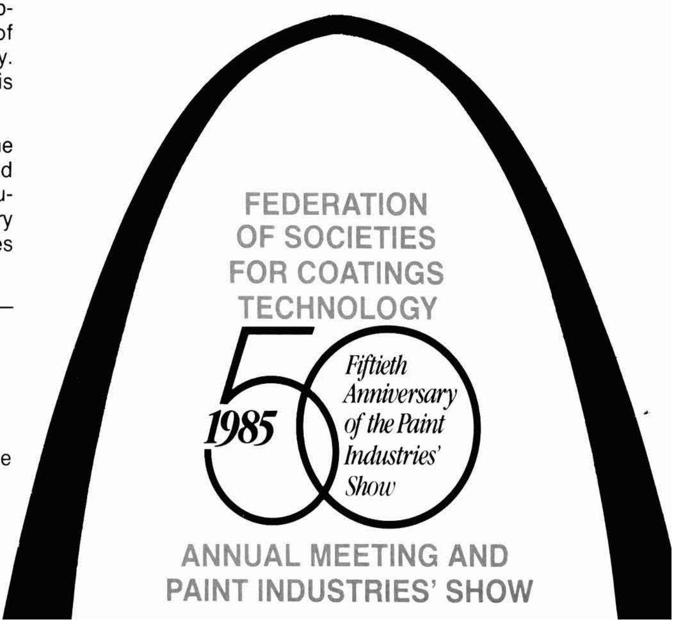
Thirteen hotels have reserved blocks of rooms for the Federation. A map showing the location of the hotels and a schedule of rates are included in this brochure.

All reservations will be processed by the St. Louis Convention and Visitors Bureau. The Bureau will send you an acknowledgment, noting the hotel to which you have been assigned. (Bureau telephone # 314-421-1166). The confirmation of your reservation will come directly from the hotel, to whom you must direct all inquiries.

Phone numbers of the hotels (Area Code 314) are:

Marriott Pavilion	421-1776	Holiday Inn Riverfront	621-8200
Sheraton St. Louis	231-5100	Mayfair	231-1500
Bel Air Hilton	621-7900	Omni-Union Station	241-6664
Best Western	421-4727	Radisson St. Louis	421-4000
Clarion	241-9500	Rodeway Inn	534-4700
Embassy Suites	241-4200	University Plaza	534-8300
Holiday Inn Market St.	231-3232		

Requests for accommodations at the Marriott Pavilion or the Sheraton St. Louis will be limited to five rooms per company. A parlor counts as one room.

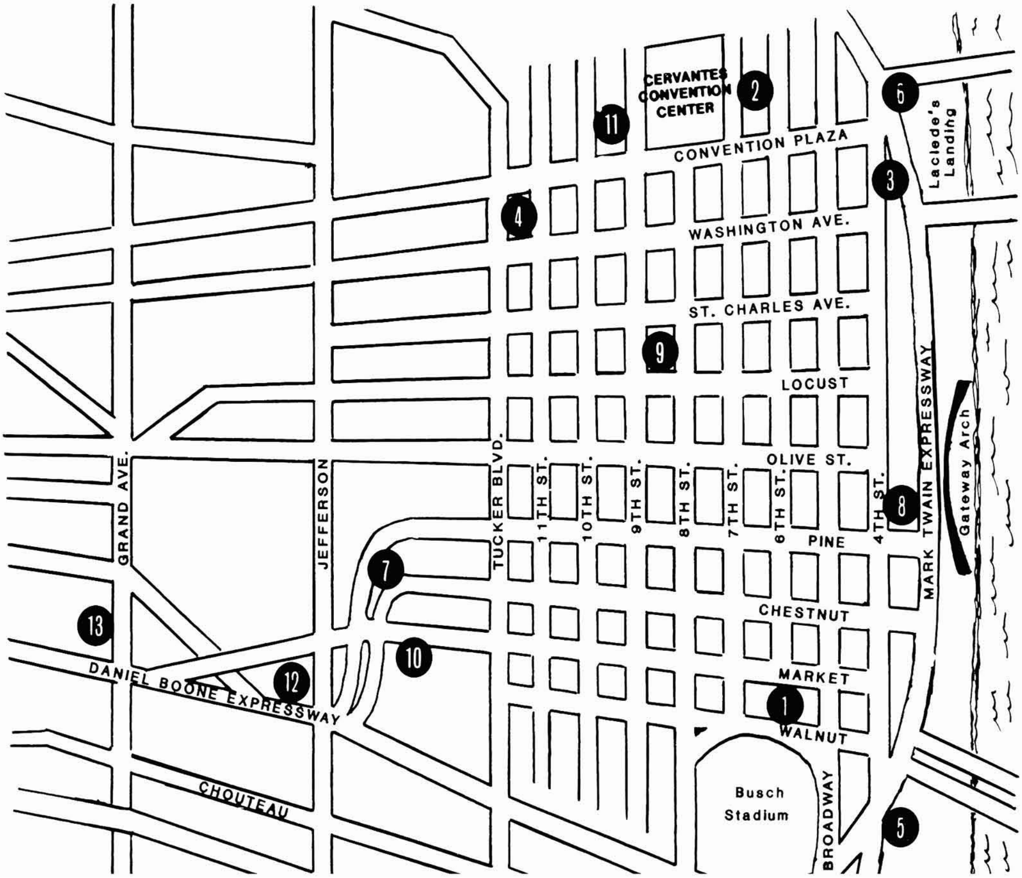


HOTEL INFORMATION AND RATES*

No. on Map	Hotel	Singles	Doubles/ Twins	Parlor & 1 Bedroom	Parlor & 2 Bedrooms
(1)	**†Marriott Pavilion**	$74	$86	$185–$295	$225–$375
(2)	**†Sheraton St. Louis**	74	86	275	
(3)	**Bel Air Hilton**	72	84	175	350
(4)	**Best Western St. Louisian**	46	54		
(5)	**Clarion**	72	84	195–315	325–405
(6)	**Embassy Suites**	80	90		
(7)	**Holiday Inn Market St.**	54	61		
(8)	**Holiday Inn Riverfront**	70	80		
(9)	**Mayfair**	59	69		
(10)	**Omni—Union Station**	83	96	250 & up	375 & up
(11)	**Radisson St. Louis**	65	81	110	380–450
(12)	**Rodeway Inn**	48	54		
(13)	**University Plaza**	49	55		

* All room rates are subject to a City and State Tax of 9.75%.

† Requests for accommodations at the Marriott Pavilion or the Sheraton St. Louis will be limited to five rooms per company. A parlor counts as one room. Additional reservations will be assigned to other cooperating hotels.



MEMBERS OF THE FEDERATION

Use This Form to Order (or Renew) Your Subscription to OCCA Journal In 1986 at Special Rate of $60.00

1986

Here is your opportunity to renew—or to place for the first time—your personal subscription to the *Journal of the Oil and Colour Chemists' Association.* Under the special exchange agreement between the Federation and the Oil and Colour Chemists' Association, Federation members are permitted to subscribe to this outstanding monthly technical journal at the special rate of $60.00 a year.

Order your 1986 subscription now by filling out the order form below. Send the order, with check or money order enclosed, to the Federation office in Philadelphia.

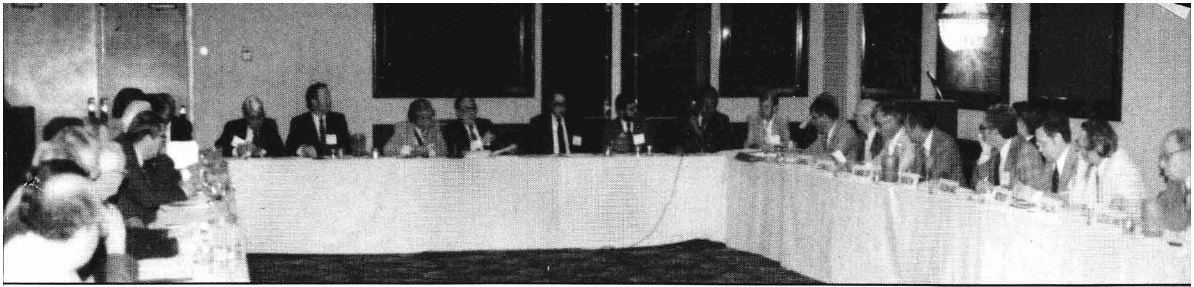
This OFFER GOOD TO FEDERATION MEMBERS ONLY. All others must order subscriptions directly from the Oil and Colour Chemists' Association, Priory House, 967 Harrow Road, Wembley, Middlesex, England HAO 2SF, at the regular subscription rates.

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
1315 Walnut Street
Philadelphia, Pennsylvania 19107

Please enter my subscription to the *OCCA Journal* for 1986. (Subscriptions accepted on a calendar year basis only).

My check or money order for $60.00 is enclosed. (Please make checks payable to the Federation of Societies for Coatings Technology). U.S. Funds.

NAME ______________________________
COMPANY ______________________________
STREET (OR BOX NO.) ______________________________
CITY ______________________________
STATE OR PROVINCE ____________________ ZIP CODE __________
COUNTRY ______________________________
I am a member of the ____________________ Society for Coatings Technology



FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY

Spring 1985
Board of Directors Meeting

Thirty-six members and 22 guests attended the Spring Meeting of the Board of Directors of the Federation of Societies for Coatings Technology on May 17, 1985 in Baltimore, MD.

The following were in attendance:

Officers

President	Joseph A. Bauer
President-Elect	William Mirick
Treasurer	Carlos Dorris

Society Representatives

Baltimore	James A. McCormick
Birmingham	Graham Fowkes
Chicago	John T. Vandeberg
C-D-I-C	Lloyd Reindl
Cleveland	Fred G. Schwab
Dallas	William Wentworth
Detroit	Gary Van DeStreek
Golden Gate	Barry Adler
Houston	Willy C.P. Busch
Kansas City	Norman Hon
Los Angeles	Jan P. Van Zelm
Louisville	James Hoeck
Mexico	Antonio Pina
Montreal	Horace Philipp
New England	Daniel Toombs
New York	Saul Spindel
Northwestern	Richard L. Fricker
Pacific Northwest	Deryk R. Pawsey
Philadelphia	Carl W. Fuller
Piedmont	Steve Lasine
Pittsburgh	Edward Vandevort
Rocky Mountain	Edmund H. Peterson
St. Louis	Thomas Fitzgerald, Sr.
Southern	Alfred L. Hendry
Toronto	Kurt F. Weitz
Western New York	Thomas Hill

Other Members

Neil S. Estrada	Golden Gate
Ted Favata	Golden Gate
James Geiger	Southern
Al Heitkamp	Northwestern
Terryl F. Johnson	Kansas City
J. Richard Keifer, Jr.	Philadelphia
Michael W. Malaga	Cleveland

Guests

Past-President of the Federation A. Clarke Boyce. (Board members Neil S. Estrada, Terryl F. Johnson, Michael W. Malaga, and James A. McCormick are also Past-Presidents.)

Annual Meeting Program Committee Chairman Joseph A. Vasta.

FSCT Technical Advisor Royal A. Brown.

Chuck Reitter, Editor, *American Paint & Coatings Journal.*

Joseph Giusto, Immediate Past-President of Baltimore Society.

The following Society Officers, who attended their meeting the previous day: Mike Castle, of CDIC; Richard Eley, of Cleveland; Ashwin Parikh, of Dallas; Robert Feisel, of Detroit; Henry Kirsch, of Los Angeles; Joyce Specht-St. Clair and Howard Ramsey, of Louisville; Joan Lamberg, of Northwestern; Yvon Poitras, of Pacific Northwest; Donald Denny, of Philadelphia; and Tony Isacco, of Pittsburgh.

Staff

Frank J. Borrelle, Executive Vice-President; Thomas A. Kocis, Director of Field Services; Rosemary Falvey, Director of Meetings and Conventions; Katherine Ferko, Assistant to Treasurer; Patricia D. Viola, Managing Editor, and Robert F. Ziegler, Editor, of JOURNAL OF COATINGS TECHNOLOGY.

Mr. Borrelle called the roll of members and reported all present.

The report of the Fall 1984 Board of Directors meeting was approved as published in the January 1985 JOURNAL OF COATINGS TECHNOLOGY.

In Memoriam

A moment of silence was observed in memory of the following FSCT Past-Presidents who died since the last meeting: S. Leonard Davidson (1970-71); Lyman P. Hunter (1962-63); Robert J. Smith (1939-40); and Birmingham Club Representative to the Board of Directors, David H.W. Lovegrove.

Reports of Officers And Staff

PRESIDENT BAUER

Time surely flies when you are busy. With "Spring Week," we have reached the half-point in the year. I am glad to report that the Federation is operating within its budget and having a great '85.

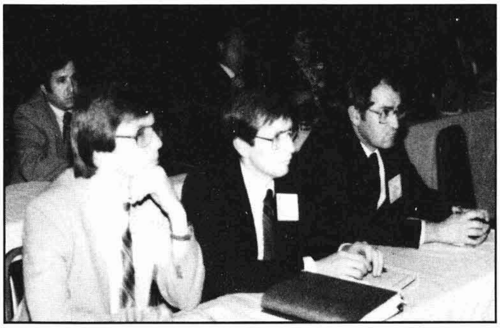
At the January Executive Meeting, two new Standing Committees were put in place. The Professional Development Committee is chaired by F. Louis Floyd. The other is the Future Planning Committee headed by Neil S. Estrada.

Also, I established two Ad Hoc Committees. One, to investigate the establishment of Federation Chairs at various universities with Dr. Loren Hill as Chairman. The other is headed by President-Elect Bill Mirick on the possibility of buying a Federation office building.

The enjoyable part of being President is visiting the Societies. So far, I have visited Chicago, Toronto, Philadelphia, Western Coatings Societies Symposium, Southern Annual Meeting, Southwestern Paint Convention, and the Pacific Northwest Symposium. It has been very enjoyable seeing old friends and making new ones. During May and June, I will visit Kansas City and Birmingham.

Plans for the Annual Meeting and Paint Show in St. Louis are right on schedule. The "Big 50" Paint Show will be another record-breaker. The program sessions arranged by Chairman Joe Vasta—"Coatings R&D, Today's Investment in Tomorrow"—will be truly outstanding.

JOSEPH A. BAUER
President



Guests in attendance included (left to right): Chuck Reitter, Editor of the *APJ*; Robert Feisel, of Detroit Society; Yvon Poitras, of Pacific Northwest Society. In the back row is Joseph Giusto, Immediate Past-President of the Baltimore Society

PRESIDENT-ELECT MIRICK

As your President-Elect, the year started with the Investment, Finance, and Executive Committee meetings in Philadelphia.

I made three Society visits: CDIC with Bob Ziegler; Cleveland with Frank Borrelle; and Montreal with Tom Kocis. At each meeting, we met with their Executive Boards and a presentation reviewing Federation programs was given to the members.

Mary and I attended the Western Coating Societies Biennial Symposium. The hospitality of the Los Angeles Society was outstanding.

By the time of the Spring meeting, I will have completed meetings with the Joint Paint Industry Coordinating Committee in Washington, D.C. and the National Painting and Coatings Association Board in Phoenix.

I am currently selecting Committee Chairmen for 1985-1986 and will be completed by mid-summer.

My compliments to the staff for their dedicated work during the refurbishing of the office.

WILLIAM MIRICK
President-Elect

TREASURER DORRIS

The FSCT is operating within a balanced budget. The Finance Committee presented the 1985 budget to Executive Committee and it was approved.

The first official duty as Treasurer was to visit the Federation office during the Executive Committee meeting and become familiar with the operation and meet the dedicated staff in Philadelphia.

As Treasurer of PRI, no formal budget was proposed as PRI Trustees plan for restructure.

Your Treasurer's travel has been minimal with a visit to Federation office and the Southwestern Paint Convention.

CARLOS E. DORRIS
Treasurer

EXECUTIVE VICE-PRESIDENT BORRELLE

1984 WAS ANOTHER GOOD YEAR

All Federation activities in 1984 were successful, making it another good year. In February 1985, as in recent previous years, a transfer of funds was made from operations to the investment trust. Everything is going well so far in 1985, including the renovation/expansion of the Federation office—however slow and difficult the process.

1985 BUDGET

In January, the Finance and Executive Committees approved a budget of $1,700,000, a three-fold increase in 10 years. The allocations are:

Income: Publications—35%; Annual Meeting and Paint Show—51%; Membership Dues—8%; Educational Activities—3%; and Miscellanous—3%.

Expense: Headquarters Office/Administration—37%; Publications—30%; Annual Meeting and Paint Show—19%; Educational Activities—5%; and Officers/Board/Committees—9%.

PUBLICATIONS

JCT: Advertising page sales continued to climb in 1984, and income was 16% in excess of the budget.

Year Book: The 320-page 1985 edition was released on March 13.

Series Units: The Co-Editors, Drs. Thomas J. Miranda and Darlene Brezinski, are moving right along with the new and updated Series on Coatings Technology. Three or four manuscripts should be released for publication this year. The Publications Committee has recommended a selling price of $5.00 each.

Other Publications: The Dictionary, Infrared Book, and Pictorial Standards Manual are selling satisfactorily. The Southern Society has released its final draft of "Consumer Guide to Paint Quality: Exterior Flat Latex Paints" to the Federation. It will be reviewed by the Executive and Technical Advisory Committees.

MEMBERSHIP SERVICES

The names of 6,945 members (4,708 Active, 1,867 Associate, 370 Other) were published in the 1985 *Year Book*. The 7,000 mark should be broken this year.

We are pleased to continue to present (via the Societies) complimentary pins and pens to 50-year members of the Federation. The list is growing and presently stands about 25. Those who attend the 1985 AM&PS will be given complimentary registrations and luncheon tickets for themselves and their spouses.

ANNUAL MEETING AND PAINT SHOW

The 1984 AM&PS—in spite of hotel and exhibit hall difficulties—was a great success. Registered attendance (7,500) was the highest ever and the Paint Show was also the biggest with 196 exhibitors occupying 45,400 net sf.

The "Big 50" Paint Show in St. Louis will set a new record. Currently, there are 234 exhibitors in 56,200 net sf. Thirty-seven exhibitors are new.

Provision will be made inside the Show for each Society to have an aluminum poster frame for commemorative and promotional display purposes.

We are fortunate to have obtained John P. McAndrews, Group Vice-President, F&FP Products, DuPont Co., as the Keynote Speaker on Monday. Jim Valvano, the dynamic, energetic, and humorous basketball coach at North Carolina State University, will be the Wednesday Luncheon Speaker.

COMMITTEE LIAISON

National meetings of the Federation/Society Technical and Educational Committees were sponsored again this year. Other committees which met, or will meet, are: Corrosion, Manufacturing, Heckel Award, Publications, Federation Chairs, Professional Development, Mattiello Lecture, and Future Planning. The Federation is pleased that it is able to continue underwriting the transportation and meeting expenses.

PROFICIENCY TESTING PROGRAM

This new Federation activity—in cooperation with Collaborative Testing Services—is going very well, as Technical Advisor Roy Brown indicates in his report.

SCAI

The third Symposium on Color Appearance and Instrumentation—sponsored by the Federation, ISCC, and MCCA, was held in mid-April in Pittsburgh. Attendance was about as expected—140.

SPRING WEEK

Our second "Spring Week" is set for mid-May in Baltimore. It will get underway with a great seminar, "Latest Developments in Home Painting." Roy Brown has arranged a unique but effective program which will bring together (at one gathering) architects, home builders, paint manufacturers, paint store dealers, painting contractors, etc. The second event of "Spring Week" will be the Society Officers Meeting on Thursday. It will conclude with the Board of Directors Meeting on Friday.

FSCT officers (left to right): Treasurer Carlos Dorris; President Joseph Bauer; Executive Vice-President Frank J. Borrelle; and President-Elect William Mirick

EXHIBITS

The Federation exhibited, or will exhibit, this year at the Western Coatings Societies Symposium and Show in Anaheim, the Baltimore Society Mini Show, and the SSPC Annual Meeting in Cincinnati. The space at the west coast show was donated by the DuPont Co. At the other two, space was contributed by the sponsor.

AUDIO/VISUAL

McWhorter, Inc. has contributed a set of its own VCR tapes on 15 quality control tests. The Technical Advisory Committee and Roy Brown have judged them to be worthy of reproduction and sale as training aids. The 15 will be incorporated into two VCR tapes, of about 45 minutes each.

OFFICER/STAFF VISITS

Officer/Staff visits so far this year have been to the monthly meetings of: Baltimore, Chicago, CDIC, Cleveland, Mexico, Montreal, Philadelphia, Piedmont, and Toronto Societies. We also attended the WCSSS in Anaheim, the Southern Annual Meeting in Atlanta, and the Southwestern Paint Convention in Dallas.

Coming up are: the Pacific Northwest Symposium, Kansas City, and the Birmingham Club's 50th Anniversary as a Federation Constituent.

FEDERATION OFFICE

Enlargement and renovation of the Federation's staff office began in February and is still in process. We have had to carry on our daily tasks with walls, ceilings, electrical wires, telephone wires, and ducts going down and then up around us. It was not unusual for duct installers, electricians, ceiling installers, painters, dry wall tapers, and carpenters to be working simultaneously while staff played musical chairs with safe work locations in order to not interfere with the workmen. Thank goodness, the end is drawing near. I thank the staff for maintaining its cool and patience, and for sticking to their chores during several difficult weeks when our offices resembled a completely disorganized, uncoordinated, and messed up three-ring circus. P.T. Barnum would have been proud of us.

In spite of all this, computerization has moved along. The CRT cables were installed and provision has been made for a "computer room."

The Southern Society generously donated $25,000 toward the refurbishing of the offices. The monies will be used to buy new furniture, particularly for the large conference room/library, which will be dedicated to the Southern Society. The Federation and staff are most appreciative of the Society's generosity.

FRANK J. BORRELLE
Executive Vice-President

DIRECTOR OF FIELD SERVICES KOCIS

COMMITTEE ACTIVITIES

Technical Advisory—Committee met in New York on December 3, to develop ideas for promoting and maintaining interest and participation in technical project work.

Discussions keyed on the importance of building on the success of previous joint meetings with Society Technical Committee Chairmen and the need to develop programs which are helpful to those attending, both in terms of project work and individual professional development, i.e., a "learning experience." Also, that projects should be encouraged in areas that are likely to have appeal to management, thus gaining support for employees taking part in such work and fostering appreciation.

It was agreed that TAC members should develop special presentations for the next joint meeting and that a tour of coatings-related laboratory or plant would be an added attraction.

Meeting of the TAC with Society Technical Committee Chairmen was held March 6 & 7, in Cleveland, which was attended by representatives of 16 Societies.

Special presentations were made by two TAC members. Jan Grodzinski explained the basics for producing good quality slides to enhance technical papers, and Colin Penny discussed a proposed project for cooperative Society work on how extender pigments affect moisture vapor transmission.

In addition to reports by Society Chairmen on their project work (five Societies advised that they plan to present papers at 1985 AM), Technical Advisor Roy Brown provided an update on the cooperative work being done by 8 Societies on paints formulated with polymers containing chemically attached mildewcides, and also reported on the Federation-sponsored Proficiency Testing Program. The group also reviewed several of the video tapes of laboratory test procedures, offered to the Federation by McWhorter, Inc. for possible distribution as a training aid.

A highlight of the meeting was a visit to the nearby Glidden Research Center, where the group enjoyed an interesting and informative tour of that very impressive facility.

Reports of Society Technical Committee activity have been submitted to the Federation office and will be published in a forthcoming issue of JCT.

Manufacturing—Committee met in Chicago, on April 2, to discuss current and proposed activities.

Primary agenda item was development of a seminar for presentation at the 1985 Annual Meeting. Topic selected was "Manufacturing the Next Generation of Coatings," which will focus on the automated paint plant, as well as production of high solids vs. conventional, trade sales and industrial water-bornes, and the role of chlorinated solvents; discussions will be designed to fit 2-1/2 to 3 hour session.

In related discussion areas, Committee plans to compile list of topics for suggested manufacturing presentations at Society meetings, as well as circulating copies of manufacturing seminar programs. In these and other areas in which the local manufacturing effort can be improved, the Committee reaffirmed its interest in lending assistance, as required and requested.

Committee is also pursuing arrangements for a proposed plant tour in conjunction with the AM in St. Louis. This would be on Thursday, October 10, following the close of the Convention, provided there is sufficient interest among attendees to lay over the extra day; as with previous such tours, attendance would be limited to Steering Committee members and Society Manufacturing Committee Chairmen.

Corrosion—Initial meeting of reorganized Committee was held in conjunction with 1984 AM. Follow-up meeting will be held May 24 in Cincinnati (immediately following Annual Meeting of Steel Structures Painting Council), to discuss areas of activity.

Educational—Steering Committee met with Educational Committee Chairmen in Louisville, on March 22; representatives from 18 Societies attended.

In addition to reports on Society educational activities, a highlight of the meeting was discussion of coatings programs at schools receiving FSCT scholarship funding; representatives of University of Detroit, Eastern Michigan University, Kent State University, University of Missouri-Rolla, North Dakota University, and University of Southern Mississippi were on hand to update their activities; recurring comments in their reports was the need for additional funding to expand their faculty and add equipment, and to attract more students into their programs.

Reports on Society educational activities, as submitted, will be published in a forthcoming issue of JCT.

Annual update of "Guide to Coatings Courses" was published in January.

Program—Planning for the 1985 AM programming began at organizational meeting of Committee, held during the 1984 AM, and was further developed at follow-up meeting held December 4 in Chicago.

Theme for this year's program is "Coatings R&D: Today's Investment in Tomorrow," which emphasizes the need for continued innovation in coatings science and technology, to meet current requirements and anticipate future needs. To assure that theme is adequately addressed, Committee is developing two sessions; an R&D Management Seminar, featuring high-ranking coatings researchers who will discuss their philosophy and perspective of research, and a session covering effective application of computers to coatings R&D.

Early indications are that the Committee will have a good supply of quality presentations for a full three days of programming.

SYMPOSIUM ON COLOR AND APPEARANCE INSTRUMENTATION

This event, held April 17 & 18 in Pittsburgh, was sponsored by the Federation in conjunction with the Manufacturers Council on Color and Appearance and the Inter-Society Color Council. This was the third such Symposium, the two previous being held in Cleveland (1978) and Louisville (1981).

Technical paper presentations and workshop discussions focused on continuing developments in color measuring programs and instrumentation for the coatings industry; also featured were the "hands-on" displays of instrumentation equipment of seven supplier firms.

A total of 145 registrants took part; included were attendees from Canada, Mexico, Belgium, West Germany, and Switzerland.

Comments expressed throughout the event, and reported in the critique sheets returned by the attendees, confirm that the Symposium was well received and that the registrants were pleased with the program.

Jacki Welker (PPG) who chairs the Federation's ISCC Committee, was in charge of the general programming and she and her Committee members arranged for all the paper presentations. The workshops and exhibits were handled by the Manufacturers Council on Color and Appearance. Both groups did an excellent job, and the success of the Symposium reflects their good work.

Symposium income and expenses were pretty much on target, and a modest surplus was realized. This money accrues to the Federation, which absorbed preliminary expenses and accommodated the promotion, registration, housing, and on-site meeting needs, all of which were handled by staff.

MISCELLANEOUS

Staff support provided for publicity, programming, and on-site arrangements for seminar on "Recent Developments in Home Painting" . . . Annual update on "Talks Available" being readied for publication . . . Liaison and staff support also provided for activities of Roon, AP&CJ, and MMA Awards Committees . . . Assisting Advisory Board in development of new Series on Coatings Technology; first four or five booklets are due to be cleared for publication later this year.

THOMAS A. KOCIS
Director of Field Services

TECHNICAL ADVISOR BROWN

THIRD NATIONAL FSCT SEMINAR

In planning the seminar, "Recent Developments in Home Painting," we have taken a broader approach in discussing the products produced by our industry. In this seminar we are involving the architect, the home builder, the painting contractor and the paint dealer along with the paint manufacturer. While having knowledgeable speakers discuss architectural paint products and their use, we will also receive the ideas and suggestions of those who design and build homes, and those who apply and sell the products of our industry.

We are interested in learning what the architects and home builders expect from modern paints. We want to learn from the paint dealer about users' preferences and about the properties the painting contractor wants in the paint he applies. This seminar, we believe, will produce some very valuable information for our industry.

The seminar has been well publicized by the Federation and by the associations representing the home builders, the architects, the paint dealers, the contractors, and the paint manufacturers.

PROFICIENCY TESTING PROGRAM

The Federation Proficiency Testing Program, begun about one year ago, now has more than 70 laboratories enrolled. The first year's program, consisting of 12 different ASTM tests conducted on various industrial and architectural paint products, is almost completed. The last set of paint samples in this series will be sent out by Collaborative Testing Services, Inc.

Test results to date provide concrete evidence that our industry *needs* this program. It is becoming very evident that many laboratories are not sufficiently well equipped or competent to conduct many of the tests needed to provide uniform quality control and analysis of paint products. The program is open to anyone interested in the testing of paint. Paint manufacturers, raw material suppliers, commercial testing laboratories, states who purchase paints and others are enrolled.

We are now in the process of developing the 1985-86 program. This involves the selection of tests to be run, and the paint and coating products to be used for test purposes. We are keeping close liaison with the Federal Technical Advisory Committee, the NPCA Scientific Committee, and the ASTM D-1 Committee on Paints and Related Materials in this endeavor. Some paint manufacturers have enrolled the laboratories of all their plants. We believe this is an excellent way to conduct an internal quality control testing evaluation.

Recent discussions of test results in determining VOC (volatile organic content) of industrial coatings by ASTM method D-3960, emphasize the difficulty in getting reproducible results when coatings contain both solvents and water.

The original belief that a program of this type would demonstrate the need for better test methods, better test instruments and more emphasis on the training of chemists and technicians was an accurate one. We welcome all suggestions and ideas for the next year's program.

COOPERATIVE WORK BY SOCIETY TECHNICAL COMMITTEES

Mildew Research: Exterior exposure of test panels using paints containing a mildewcide chemically attached to the latex polymer, continues in many areas of the country. Eight Society Technical Committees are involved in this work. At the meeting of the TAC and Society Technical Committee Chairmen held in Cleveland, March 6-7, reports and discussions were held. Mildew growth is developing on many of the exposed panels, including the control paints, the experimental mildewcidal paints and commercial mildew-resistant paints.

Board members in attendance included (left to right): John T. Vandeberg (Chicago); Graham Fowkes (Birmingham); and James A. McCormick (Baltimore)

It is still too early to draw any definite conclusions regarding experimental paints. The program will continue and we expect to solicit another round of progress reports from participants in the near future. Cooperative projects of this type are beneficial to the industry and provide interesting discussions of the TAC and Society Technical Committee Chairmen. Other possible cooperative projects are being investigated and we welcome suggestions.

McWhorter A-V Tapes: A group of 15 tapes donated to the Federation by McWhorter, Inc. were reviewed. Each tape demonstrates the performance of a quality control test. Some of the tapes were shown to the Technical Advisory Committee and Society Technical Committee Chairmen at the March meeting in Cleveland.

It is thought that the group of tapes can be combined into two 35-minute tapes by the Federation to be used in training laboratory technicians to conduct quality control test methods.

ROYAL A. BROWN
Technical Advisor

Review of Actions Of Executive Committee

One of the duties of the Board of Directors is to approve or disapprove the actions of the Executive Committee.

The actions of the Executive Committee (at meetings of October 27, 1984 and January 18, 1985) were included with the minutes mailed previously to Board Members. The actions at the May 15, 1985 meeting of the Executive Committee were presented to the Board during the present meeting.

The actions of the committee presented to the Board are as follows:

OCTOBER 27, 1984

That the lease at the present Federation offices (1315 Walnut St., Philadelphia, PA) be renewed for five years; the lease to include (if possible) a provision permitting sub-lease.

That an Ad Hoc Committee be formed to study the feasibility of purchasing or erecting a building to house the Federation office.

That an Ad Hoc Committee be appointed to study the possibilities and ramifications of Federation sponsorship of "Chairs" at various universities.

That $53,500 be appropriated to Federation Committees, Account 677, during 1985.

That $9,000 be appropriated to the Educational Committee, Account 750, during 1985.

That the By-Laws Committee be instructed to prepare the enabling resolutions to amend Standing Rule II (D) so as to provide for a review of all applications for Federation Honorary Membership by the Federation Executive Committee.

That Mr. Borrelle enlarge upon the current qualifications regarding the establishment of new Societies, as stated in Standing Rule I (A).

That the services of Royal A. Brown as Federation Technical Advisor be continued from January through December 1985.

That Federation staff salaries be increased, effective November 1984, and that the salary budget for 1985 be set at 335,000.

JANUARY 18, 1985

That the Federation Estimated Statement of Income ($1,687,000) and Expense ($1,412,000) for 1984 be accepted.

That the PRI Advisory Committee be discharged with thanks for an excellent written and oral report.

That President Bauer form a new Federation Committee—"Professional Development"—and instruct the new group to pursue the recommedations of the PRI Advisory Committee.

That the By-Laws Committee prepare the enabling resolutions to add "Professional Development" and "Future Planning" to the list of Standing Committees in By-Laws Article, V, B.

That the Paint Research Institute Trustees be requested to change the name of the Paint Research Institute to "Coatings Industry Education Fund."

That the Co-Editors of the new *Series on Coatings Technology* prepare a report for the Board of Directors that summarizes the status of the series.

That a set of Guidelines (for Groups Wishing to Affiliate with the Federation) be forwarded to the By-Laws Committee for review and consideration for inclusion in the Standing Rules.

That, in commemoration of the 50th Anniversary Paint Show, 50-year members and spouses who attend the 1985 AM&PS in St. Louis be given complimentary registration and luncheon tickets.

That the four recommendations of the Finance Committee be accepted and that the Operating Budget of the Federation in 1985 be: Income—$1,700,000; Expense—$1,670,000.

MAY 15, 1985

That an additional appropriation of $12,000 be made to Technical Advisory Committee in 1985, so that committee can change time of annual meeting of Society Technical Committee Chairmen to fall (beginning November 1985) and in the fall thereafter.

That the hold on applications for Federation Honorary Membership be extended until October 10—the date of the fall Executive Committee meeting and four days after By-Laws Committee reports to Board.

That an expenditure of $75,000 be authorized to purchase hardware and software to computerize staff operations (JCT subscriptions, accounting, advertising, Paint Show, word processing, JCT papers, etc.)

That $1,000 be appropriated to the Steel Structures Painting Council to continue the Federation's supporting member affiliation.

That the By-Laws Committee be instructed to prepare enabling resolutions to amend By-Laws VIII so that Society Honorary Member dues will be lowered from $20 to $10.

That the Southern Society's finished draft of "Exterior Flat Latex Paints" be referred to the Technical Advisory Committee. Report due in fall.

That two proposed awards—"Southern Society Memorial Award" and "Mathematics and Statistical Methods Award" (by Joe Prane and Earl Hill) be referred to Future Planning Committee.

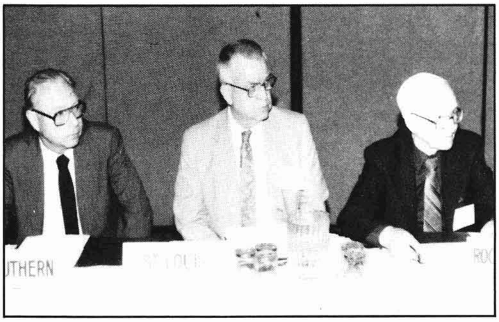
That the Southern Society be thanked for its generous contribution of $25,000 toward the refurbishing of the Federation's staff offices.

That the request from Prof. Irv Krieger, of Case Western Reserve, for $7,500 to support the 1986 Gordon Research Conference on Coatings and Films, be deferred for further study.

That Federation co-sponsorship of an automotive color seminar with MCCA and Detroit Color Council in spring 1986, be approved—*provided* details, dates, and other arrangements can be worked out satisfactorily.

That Spring Week 1987 be held in Seattle, provided details, arrangements, and schedule can be worked out satisfactorily with Pacific Northwest Society.

[*All the above actions of the Executive Committee were approved by the Board of Directors on May 17, 1985.*]



Representing their Societies were (left to right): Alfred L. Hendry (Southern); Thomas Fitzgerald, Sr. (St. Louis); and Edmund H. Peterson (Rocky Mountain)

By-Laws

No By-Laws changes will be offered at this meeting.

The following By-Laws proposals will be prepared for the Fall meeting:

(1) Addition of the following as Standing Committees: Future Planning Committee and Professional Development Committee.

(2) Guidelines for local technical groups wishing to affiliate with the Federation.

(3) Revisions in procedures for nominating an individual for Federation Honorary Membership.

(4) Change in Federation dues for Society Honorary members from $20 to $10, to be consistent with the $10 paid by Retired members.

FRED G. SCHWAB
Chairman

From left to right: Past-Presidents Neil S. Estrada and Terryl F. Johnson; and Representative Al Heitkamp (Northwestern)

Nominations

The Nominating Committee places the following persons in nomination for office with terms to become effective October 10, 1985:

President-Elect: Carlos Dorris, of Dallas Society (Jones-Blair Co.). One-year term. He is currently Treasurer.

Treasurer: Deryk R. Pawsey, of Pacific Northwest Society (Rohm and Haas Canada Inc.). One-year term.

Executive Committee: Dan Toombs, of New England Society (Lukens Chemical Co.). Three-year term. Kurt F. Weitz, of Toronto Society (Indusmin Ltd.). One-year, to fill unexpired term of Mr. Pawsey.

Board of Directors (Members-at-Large): Richard M. Hille, of Chicago Society (General Paint & Chemical Co.); John Lanning, of Louisville Society (Porter Paint Co.). Two-year term for each.

Board of Directors (Past-President Member): J.C. Leslie, of Kansas City Society. Two-year term.

There were no nominations from the floor.

Elections will take place during the Board of Directors meeting on October 6, 1985, in St. Louis.

Members of the Nominating Committee are: Past-President Howard Jerome, and Society Representatives Richard L. Fricker, James A. Hoeck, and Lloyd Reindl.

TERRYL F. JOHNSON
Chairman

Society Business

SALE OF FEDERATION YEAR BOOK

Los Angeles Society asked that Federation not sell Federation *Year Book* to non-members, because of LA's own problems with employment search organizations.

Federation does not knowingly sell *Year Book* to "head hunters."

Discussion revealed that LA *Year Book* is available in its library at City of Commerce and probably in Golden Gate Society library in Redwood City. Also that LA Society circulates its *Year Book*, free of charge, to: its members; members of the Golden Gate, Pacific Northwest, and Rocky Mountain Societies; and to the related LA, GG, PNW, and RM Paint and Coatings Associations.

Federation Board approved a motion which stipulated that Federation continue its present practice.

BOSTON STONE

New England Society reported that $4,664 (of $5,084 in contributions) was expended in study by Society for Preservation of New England Antiquities to determine the condition of the Stone and alternatives to conserve it. SPNEA recommended six options. No decision yet.

Federation Office

It was reported that the renovation and remodeling of the present Federation headquarters office in Philadelphia is nearing completion. The square footage has been expanded from 4,150 to 7,150 sq. ft.

The gift of $25,000 from the Southern Society was acknowledged with sincere appreciation. The funds will be used for new furniture in offices and conference room.

Federation staff is working to complete the arrangements for the installation of a computer system to automate the areas of membership/JCT circulation records, JCT editorial and advertising, accounting and bookkeeping, Paint Show, and word processing. The system should be implemented in the fall.

Committee Reports

CORROSION

This committee had its formative meeting on October 25, 1984, during the Federation Annual Meeting in Chicago, IL. While committee membership is at fourteen, not all were able to attend.

Since the field of corrosion is an immense one and encompasses disciplines that are quite time consuming, it was decided to narrow the thrust of any technical investigation to intimate interactions with the National Association of Corrosion Engineers (NACE), and with the Steel Structures Painting Council (SSPC), with further limitations imposed upon this committee restricting itself to ferrous substrates. It must be realized that even with this restriction the potential for investigative insight is enormous, and serious

Board members include (left to right): Willy C.P. Busch (Houston); Barry Adler (Golden Gate); and Gary Van DeStreek (Detroit)

In attendance were Edward Vandevort (Pittsburgh); Steve Lasine (Piedmont); and Carl W. Fuller (Philadelphia)

consideration might have to be given to further narrowing down the field of interest.

In the past five or six months we have concentrated our efforts on those from SSPC. That organization has received in the past an outright grant from the Federation, and has also received in the past a stipend for corrosion projects of its own choosing.

The committee knows that surface preparation plays an important role in this field and, in a cooperative effort with appropriate subcommittees in American Society for Testing and Materials (ASTM), Committee D-1 is looking into the performance effects on coatings as a result of diverse methods of surface preparation, using a system of blast cleaning and changing blasting media.

The Chairman has initiated contact with a British firm, which is involved in providing, for a price, of course, a series of audio-visual slides, or video packages, that provide an insight into corrosion and its remedies from an educational point of view. This entire presentation is a major one, and could easily be cropped for specific purposes. Limited programs in the video format are available to this committee.

The Corrosion Committee is slated to meet in Cincinnati after the Annual SSPC meeting, May 24, 1985.

Alexander A. Chasan
Chairman

ENVIRONMENTAL CONTROL

Since the Annual Meeting, I have attended meetings of the NPCA TSCA Task Force, Air Quality Task Force, Hazardous Waste-Water Quality Task Force, and two EPA conferences on the RCRA amendments.

An article on the Federal Right to Know Law was published in the March issue of the JCT.

I will continue to attend meetings of NPCA task forces and EPA conferences and report to the membership via direct mail to the Societies or via the JCT.

Sidney J. Rubin
Chairman

FEDERATION-SPONSORED CHAIRS

As instructed by the Board of Directors at the Fall 1984 Meeting, President Bauer appointed this Ad Hoc Committee to study the possibilities and ramifications of Federation sponsorship of "Chairs" at various universities. The committee met on April 3, 1985 with all members present: Loren Hill, Howard Jerome, Joe Koleske, John Oates, and Harry Scott. Committee members were unanimous in support of partially funded chairs as an effective way for the Federation to promote education in the coatings field. A proposal to allocate Federation funds for salary supplements of new tenured faculty positions will be submitted following further study of possibilities and ramifications. The main benefit to the coatings industry of such allocations will be an increase in the number of well-trained entry level employees.

Many details will be considered before this committee submits a funding proposal to the Board. At the April meeting, consensus was reached on the following: new faculty supported by the Federation should clearly be in the coatings field as opposed to related fields; demonstration of commitment by university administrators to support of a coatings program should be a pre-requisite for consideration of salary funding; all universities with established coatings programs should be given an opportunity to apply for salary funds; criteria should be established for selection of universities to receive salary funds, and these criteria should be communicated to potential applicants. The level and duration of Federation support was considered in a lengthy discussion. Three universities have already indicated their requirements for partial support by the Federation for establishing a new position; $14,000/year for 10 years, $10,000/year for 10 years and $20,000/year for 3 years. At these requested support levels, it is evident that the universities anticipate substantial funding from other sources. Requiring that the new faculty member be hired on a tenure track will help insure that the position will continue to exist after the years of support have been completed. Continuing the position beyond the requested support years is clearly the intent of department chairmen who have already requested salary support. The question of funding level and duration is still under consideration. For ease of administration of the salary funding program, it would be preferable to select a single level and a single duration for all recipients. The committee did not reach a consensus concerning the advisability of supporting at a high level at one or two universities versus the alternative of supporting at a lower level at three or more universities.

Universities do not have uniform practice concerning designation of a "chair". At some universities a "chair" means an endowed chair. The endowment is sufficient, in such cases, to pay the faculty member's salary from earnings on the endowment. Clearly this endowment level of funding is not anticipated. Some universities may be willing to call the position a "Federation Chair" at funding levels similar to those discussed in the previous paragraph. Committee members, however, were not in agreement concerning the advisability of use of the term "chair" even if the universities were amenable to this term. Designation of new positions as "Federation Professorships" may be preferable and less likely to be misunderstood.

The Chairman of this Ad Hoc committee attended the meeting of the FSCT Education Committee on March 22, 1985. Six universities were represented there. Representatives reported on their coatings programs. It was evident that the number of faculty members was a major factor limiting enrollment in coatings programs. The six universities in attendance were those which receive FSCT Scholarship Awards. The importance of Scholarship Awards to the coatings programs was strongly confirmed. Salary support, considered in this report, should be an additional allocation and should not diminish FSCT Scholarship Awards. Universities represented at the March meeting were Eastern Michigan University, Kent State University, North Dakota State University, University of Detroit, University of Missouri-Rolla, and University of Southern Mississippi.

Loren Hill
Chairman

FUTURE PLANNING

This committee, comprised of Neil S. Estrada, Chairman, A. Clark Boyce, Milton A. Glaser, Howard Jerome and Colin D. Penny, will have its first meeting on May 16, 1985, in Baltimore.

The charge of the committee is:

(1) To make future plans for personnel requirements of the Federation.

(2) Investigate future activities that the Federation can undertake to develop the Coatings Industry.

Methods of carrying out this charge and areas of operation will be discussed. Any suggestions of the topics that should concern the committee will be most welcome.

NEIL S. ESTRADA
Chairman

MEMBERSHIP SERVICES

In keeping with the duties set out in the Federation *Year Book,* the Membership Services Committee has taken several constructive steps "to encourage and assist the Societies" in their membership programs.

(1) Names of companies, not represented by members in the Federation, were circulated on a geographic basis to Constituent Society Membership Chairmen, for prospects.

(2) Non-member registrants to the 1984 AM & PS, from a list compiled by FSCT staff, will be canvassed for possible membership.

(3) Chairmen of symposia, seminars, and sectional (Southern, Southwestern and Pacific Northwest) conventions, have been requested for registration lists.

(4) Lists of recent coatings courses at Rolla have been screened, with names of non-FSCT members sent to the respective Society Membership Chairmen. Other universities will also be requested to send similar lists.

(5) After determining the largest per cent increases in membership from the Society rosters, gifts of appreciation will be awarded to the following:

(1) Mexico	+ 23.2%
(2) Toronto	+ 18.3%
(3) Detroit	+ 18.1%

As a note of interest, the latter two Societies send monthly Newsletters to their membership, underlining the importance of communication as a service.

Last, the total membership of the Federation nears the 7,000 mark, thereby heading for another milestone in the proud history of this organization.

HORACE PHILIPP
Chairman

PAINT HISTORY

This committee is, at best, inactive. No word has been received from any member of the committee in over a year. Efforts to resume activities have been futile; efforts to procure new and active members have produced the same negative results. For all intents and purposes the Committee no longer exists.

All information concerning the work this Committee has done in the past has been forwarded to M. Jacques Roire in Paris, France along with an offer to assist him in any way we can. M. Roire, who was contacted by Frank Borrelle, is interested in pursuing this endeavor himself.

I regret that the committee is no longer functioning.

JOSEPH H. BOATWRIGHT
Chairman

PROFESSIONAL DEVELOPMENT

President Bauer formed this committee in response to, and to implement the recommendations of, the Ad Hoc PRI Advisory Committee. In addition to the Chairman, President Bauer appointed Ruth M. Johnston-Feller, Darlene Brezinski, Howard Bender, Mary G. Brodie, Colin D. Penny, Richard M. Hille, Jim E. Geiger, and George R. Pilcher to serve on the committee. In making these selections, President Bauer insured a high degree of balance and diversity among the members in professional background, employer size, and employer type. In order to insure adequate coordination with other Federation functions, ex officio members of the committee will consist of the Treasurer of the Federation, the Chairman of the Education Committee, and the Chairman of the Technical Advisory Committee.

The first meeting is scheduled for May 22, 1985. At that time, we will take up the recommendations of the Ad Hoc PRI Advisory Committee, particularly the one regarding initiating a first program as early as possible.

To assist in the coordinating function, I attended the recent meeting of the Education Committee Chairmen. This proved to be a very valuable visit, both in updating me on the wide diversity of educational activities already in place within the Federation, and in focusing on a number of key issues for me which could well be addressed by the Professional Development Committee. I have also been assimilating a number of documents relating to professional development activities in other professionl societies of our type. These will be used as examples for discussion and consideration at our upcoming meeting.

The primary objective of this new committeee will be to provide for the professional development through continuing education of the technical staff of our industry (FSCT membership). The secondary objective of this committee will be to address those issues which influence the ability of our industry to attract needed professional talent.

F. LOUIS FLOYD
Chairman

PUBLICATIONS

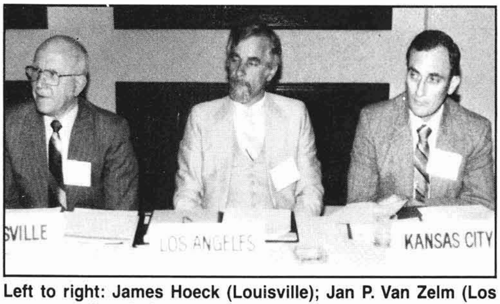
A meeting of the Publications Committee was held on March 26, 1985 in Philadelphia. The following were discussed:

(1) The "Safety Net" column proved to be impractical probably due to reluctance of individuals to report accidents and the difficulty to clear sensitive information for publication.

(2) "Open Forum" and "Humbug from Hillman" continue to be popular features in the JCT and the members commended Mr. Hillman for his continuing efforts to write the column.

(3) The Crossword Puzzle submitted by Earl Hill will continue.

(4) Other features which may be needed include a Computer Column. Dr. Darlene Brezinski will provide more information on this; papers from an Executive Viewpoint will also be solicited.



Left to right: James Hoeck (Louisville); Jan P. Van Zelm (Los Angeles); and Norman Hon (Kansas City)

(5) A suggestion to write an article favorable to the Coatings Industry for the *Wall Street Journal* was discussed. Sidney Lauren will pursue the matter.
(6) Membership of the Editorial Review Board and review procedures were discussed.
(7) Roon Award papers will be reviewed by the Editorial Review Board
(8) The Federation Series on Coatings Technology has 24 authors committed and the Editors (Drs. Brezinski and Miranda) have received six manuscripts from authors. Our plan is to have at least four booklets approved for publication this year.
(9) Technical paper supply is adequate.
(10) The Chairman expressed his sincere thanks to the members of both committees for their dedicated efforts on behalf of the Federation.

THOMAS J. MIRANDA
Chairman

ROON AWARDS

The solicitation of technical papers for the Roon Award competition has resulted in 13 participants indicating their intentions to submit papers by the May 1st deadline. Indications are that these papers will have a high level of appeal to a broad sector of our membership.

The response has also resulted in an excellent balance between industrial and academic participants.

We are looking forward to a large attendance for the presentations of these papers at the Annual Meeting in St. Louis.

P.W. HARBAUGH
Chairman

TECHNICAL ADVISORY

The Technical Advisory Committee (TAC) met in Cleveland on March 6 and 7. Sixteen Societies were represented. Additionally, TAC members Jan Grodzinski (Toronto), Colin Penny (Baltimore) as well as the Chairman were in attendance as were President-Elect Bill Mirick, Cleveland Society President Bob Thomas, Federation Technical Advisor Roy Brown, JCT Editor Bob Ziegler and Field Services Director Tom Kocis.

Each Chairman briefly discussed his Society projects and, where problems existed, sought and obtained ideas as to how to proceed. This part of the meeting resulted in an enthusiastic interchange, with numerous suggestions provided.

The entire group visited Glidden's Dwight Joyce Research Center and had an opportunity to see much of their instrumentation as well as the more practical side of how paint is studied and formulated at Glidden. The committee was appreciative of Glidden's hospitality and particularly appreciative of the efforts of Dr. Alex Ramig and Dr. George Pekarik for hosting the tour.

Thomas Hill (left) represented the Western New York Society and Kurt F. Weitz represented the Toronto Society

Board members (left to right): Daniel Toombs (New England); Horace Philipp (Montreal); and Antonio Pina (Mexico)

Additional highlights of the meeting were presentations by TAC members Jan Grodzinski on Effective Slide Preparation and Colin Penny on a recommended project for cooperative effort by various Societies on The Effect of Extender Pigments on Moisture Vapor Transmission.

Roy Brown provided an update on the status of the cooperative Society program to evaluate the pentachlorophenol emulsion paint that resulted from the PRI Mildew Consortium (panels are out in a variety of locations for as long as 17 months—not long enough to provide definitive data).

The status of the Reference Program being run by Collaborative Testing Services (CTS) was also reviewed. In this program companies perform various tests on submitted samples and send the data to CTS where it is analyzed statistically for accuracy. A fee is paid to CTS. Participation in the program provides a company with an opportunity to check on the accuracy of its instruments as well as how effective its personnel are in performing the test procedure. To date there are about 70 participants in the CTS program.

The McWhorter Co. has prepared 15 VCR tapes showing how to perform various tests. The tapes have been offered to the Federation for possible distribution as training tools. A few tapes were reviewed by the committee and it was recommended that the Federation accept the McWhorter offer and take steps to make the tapes generally available to the membership.

Bob Ziegler expressed the willingness of the JCT to cooperate in the publication of Society papers and further reminded the members of the availability of JCT space to print information on project status as well as on projects which were completed but did not result in a paper.

A change in the TAC meeting time—from spring to fall—was discussed. It was generally agreed that a fall meeting would be more desirable for a few reasons, namely:

(1) The fall is the beginning of a Society meeting year so there is more continuity in maintaining the enthusiasm that results from the TAC meeting.
(2) There is more time between the TAC meeting and the Annual Meeting for development of papers and talks.
(3) New Technical Committee chairpersons are more likely to be appointed in the fall. Spring attendees, if not reappointed, are "lame duck."

Inasmuch as this change will require an expenditure of heretofore unbudgeted funds (in effect there will be two meetings in 1985) the Chairman will make application to the Federation for a supplemental expenditure.

The meeting started and ended on an enthusiastic "high."

SAUL SPINDEL
Chairman

DELEGATE TO NPCA SCIENTIFIC COMMITTEE

The NPCA Scientific Committee, meeting on April 16 and 17 in Columbus, OH, opened with a visit to the Whirlpool plant in Marion, OH to view their operation. The plant has three painting lines and applies various priming coats and topcoats. All products are low VOC coatings and the plant is in compliance with air pollution regulations. The facility has a capacity to produce about 8,000 units per day.

A relatively new concept for paint production, Statistical Process Control (SPC), is gaining impetus. The pressure for SPC is being generated by manufacturers of high volume items such as autos and appliances. SPC relates to a total statistical analysis of all of the operations related to manufacturing in an attempt to improve consistency of production, increase manufacturing efficiency, and ultimately reduce costs. There are video tape presentations available on implementation of the program. A new subcommittee, chaired by David Graham (Lilly Industrial Coatings), was established to study the applications of SPC as well as to develop guidelines as to how to implement same.

NPCA has developed a slide-tape presentation on HMIS (Hazardous Material Identification System). Compliance with HMIS is set for November 25, 1985. The slide tape, literature on how to implement HMIS, and a raw material rating manual is available from Labelmaster (Chicago, IL).

EPA has recently issued a VOC Data Sheet which will allow a paint user to calculate, from data supplied by the paint manufacturer, the VOC of the coating that is being applied. The document, in effect, relieves the applicator from the responsibility for determining VOC by testing.

The South Coast Rule 1113 VOC requirement of 380 gm/L for non-flat architectural coatings is due to expire on September 2, 1985. Attempts are underway to extend the expiration date rather than require implementation of a lower VOC requirement. The local California districts are increasing their degree of enforcement for compliance with air quality regulations by taking and testing numerous samples from both architectural and industrial users.

1,1,1, Trichlorethylene and methylene chloride are being investigated in California as potential waste contaminants.

EPA is considering an investigation of methylene chloride due to suspected carcinogenic properties. A survey to evaluate its use pattern may be conducted. CPSC is also investigating the use of methylene chloride in paint removers and aerosols.

EPA has issued a draft Federal Register notice New Source Performance Standard for the Industrial Surface Coating of Plastic Parts for Business Machines.

Numerous European and Scandinavian studies on solvent toxicity, regarding health affects allegedly related to solvent exposure, have been studied by NPCA. Language relating to labeling (Bulletin 56) has been developed.

Combustion toxicity is one of the newer categories being considered. Combustion toxicity refers to the products that result from a fire in a building environment. All building products, including paint, are considered potential toxic sources. New York State is investigating the inclusion of a requirement for determination of this property in a new building code that is being developed. Other states (New Mexico, Nevada, and Massachusetts) are also looking at combustion toxicity characteristics. NPCA is investigating the economic impact of combustion toxicity.

Representing their Societies were Deryk R. Pawsey (Pacific Northwest); Richard L. Fricker (Northwestern); and Saul Spindel (New York)

Federal legislation on a community "Right-to-Know" is being explored in the Congress. NPCA is developing a position paper claiming that the MSDS sheet should be the appropriate document to be used to develop "Right-to-Know" information.

NPCA has registered concern with EPA that the Significant New Use Rule (SNUR) is unduly long generally taking more that 18 months to finalize. In 1986 EPA plans to propose 10 new SNUR's and finalize 15.

NPCA is conducting a survey on the use of butoxyethoxyethanol (Carbitol) and its acetate in order to demonstrate NPCA's ability to develop statistically valid aggregate totals on the use of these solvents in water-borne and solvent based trade and industrial coatings. If successful, NPCA may obtain authorization from EPA to conduct future surveys and relieve individual companies from this responsibility.

EPA has proposed an update of all data on products listed in the TSCA Master File. EPA, working with ASTM D-1, is looking for a rapid test method to determine volume solids of the dried coating in order to determine transfer efficiency. ASTM D-2697 is considered too lengthy.

ASTM D-1 is still attempting to resolve the negatives cast on a Proposed Guide for "Purchasing Commercial Architectural Paints by Weighted Cost Average." This procedure is presently in use in Virginia, Georgia, North Carolina, and South Carolina. ASTM F-15, Consumer Product Standards, is interested in developing a paint labeling guide to provide information about expected paint performance. If D-1 does not take any action, F-15 plans to do this.

The NPCA Paint Industry Labeling Guide is being completely revised and the target date for publication is October, '85.

Other topics included in the discussions at the meeting were a review of the procedures used to determine VOC, various FSCT activities and the Proficiency Testing Program.

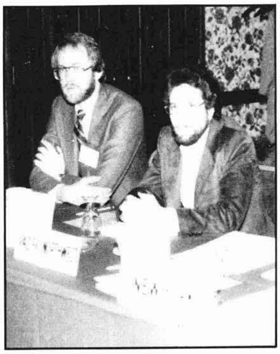
Saul Spindel
Delegate

In attendance were (left to right): William Wentworth (Dallas); Fred G. Schwab (Cleveland); and Lloyd Reindl (CDIC)

NEXT MEETING

The next meeting of the Federation Board of Directors will be held on Sunday, October 6, 1985, 9:00 a.m., at the Marriott Hotel in St. Louis, MO.


LOUISVILLE
KANSA

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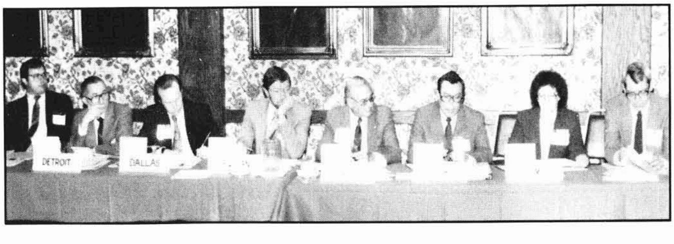
DETROIT
DALLAS

Committee Activities

Scholarships, Society Efforts Head Agenda At FSCT/Society Educational Committee Meeting

Society Educational Committee representatives met recently with members of the Federation Educational Steering Committee to discuss current Society projects and future local and national programs. The meeting, held March 22 in Louisville, was chaired by Ted Favata, of Golden Gate Society, Vice-Chairman of the FSCT Educational Steering Committee.

Topics of discussion included scholarships, promoting career opportunities, and Society-sponsored coatings courses at local colleges.

In addition to Vice-Chairman Favata, the following Society Educational Committee representatives attended: Helen Keegan (Baltimore); Dick Cranstoun (Chicago); Lloyd Reindl (C-D-I-C); Dick Eley (Cleveland); Jeff Ransome (Dallas); Dan Melnyk (Detroit); Dan Gilbert (Golden Gate); Mark Dante (Houston); Jim O'Brien (Kansas City); Melinda Rutledge (Los Angeles); Jim Doyle (Louisville); Jeff Kaye (New York); Mike Harris (Pacific Northwest); Jeff Johnson (Rocky Mountain); Jim McDerby, Jr. (St. Louis); Brian Budzian (Southern); Roy Donnelly (Toronto); and Jim Price (Western New York).

Educational Steering Committee members attending, in addition to Vice-Chairman Favata, were: Carl Knauss (Cleveland); and Johnny Gordon (Detroit).

Guests in attendance were: Federation President Joe Bauer (Louisville); Lou Floyd (Cleveland), Chairman of Professional Development Committee; Loren Hill (New England), Chairman of Ad Hoc Committee on Federation Chair(s); Taki Anagnostou (Detroit), representing University of Detroit; Frank Jones (Northwestern), representing North Dakota State University; Jim Stoffer (St. Louis), representing University of Missouri-Rolla; and Charles Hoyle (Southern), representing University of Southern Mississippi.

Also attending were: Roy Brown, FSCT Technical Advisor; Bob Ziegler, Editor of JCT; and Tom Kocis, FSCT Director of Field Services.

Scholarships

Funding for the Federation scholarship program was increased for 1985-86 by the Board of Directors to $22,000. The recipient schools are: University of Detroit—$2,000; Eastern Michigan University—$2,000; Kent State University—$3,000; University of Missouri-Rolla—$3,000; North Dakota State University—$6,000; and University of Southern Mississippi—$6,000.

Representatives from the above schools attended the meeting and each presented an overview of their respective coatings programs.

University of Detroit: Taki Anagnostou reported on their coatings program, which was initiated in 1969. This is an inner-city school which this year has its largest enrollment—32 students, of which 12 are full-time students. Currently, there is funding shortfall. This has been the case for several years; as a result the lab course has not been taught since 1980. A suitable volunteer instructor from industry cannot be found to carry on, as had been the case since the laboratory opened in 1975.

Eastern Michigan: Johnny Gordon described the four-year Polymers and Coatings program at EMU, which began in 1981, and which emphasizes a combination of theory and hands-on practical experience in the synthesis of polymers and the formulation of paints and coatings. In 1983, a four-year curriculum in Coatings Process Technology was added. Currently, about 80 students are enrolled in the two programs; students must spend at least four months in full-time co-op program in some part of the coatings industry. A continuing education program offers short courses. School recently sponsored a successful EXPOCOAT event, which hosted approximately 200 high school and community college students, who were given some exposure to the coatings curricula; 10 students enrolled in the program as a result. Funding is being sought to support co-op program, expand faculty, and purchase equipment.

Kent State: Kent State's coatings program, which began in 1973, was described by Carl Knauss. The scholarship program is designed to have six students on scholarship in their Sophomore through Senior years. Continuing education program offers short courses on: introduction to coatings; coatings applications; chromatography; dispersion; adhesion; and rheology. The school would like to add adjunct professors to the program.

University of Missouri—Rolla: Jim Stoffer reported on the Polymers and Coatings Science program at Rolla, which includes undergraduate and post-graduate training; continuing education short courses, averaging 250-300 attendees annually, are held in Spring and Fall. Funding is being sought to expand faculty, support graduate research projects, and purchase equipment.

North Dakota State: NDSU was the first school to offer coatings courses (1907), and its current program was described by Frank Jones. The Polymers and Coatings Department has about 20 undergrads coming into program annually; postgrads currently total 25. Intensive summer short courses are also offered. Funding is being sought to expand faculty and to purchase equipment; State financial support is down due to plight of North Dakota economy.

University of Southern Mississippi: Charles Hoyle reported on the USM Polymer Science program which began in 1970. Approximately 100 students are currently enrolled (75 undergraduate; 25 graduate); current Freshman class is largest ever (35 students). Faculty has been bolstered by addition of four new members. Active recruiting effort, via advertising and visits to high schools, is aimed at doubling student enrollment in Polymer Science program in the next several years.

Open Forum

- Improving industry image and promoting career opportunities continues as an educational challenge, and attendees expressed support for efforts in this area; it was recognized, however, that such efforts should be part of a well-developed and comprehensive program, properly conceived and executed, to be successful. It was suggested that this could be undertaken as part of the Professional Development Committee activity.
- FSCT booth at Chemical Show might be considered for promotion of coatings industry activities.
- Scholarship schools are appreciative of complimentary booth space accorded them at Paint Show, and exhibiting has proven very worthwhile for them.
- Schools could use funds to support industry personnel who help in developing curriculum and teaching—becoming ex-

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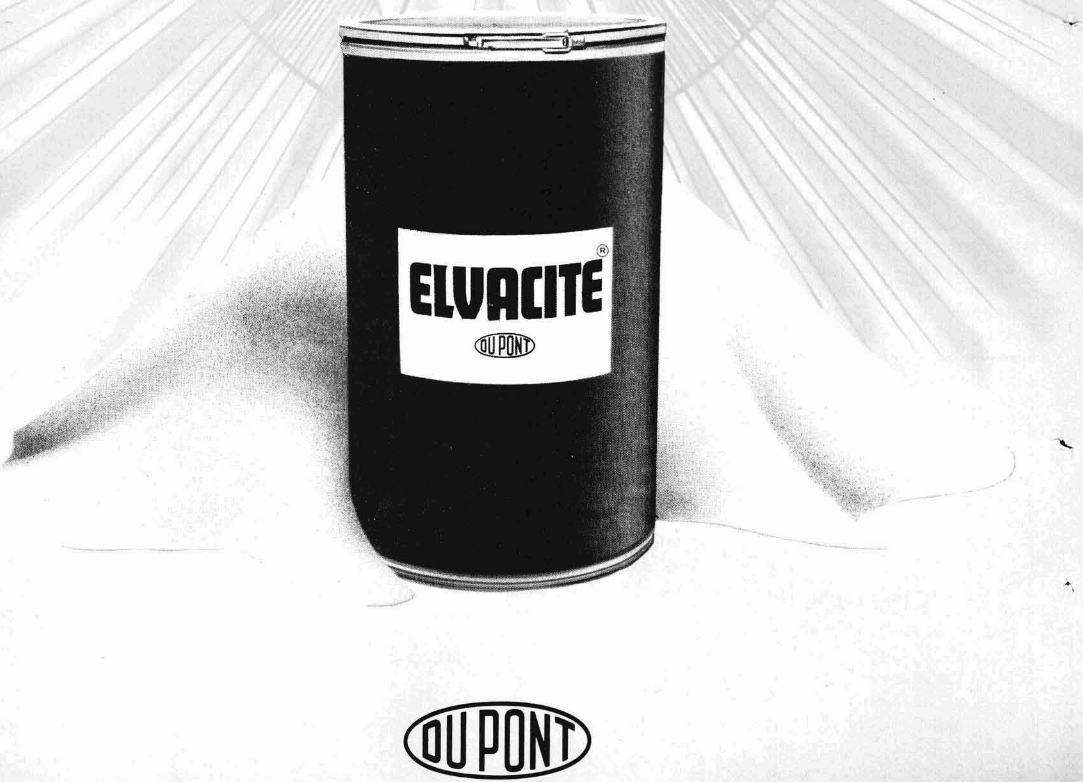

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tremely difficult to continue attracting volunteers.

- Industry help needed to expand co-op programs for students; high school science teachers might be considered for meaningful and responsible summer jobs—this would provide first-hand experience in the industry, which could help spur promoting career opportunities to their students.

Society Reports on Activities

The following are summaries of reports on Society Educational activities.

Baltimore

Sponsored mini-seminar at February Society meeting . . . Continuing scholarship award program; stipend has been increased to $1,000 annually. Committee screens applicants and administers the program . . . Educational Committee and Manufacturing Committee jointly sponsoring seminar on "Dispersion" in May . . . Mini Paint Show held on April 17.

Chicago

Activities are jointly sponsored with Chicago PCA. Annual SYMCO symposium to be held Nov. 5 and 6, will have as its theme, "The Right Stuff." . . . Management Development Seminar held April 23 . . . Will continue basic coatings technology course, given every other year; '84-'85 is "off year" and Committee is planning refinements and improvements to the program . . . Helped establish Master of Science program in coatings technology at DePaul University, to begin in the Fall of 1985 . . . Continuing scholarship program as well as supporting local Science Fair.

C-D-I-C

Major activity is developing presentations for Society monthly meeting (format is to have two speakers: pre-dinner speaker deals with paint-related technical topic; after-dinner speaker features general interest topic). Recent meetings included presentations on: physical fitness; estate planning; crime prevention; and coatings for spacecraft.

Cleveland

Development of two-day annual technical conference, "Advances in Coatings Technology," is main activity; this year's event, held March 12-13, featured four symposia: polymer and pigment dispersions; disperse systems; rheological modeling; and general topics . . . Initiated pilot program of co-sponsoring meetings of student technical society affiliates at Case Western Reserve (in conjunction with Society of Plastics Engineers) and at Kent State (in conjunction with American Chemical Society); supply industry speakers, with aim of promoting awareness of coatings and its career opportunities . . . Sponsoring, in conjunction with local PCA, student paper competition for college juniors; cash prizes will be awarded for winning research paper, based on list of suggested topics. Program has been publicized at all area schools, and appropriate faculty members are cooperating . . . Monographs and reference books have been purchased for Kent State and Case Western Reserve to augment their libraries in the coatings science area . . . Offer reduced student fees for attendance at monthly Society meetings and annual technical conference . . . Continuing sponsorship of area high school Science Fair, assisting in judging and providing prizes.

Dallas

Educational efforts being revitalized; Committee being reorganized and prospective programs being evaluated.

Detroit

Evening coatings courses sponsored at University of Detroit; courses currently being offered: Polymer Technology for Coatings; Surface Coatings Technology; Principles of Color Matching Technology; Fundamentals of Automotive Paint Systems; and a Coatings Laboratory Course; two polymer courses are also offered—students may apply credits for these toward a U of D degree . . . Sponsored a three-day lecture/lab course at U of D on Electrodeposition of Organic Coatings, which was conducted by Dr. George Brewer . . . Planning a one-day course in May on industrial painting, for production personnel . . . Continuing to hold Education Night, to which area high school science teachers are invited; attendance has stabilized—would like more participation by private schools . . . Annual FOCUS symposium (Future of Coatings Under Study) held April 9 on the topic of "Troubleshooting" . . . Renewed $1,000 tuition scholarship to support coatings program at Eastern Michigan University . . . Continuing two-hour lecture series on "Automotive Refinishing Basics."

Golden Gate

Sponsor, along with local PCA, of four-part course on Introduction to Coatings Technology; course includes tours to various industry plants in the Bay Area to familiarize students with processes involved in the manufacture of coatings. Offshoot of the course is a newly-established section designed for the Bay Area Coaters Association, a group of specialty producers who primarily serve the microcomputer/electronic instrument manufacturers—portion of course tailored to more specifically address their needs; meetings are held separately for this group in the San Jose area because of proximity of their members. Major factor in establishing this section was imposition of very stringent VOC regulations on miscellaneous metal parts coatings implemented by Bay Area Air Quality Management District last September—this program enabled their members to catch up quickly on general coatings technology and prepare for compliance ... Planning renewed effort to include painting contractors and engineering consultant firms in program for 1985-86 ... Continuing scholarship program and support of coatings section at Redwood City Public Library.

Houston

Scholarship program has been initiated; funds are committed to support children of Society members ... Efforts underway to establish coatings program at local community college.

Kansas City

Continuing contribution to scholarship program at University of Missouri-Rolla ... Participating in local Science Fair; assist in judging and award prizes (each of three winners receive savings bond and their school science departments receive check in matching amount). Presentations are made at Society monthly meeting, at which winning exhibits are displayed ... Planning slide-tape training program aimed at people new to coatings industry.

Los Angeles

Continuing sponsorship of paint technology course at Cal State–Los Angeles; committee provides instructors and coordinates all arrangements. This is basic course, aimed at imparting formulating skills; students successfully completing course are awarded certificates ... Scholarship program is being maintained; students must pursue studies in coatings-related area ... Continuing support of coatings section at City of Commerce Public Library.

Louisville

Continuing sponsorship of coatings courses at University of Louisville. Current schedule includes: Formulation of Chemical Coatings; Instrumental Analysis; and Principles of Formulation and Paint Calculations.

New England

Sponsoring technical paper competition for area college students; cash awards will be credited to student accounts toward tuition and/or books for up to three prize winners ... Initiating work on slide-tape program on "Opportunities and Careers in Paint Technology."

New York

Joint sponsorship of coatings courses with local PCA continues. Two-year, four-semester course on Understanding the Basics of Coatings is conducted at Fairleigh Dickinson University; each one-year, two-semester module is a complete course in itself and may be taken independently, with certificate awarded for successful completion. Each of the four semesters qualifies for three CEU's of credit. Laboratory Course for Paint Technicians (12 weeks) is designed for new technicians in the industry and consists of lectures, demonstrations, and "hands-on" lab exercises; lectures are given by industry specialists and conducted at lab of lecturer's employer. Course is offered every two or three years as interest dictates ... Continuing efforts to establish Coatings Center at Fairleigh Dickinson ... Continuing participation in Career Day programs at area schools; are hopeful of developing literature and lab experiments (college level) for these efforts.

Pacific Northwest

Continuing sponsorship of basic coatings technology course at British Columbia Institute of Technology ... Sponsored advance course on "Latex and Water-Borne Finishes."

Piedmont

Planning mini-symposium in Spring on career opportunities in coatings ... Promoting local industry support for summer co-op program for coatings students.

Rocky Mountain

Little or no activity in recent years. Committee being reorganized to initiate meaningful programs.

St. Louis

Continuing support of scholarship program at University of Missouri–Rolla ... Tenth Annual Education Night will be held in April; local high school science and chemistry teachers are invited to acquaint them with career opportunities in coatings ... Will again provide cash awards to winning exhibits in local Science Fair (for both high school and primary school students) ... Instituted award to recognize above-average contributions by local paint technicians.

Southern

Close liaison maintained with University of Southern Mississippi through financial support and sponsorship of annual Water-Borne and Higher-Solids Symposium; USM students invited to present papers at Society Annual Meeting.

Toronto

Coatings courses sponsored at George Brown College; diploma course there being reviewed by Board of Governors for accreditation.

Western New York

Activities being reactivated; scholarship fund established for children of Society members; planning increase in the number and amounts of scholarships, as well as exploring supplementary means of raising funds for the program ... Studying joint venture with Technical Committee.

Special Discount Fares Available from TWA To Annual Meeting in St. Louis

Special arrangements have been made with TWA to offer discounted fares within the U.S. to/from St. Louis, MO, for the October 7–9 Annual Meeting and Paint Show at the Cervantes Convention Center. These special fares are available only when you call the unlisted toll-free number (800-325-4933); in Missouri only, call (800-392-1673). Be sure to ask for lowest fare available! You must give the FSCT Convention number which is:

#9911077

THIS PAPER WAS AWARDED SECOND PRIZE IN THE 1984 ROON AWARD COMPETITION

Dispersion of (Magnetic) Pigment Powders In Organic Liquids

H.F. Huisman
PD Magnetics B.V.[*]

The dispersion of a magnetic pigment in a liquid medium involves four distinct processes: (1) initial wetting of the pigment powder particles; (2) mechanical breaking down of the powder particles to a smaller size; (3) densifying the small but "aggregated" particles; and (4) displacement of air from the pigment particle surfaces and stabilization of the particles against flocculation.

The densification of the aggregates is a very important process in dispersing magnetic pigments, but there are strong indications that it occurs also in the dispersing process of nonmagnetic pigments. The densification process can be followed by determining the average effective particle density of the aggregates by means of mercury porosimetry measurements. If the pigment is dispersed in a high speed sand mill, the densification process follows kinetics, which are best described by a relation linear in log time. The initial part of the breakdown process can also be described by the same relation (linear in log time), but it slows down much earlier than the densification process. This indicates that the two processes are distinct.

The properties derived from flow curves, which were measured during the dispersion process, cannot be explained on the basis of pigment volume alone, as is done in most viscosity equations for semi-concentrated pigment dispersions. Also, the Mooney approach, which in some way takes into account the particle size, does not describe our flow data properly.

By introducing a particle size effect in the viscosity equation the change in properties, derived from the flow curves, can be understood. The effective pigment volume and the particle size are equally important for analysis of the flow data. The flow curve analysis can also be used to understand and optimize the dispersion process of inorganic pigments.

INTRODUCTION

Dispersion of pigment powders in liquids has been the object of research for several decades. The basics of pigment dispersion have been elucidated in many outstanding papers. These fundamentals are so well established now that they are described in text books[1–3] and are common knowledge for all workers in the field. But despite the extensive literature, there is one aspect that has received relatively little attention. The behavior of pigment dispersions as the dispersion process proceeds is not often described, and, if it is, the description has a more or less qualitative character.[1–4] This is rather noteworthy because every paint technician has seen typical changes in the rheological characteristics of a dispersion as the milling process continues, and often uses this gradual change more or less intuitively as a technique to optimize the paint formula and the milling procedures.[5]

In studying the dispersion of magnetic and nonmagnetic pigment powders at PD Magnetics, it became obvious that pigments in ready-for-use magnetic tape dispersions are not present as single (primary) particles but that the independent entities (flow units) are aggregated[†] particles,[6–9] and that at least for magnetic pigments these "aggregates" mainly originate from the original powder.[6, 7] However, if aggregates are present to such a large extent, the effective pigment volume concentration, the

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Presented at the 62nd Annual Meeting of the Federation of Societies for Coatings Technology in Chicago, IL, October 25, 1984.

[*] Molenstraat 37, 4902 NM Oosterhout, The Netherlands.

[†] By aggregates we include all particles that are not single (primary) particles and that are held together by some force; we do not distinguish between aggregates, agglomerates, flocculates, clusters, etc.

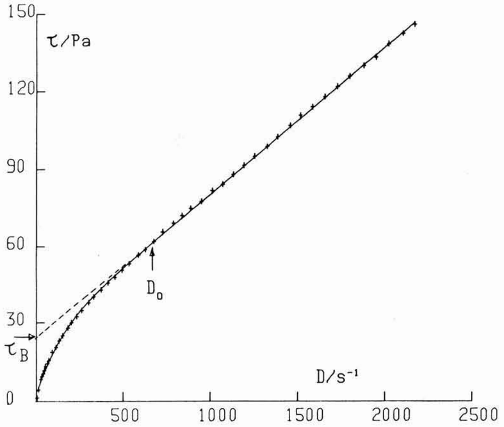

Figure 1—Typical flow curve of magnetic dispersion

basis for all evaluations of pigment dispersions and coatings, cannot be calculated from weight percentages by using the "handbook value" of specific gravity of the pigment as the conversion factor.

One must use the average effective particle density* to calculate the pigment volume concentration.[10] In a number of cases this effective particle density can be determined from mercury porosimetry measurements.[10, 11]

The characteristics of the magnetic particles, aggregates, in dispersions was used to interpret the behavior of a series of magnetic iron oxide dispersions of which the milling time was the only variable.

EXPERIMENTAL

Materials

Dispersions of acicular $\gamma-Fe_2O_3$, MO 2228HC from Pfizer, were prepared under the following conditions: Milling apparatus—Pendraulik Rührwerk LD 50, laboratory pearl mill (size: 1.5 litres), closed airtight and cooled with tap water; grinding media—glass beads 1 mm diameter; and milling time—varied from 1 to 96 hours.

The composition of the dispersions was based on a standard audio formulation[12] containing a polyester polyurethane blended with a phenoxy resin, a dispersant, additives for good mechanical performance of the magnetic tapes, and a solvent mixture of tetrahydrofuran and cyclohexanone. Total solids (magnetic pigment, binders, dispersant, and additives) was 35 wt %. The magnetic pigment on solids was 75 wt %. Magnetic coatings were made on a laboratory 2″ coating machine.[13] After calendering the magnetic layer to obtain a smooth surface, the coated polyester film was cut to a prescribed width to give magnetic tapes.

Table 1—Effective Particle Density

Dispersing Time [hr]	$V_p^a \times 10^4$ [m³/kg]	d_{agg}^b [g/cm³]
0	5.15	1.37
1	3.63	1.73
2.5	3.54	1.76
6	3.09	1.92
16	2.78	2.04
40	2.46	2.18
96	2.17	2.33

(a) Volume of the pores in the aggregates.
(b) Specific gravity of iron oxides 4.6 [g/cm³].

Average Effective Particle Densities

The average effective particle density is obtained by reclaiming the pigment from the dispersions.[11] About 10g of the magnetic dispersion was dried and the binder material extracted with THF in a Soxhlet apparatus.

Carbon analysis of the dried powders showed that all binder and dispersant was removed.

Of the remaining powder the average particle density was measured with mercury intrusion porosimetry. Details of the equipment, the measuring procedure, and data evaluation of the data were described earlier.[14]

The average effective particle density, d_{agg}, is calculated from the pore volume in the aggregates, Vp, with

$$d_{agg} = \frac{1}{Vp + 1/d_p^\circ} \qquad (1)$$

where d_p° is the specific gravity of the magnetic pigment.

Sedimentation Volumes

Relative sedimentation heights were obtained. Six grams of the dispersions were diluted with 15 mL of the solvent mixture (THF/cyclohexanone) and after 24 hours the sediment height in a flocculation tube was measured. The heights are in mm and include the thickness of the bottom of the tube.

Viscosity Measurements

All viscosity measurements were obtained at 25°C using a Haake rotational viscosimeter, type Rotovisko RV 3, with a rotating inner cylinder and a rate of shear in the range 0-2250 sec^{-1}. The distance between the inner and outer cylinder was 1 mm and therefore no correction for slippage at the walls of the cylinder was needed. The viscosimeter was connected with a Philips microcomputer (PM 4410) for ease of data handling.

The measuring program of the PM 4410 controls the viscosimeter and lets the shear rate rise in 10 minutes from the lowest value to 2250 sec^{-1}, maintains the highest shear rate for one minute, and finally lowers the shear rate to its lowest value also in 10 minutes. All data given are taken from the portions of the flow curves corresponding to descending shear rates, because the descending curves are more reproducible than the ascending curves for magnetic dispersions. Improved accuracy is obtained by fitting the experimental data points to a curve according to an equation developed by Kuin,[15] derived by analyzing the energy dissipation processes involved in Couette flow.

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*According to British Standard 2955: 1958 and British Standard 4359: Part 2: 1971.

In terms of shear stress, the Kuin equation reads:

$$\tau_{tot} = \tau_Z + \eta_N D + \frac{\eta_A}{K}(1 - e^{-KD}) \qquad (2)$$

In which τ_Z = yield value, D = shear rate,
η_N = the slope of the linear part of the curve,
η_A = and K are constants, of which the physical meaning will be described.[15]

The first and second terms of equation (2) have their usual meaning. The third term is a measure for the elastic deformation of the flocs and describes mathematically the transition region between τ_Z and the linear part of the flow curve. The constant K, a relaxation time, determines the value of D_o, the shear rate at which the flow curve becomes linear and $(1 - e^{-KD})$ can be neglected. The equation gives an accurate mathematical description of the flow curve of concentrated and semi-concentrated flocculated dispersions of which the curve of *Figure* 1 is a typical example. After computer fitting the experimental-data with equation (2) the Bingham viscosity, η_N, and the Bingham yield value, $\tau_B = \tau_Z + \eta_A/K$, are calculated.

EXPERIMENTAL RESULTS

Average Effective Particle Density

The particle densities of the reclaimed powders are given in *Table* 1. The pore volume in the aggregates decreases, and consequently the average effective particle density increases as a function of milling time. For both variables, Vp and d_{agg}, the best fit with milling time is logarithmic. The correlation coefficients are not significantly different for either variable. In *Figure* 2 the relation of d_{agg} to milling time is shown, the solid line being the fitted curve. The aggregates densify more slowly as milling time increases. If the linear time scale t is then transformed into log t, as a new independent variable, aggregate densification assumes pseudo zero order kinetics.

Table 2—Sedimentation Heights

Milling Time [hr]	d_{agg} [g/cm³]	Sedimentation Height [mm]
0	1.37	—
1	1.73	14.60
2.5	1.77	13.65
6	1.92	12.20
16	2.04	11.35
40	2.18	10.40
96	2.33	9.45

The same relation is generated if the coerciveness of the dried, magnetically unoriented samples is measured instead of the aggregate density. The coerciveness, Hc, measured with a vibrating sample magnetometer, and the milling time, t, are related according to the equation:

$$Hc = 315 - 4.8\, ln(t) \qquad (3)$$

with a correlation coefficient of 0.96.

It has been shown[6] that the Hc and the aggregate density are linearly related; therefore equation (3) is equivalent to the relation in *Figure* 2.

This result means that the effective pigment volume concentration in dispersions and in the coatings made from these dispersions decreases linearly with the logarithm of milling time.

Sedimentation Volumes

Sedimentation heights, directly related to sedimentation volumes, are given in relation with milling time and aggregate density in *Table* 2. The sedimentation height is plotted as a function of the reciprocal of the aggregate density in *Figure* 3. There is a very good linear fit; only the point that represents the shortest milling time (1 hr) deviates slightly from the fitted curve.

This is because the surface of the aggregates formed by breaking down the original powder particles undoubtedly is irregular in the early stages of the dispersion process. After some time a more or less steady state in particle shape is reached.

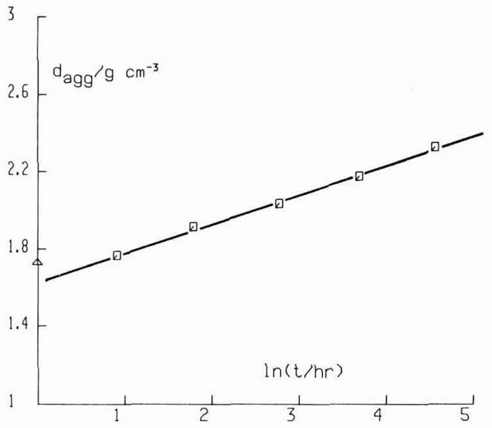

Figure 2—Aggregate density with milling time. Δ is the aggregate density of the original pigment powder. Solid line is the fitted regression curve

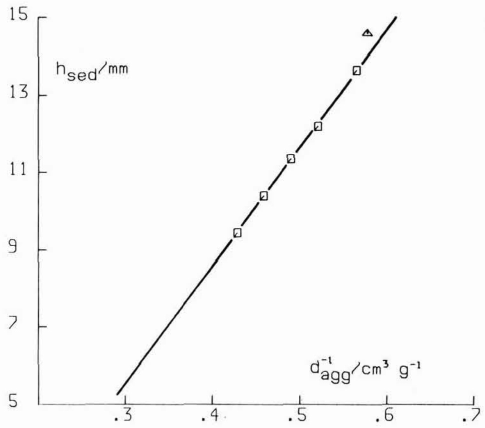

Figure 3—Sedimentation height vs the reciprocal of the aggregate density. Δ is the one hour point. Solid line is the regression curve

This means that if the shape and the surface of the particles have been adapted to the specific shearing and impact forces, which the particles endure in the dispersion process, the relation shown in *Figure* 3 is valid. *Figure* 3 proves that the sedimentation volumes are directly related to the reciprocal of the aggregate density and not to the volume of the pigment, Φp, as calculated with the reciprocal of the skeleton density. This result is in agreement with the findings of Michaels and Bolger.[16]

The result also means that the packing of sediments on the basis of the effective pigment volume is constant, except for the first point (1 hr dispersion). This is realistic because particle-particle interaction, as well as the overall stability of the different dispersions, remains essentially constant for dispersions with a milling time of 2.5 hrs and more.

Properties from Flow Curves

The results of the analyses, the Bingham viscosity, and the Bingham yield value are given in *Table* 3 in relation with milling time and the average particle density.

Bingham Yield Values

The Bingham yield value is related to the attractive interactions between the flow units[17] and therefore depends on the square of the particle volume concentration. The equation for this dependence is:

$$B = \frac{3\phi^2}{2\pi^2 a^3} E_{sep} \qquad (4)$$

where ϕ is the volume fraction of flow units with radius a and E_{sep} is the energy needed to separate a doublet of flow units. This dependence has been amply confirmed and documented.[18–20]

If ϕ is based on the skeleton density of the particles (and is therefore constant), the data in *Table* 3 do not fit equation (4). In order to explain the observed decrease of τ_B with milling time, E_{sep} would have to decrease faster than a^3.

This is not realistic because for spherical particles the van der Waals attraction energy and therefore also E_{sep} is proportional to a^2.[21, 22] This means that τ_B at constant volume concentration must be proportional with 1/a, which has been confirmed experimentally.[19] Therefore the decrease in τ_B with milling time cannot be explained assuming a constant pigment volume concentration, unless one makes the unlikely assumption that particle size increases with milling time. If, however, the aggregate density is used to calculate the effective pigment volume concentration, the expected relation is found with a reasonable correlation coefficient.

Table 3—Flow Curve Analysis

Milling Time [hr]	d_{agg} [g/cm³]	ϕ_{agg}[a]	ϕ_p[b]	η_{Nr}[c]	τB [Pa]
0	1.37	—	—	—	—
1	1.73	0.153	0.058	1.928	27.6
2.5	1.77	0.147	0.057	1.735	24.5
6	1.92	0.137	0.057	1.729	23.6
16	2.04	0.130	0.058	1.827	18.6
40	2.18	0.121	0.057	1.889	11.1
96	2.33	0.116	0.058	2.215	9.3

(a) $\phi_{agg} = \frac{26.25/d_{agg}}{26.25/4.6 + 73.75/d_b}$.

(b) $\phi_p = \frac{26.25/4.6}{26.25/4.6 + 73.75/d_b}$.

$d_b = 0.789$.

(c) $\eta_N/\eta o = \eta_{Nr}$.

The experimental Bingham yield values are plotted in *Figure* 4 as a function of the square of the effective pigment volume concentrations, ϕ_{agg}. The data for the relative short milling times (1 and 2.5 hrs) deviate from the fitted curve. An explanation may be that the size and shape of the particles are still irregular and the distance of nearest approach for two flow units is relatively large leading to a lower E_{sep} and to a lower τ_B.

Hunter and Frayne[23] derived a relation for τ_B which is slightly different from equation (4). It shows τ_B as a linear function of the floc volume ratio, equal to d_p^o/d_{agg} in our notation. This means that τ_B should be a linear function of $(1/d_{agg})$. This relation is shown in *Figure* 5. Though the coefficient of correlation is less than for the relation shown in *Figure* 4, the accuracy of the data does not allow us to make a statement about which relation fits best. The results of *Figures* 4 and 5 show very clearly that the individual flow units are the aggregates, with average density d_{agg}, and not the primary particles. This conclusion does not change if larger flocculates, of which the size depends on the rate of shear, are formed from the aggregates.

Bingham or Plastic Viscosity, η_N

Above the critical rate of shear, D_o in *Figure* 1, the interactions between individual flow units have been overcome by the shear field, and the relative slope of the linear part of the flow curve, η_N, is assumed to be only a function of pigment volume concentration and of particle size. The first attempt at expressing viscosity as a function of concentration is due to Einstein.[24]

$$\eta_{Nr} = \eta_N/\eta_o = 1 + K_E\phi \qquad (5)$$

where η_{Nr} is the relative viscosity of the particulate matter, η_o is the intermicellar viscosity, ϕ is the pigment volume concentration, and K_E is the Einstein coefficient which depends upon the shape of the particles and is equal to 2.5 for spheres. This equation is only applicable in very dilute suspensions.[25] Numerous equations have been proposed to extend this equation to higher concentrations of suspended material.[26] Generally one uses a series expansion of the concentration, e.g.[27]

$$\eta_{Nr} = 1 + 2.5\,\phi + B\phi^2 + C\phi^3 \ldots \qquad (6)$$

This and similar equations[28] show a monotonically increasing relative viscosity with volume concentration. Therefore they cannot explain increasing plastic viscosity either with a constant concentration, if ϕ_p is used, or with a decreasing volume concentration, if ϕ_{agg} is used. The same kind of observation, increasing viscosity with milling time, was made by Jefferies.[4] He postulated an in-

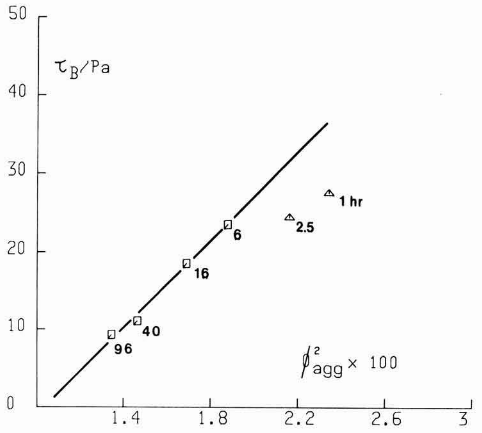

Figure 4—Bingham yield values vs the square of the effective pigment volume concentrations. Gillespie relation[23]

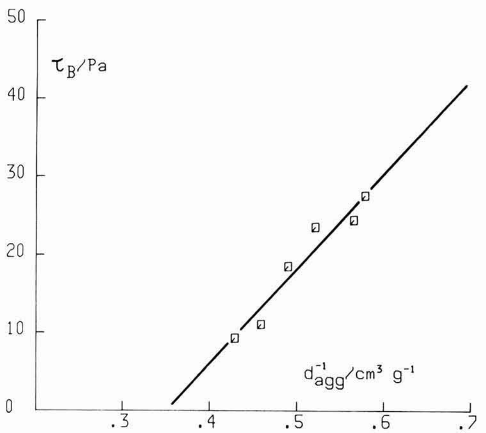

Figure 5—Bingham yield values vs the floc volume ratios. Hunter and Frayne relation[28]

crease in the amount of polymer adsorbed on the pigment surface, such adsorption being dependent on the provision of energy which is effective at the pigment medium interface. This assumption is very unlikely and has never been found in polymer adsorption studies. In the system we investigated, polymer adsorption is very low due to the presence of a very effective dispersant which preempts the interface, and certainly does not increase with milling time.[29] There are numerous indications that the viscosity increase is caused by decreasing particle size,[30-34] a logical consequence of the dispersion process.

The equation theoretically derived by Mooney using a functional analysis[35] can in principle account for particle size effects. The different terms explain self-crowding, crowding among particles of different sizes, and hydrodynamic interaction. For monodisperse systems the relation becomes

$$\ln \eta_{Nr} = \frac{K_E \phi}{(1 - S\phi)} \qquad (7)$$

where K_E and S are constants, representing the Einstein coefficient and the inverse of the maximum volumetric packing factor respectively. Although the primary particles are acicular, K_E is reasonably constant after one hour of milling because the orientation ratio of the particles in a magnetic field, a measure for the acicularity of the flow units, hardly increases with milling time. Therefore S is the only variable that can account for an effect of the size of the particles with increasing milling time. However, the packing efficiency of the pigment increases with milling time, which is in agreement with the sediment volume. This means that S, the reciprocal of the volume packing, decreases and $_{Nr}$ should decrease also. This is not in agreement with the actual viscosity data. Saunders[32] found by using S as the adjustable parameter that S increases with decreasing particle size. Because Saunders did not measure the packing factor, proof of the original Mooney interpretation is not debatable. For our systems we must conclude that the Mooney equation does not account for the effect of particle size in a proper way. Equations which contain specific terms for the influence of particle size on viscosity were developed by Weltmann and Green[30] for nonaqueous TiO_2 suspensions and by Oldroyd[34] and by Rajagopal[33] for emulsions.

In the Weltmann and Green equation:

$$_{Nr} = A \exp(B\phi) \qquad (8)$$

A and B are constants of which B depends on the average particle size and increases with decreasing diameter. They found experimentally that B is a function of the logarithm of the particle diameter d:

$$-B = f(\ln d) \text{ or } d = f(e^{-B}) \qquad (9)$$

With the data from *Table* 3 and equation (8), B can be calculated. By using ϕ_p, one gets a series of B's (B_1), and, by using ϕ_{agg}, another series of B's (B_2). B_1's and B_2's are tabulated in *Table* 4. In a dispersion process the average particle diameter decreases and the change of d with time gives information about the order of the dispersion action. The best fit is with ln t and the following relation holds.

$$e^{-B} = \text{constant} + \text{constant} \ln t \qquad (10)$$

Applying equation (10) on the two series of B gives, respectively,

$$e^{-B_1} = \text{constant} - 2.10^{-4} \ln(t), \text{ with } r^2 = 0.86 \qquad (11)$$

and

$$e^{-B_2} = \text{constant} - 6.9 \times 10^{-3} \ln(t), \text{ with } r^2 = 0.996 \qquad (12)$$

In *Figure* 6 the correlation function [equation (12)] and the calculated B's are shown. In both cases the 1 hr and 96 hr points are left out.

Another equation describing the effect of particle size on viscosity was developed by Rajagopal.[33] The equation

$$\eta_{Nr} = 1 + A\,\phi \qquad (13)$$

can be considered an approximation of the Weltmann and Green equation. A series expansion of equation (8) makes that clear. In equation (13), A is a constant which is considered to be a function of 1/d. With the data from *Table* 3 one gets again two series of A's: A_1's with ϕ_p and A_2's with ϕ_{agg} (*Table* 4).

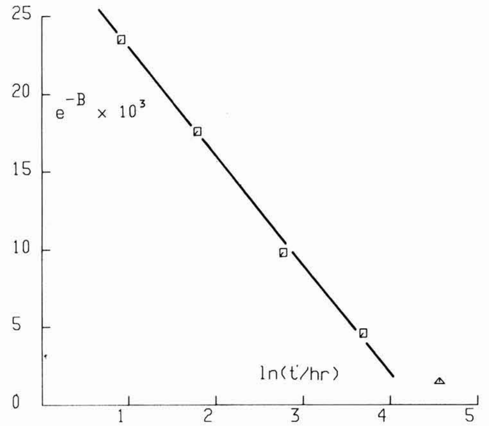

Figure 6—Effective particle diameter, in arbitrary units estimated with the Weltmann and Green equation,[9] vs the logarithm of milling time

Also, here the best fit of d (= 1/A) is with $ln(t)$ and we find, respectively,

$$1/A_1 = \text{constant} - 0.005\, ln(t), \text{ with } r^2 = 0.88 \qquad (14)$$

and

$$1/A_2 = \text{constant} - 0.024\, ln(t), \text{ with } r^2 = 0.98 \qquad (15)$$

One sees that the relations on the basis of the aggregate volume, ϕ_{agg}, give better correlation coefficients than on the basis of the skeleton volume.

Assuming that the Weltmann and Green, the Rajagopal relation, or both are correct, the decrease in average particle size follows a kinetic path which is best described by a relation zero order in log t. Contrary to the densification process, this process slows down considerably after 40 hours of milling. These results are qualitatively in agreement with the milling analyses given in the literature.[36-41]

DISCUSSION

The model used to interpret the sedimentation and viscosity data is based on the premise that in a dispersion of particulate pigments the structural and ultimate working units are aggregated particles and not the primary particles, and that these "aggregates" persist throughout all practical operations.

Table 4—Particle Size Parameters

Milling Time [hr]	ϕ_p	B_1[a]	A_1[b]	ϕ_{agg}	B_2[a]	A_2[b]
1	0.058	11.32	16.00	0.153	4.29	6.065
2.5	0.057	9.67	12.859	0.147	3.75	5.000
6	0.057	9.61	12.789	0.137	4.04	5.321
16	0.058	10.34	14.172	0.130	4.62	6.323
40	0.057	11.16	15.596	0.121	5.38	7.347
96	0.058	13.71	20.948	0.116	6.50	10.474

(a) From $\eta_N / \eta_o = e^{B\phi}$ [equation (8)]
(b) From $\eta_N / \eta_o = 1 + A\phi$ [equation (13)]

From earlier work[6, 8, 10, 11] the conclusion was drawn that the aggregates originate mainly from the pigment powder particles and that the structural features incorporated in the dry powders show up in the final performance of the dispersions. This is supported by the work[16, 18, 42, 43] describing the research on flocculated systems, and the knowledge that in most pigment preparations a flocculation step is built in to separate the pigment particles from their reaction fluids. This view is also supported by the often seen beneficial effects of dry pigment treatments, such as compaction and micronizing.

The "aggregates" must have a considerable strength because they have endured the strong forces of the dispersion process; therefore they can be identified after reclaiming the pigment from the dispersion.[11] The effective volume of the aggregates is characterized by their effective particle density, which can be derived from mercury porosimetry measurements.*

The process of dispersing a magnetic pigment powder in a liquid may now be divided in four stages:

(I) INITIAL WETTING OF THE PIGMENT POWDER: This process is reasonably understood and described in many textbooks. The pigment volume concentration is given in reference [10].

$$PVC = \frac{Wp/d_{agg}}{\dfrac{Wp}{d_{agg}} + \dfrac{1-Wp}{db}\left\{1 - f\left(\dfrac{1}{d_{agg}} - \dfrac{1}{d_p^\circ}\right)\dfrac{Wp}{1-Wp}\cdot db\right\} + V_{por}} \qquad (16)$$

where Wp = Weight fraction of the pigment
1 − Wp = Weight fraction of the rest of the system
d_{agg} = Effective particle density of the aggregates
db = Density of the binder solution
d_p° = Skeleton density of the pigment
f = Wettability factor
V_{por} = Air in the system but not in the aggregated particles

This equation explains why in the initial stage of the dispersion process the changes are so tremendous.[45] As wetting and dispersion goes on, d_{agg} becomes larger, f goes from 0 (no wetting) to 1 (complete wetting) and V_{por}, a measure for the air in the system, goes slowly to zero.

(II) BREAKING DOWN, BY MECHANICAL ENERGY, OF THE POWDER PARTICLES INTO SMALLER UNITS: This process follows a kinetic path that is zero order in log(t) but after some time this rate slows down and the final particle size is reached asymptotically.[39-41]

The relation, linear in log(t), found experimentally for the breakdown process is not a description of a simple kinetic relation such as a zero, first, or second order reaction rate law. It really means that the reaction rate is a function of reaction time, and that it decreases continuously until it becomes zero.

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*In principle, N_2 or Ar condensation (BET) technique also may be used.[44]

A kinetical model that contains this aspect is the "logistic growth model,"* which has been developed for processes that reach their final value asymptotically and of which the reaction rate decreases with reaction time. Many examples of this type of process can be found in naturally occurring reactions. This model was also used extensively in the report of the Club of Rome Project.[46] The equation that can be used to fit the particle size data (e^{-B} in *Table* 4) is

$$e^{-B} = \frac{A\,D}{D + (A - D)\exp(-C.t)} \qquad (17)$$

where

A is the final value of e^{-B}, the final particle size

D is the initial or start value of e^{-B}, the initial particle size

C is $\alpha\ .\ A/(A - D)$, where α is the reaction rate constant at $t = o$, and is equal to zero when $e^{-B} = A$.

In *Figure* 7 the experimental data and the fitted curve are given. This figure shows that there is a good fit with equation (17), and that the breaking down part of this dispersion process in a pearl mill follows the kinetic model that is the basis of the logistic growth approach. To break down the powder particles, sufficient force must be exerted to overcome the forces holding the particle together. Most of the disruption is done by the shear transmitted through liquid surrounding the particle. An estimate for this hydrodynamic force (F_H) is given by Goren.[47]

$$F_H = f(\eta_s\,.\,a^2\,.\,D) \qquad (18)$$

where η_s is the liquid vicosity, a is the radius of the particle, and D is the shear rate.

As long as the particles are relatively large, the hydrodynamic disruption force exceeds considerably the forces holding the particles together. In this stage the disruption rate is determined by the volume concentration of the particles and the milling parameters, which can be considered as constant in the milling series. For small particles the hydrodynamic force is too small to disrupt the particles and only the particles that are larger than a limiting value have a chance of being broken down. This means that the reaction rate must slow down and that the final situation is reached asymptotically. In our experiments this decrease becomes noticeable after about 40 hours of milling.

(III) DENSIFICATION OF THE AGGREGATES: This process is a result of (1) physical impact; (2) particle-particle attrition; and (3) shear forces, which tend to align the acicular particles in the aggregates. The overall result of this process depends on the strength of the aggregates, on the particle volume, and on the milling parameters. Most of the densification is accomplished by impact on the particles by the milling media. Wahl[38] derived a simplified model for the milling action in a high velocity media mill. His analysis, adapted to the densification process, leads to a pseudo zero order reaction rate law for such a process.

This is supported by the data given by Nakamae, et al.[48] They measured for several magnetic systems the magnetic saturation flux density (J_s) as function of milling time. Because J_s is linearly related with aggregate density,[6,10] the relation is nicely demonstrated.

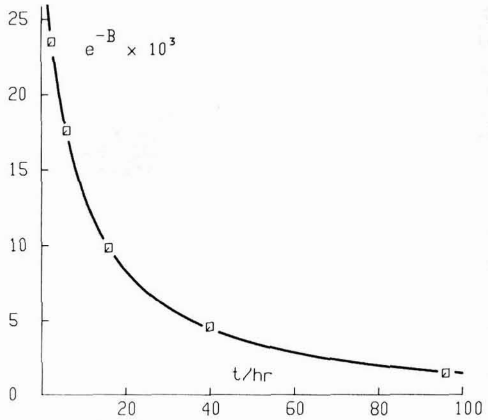

Figure 7—Effective particle diameter (in arbitrary units) as function of milling time and fitted with the logistic growth model (solid curve)

Also our data show an almost perfect pseudo zero order reaction rate law. This is illustrated by plotting aggregate density versus the logarithm of milling time (see *Figure* 2). There is no significant deviation from the linear relation until the longest milling time (96 hours), contrary to the breaking down process which slows down considerably after 40 hours of milling. This means the two processes, breaking down of the powder particles and densification of the aggregates, are distinct processes.

Because the two processes are mainly accomplished by different mechanisms, shear and impact, one can control the two processes almost independently. An extreme example of this independence is first compacting the dry or slightly wet powder to a desired aggregate density and then dispersing the powder in a liquid with high speed stirring equipment. This also explains the often seen beneficial effect of working with densified or micronized (magnetic) pigment powders.

(IV) STABILIZATION OF THE PARTICLES BY THE ADSORPTION OF STABILIZING MOLECULES (BINDERS AND/OR DISPERSANTS): This aspect of the dispersion process is well covered in the textbooks. A new experimental approach for determining the adsorption isotherms and the competing interaction between surface active and polymeric molecules has been published recently.[29]

CONCLUSIONS

In the process of dispersing (magnetic) pigments one can distinguish four different process steps instead of the generally accepted three. To the wetting, the breakdown, and the stabilization steps one has to add a step in which densification of the aggregated particles takes place.

The densification process follows a pseudo zero order reaction rate law with log t as the independent variable.

The process of breaking down the powder particles into smaller units also follows a pseudo zero order rate in the

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*The author thanks Mr. C.J.F.M. Rasenberg for bringing this model to his attention.

beginning. However, after about 40 hrs the rate constant decreases very rapidly and the final size is almost reached at that time. A logistic growth model, adapted to particle size data, describes the breakdown process perfectly.

The densification step and the breakdown step are independent processes.

Analysis of the flow curves derived from the dispersions with increasing milling time showed that the Newtonian or (Bingham) viscosity could not be interpreted with the usual concentration dependence of the relative viscosity, and also that the Mooney equation did not describe the concentration dependence in a proper way. This inadequacy must be attributed to the fact that those equations do not properly account for the effect of particle size. The Weltmann-Green equation describes the results and could be used to derive a relative particle size.

The decrease in the effective pigment volume, on the basis of the measured aggregate density, and the decrease in particle size, derived from the WG equation, with dispersion time explains the change in the properties derived from the flow curves.

The analysis of the flow curves shows that rheological measurement during the dispersion process is a very powerful tool for understanding and optimizing the dispersion process of pigments.

ACKNOWLEDGMENTS

The author thanks PD Magnetics' management for permission to publish this paper, Mr. P. Kuin from Philips Central Research for the viscosity measurements, and Mr. C.J.F.M. Rasenberg for assistance in the experimental work and his contributions in the interpretation of the results, and Mr. D. M. Hiller (Du Pont, Wilmington) for his editorial comments.

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A New Computational Method For Determining the Shear Rate Dependent Viscosity of Coatings

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A new mathematical model to determine coating viscosities over a wide range of shear rates has been developed. The method is based on a spring relaxation technique using a Brookfield viscometer to measure the drag forces in the coating material. The spring relaxation data was transformed into a three parameter mathematical model so that the data could be conveniently differentiated to obtain viscosity profiles. As a result, the viscosity profiles of a nonaqueous dispersion (NAD) lacquer at medium (10 sec-1) to ultra-low (0.001 sec-1) shear rates were determined. The general characteristics of these profiles are consistent with published data. In addition, this method has the capability of calculating the coating viscosity for both power law and Newtonian regions.

INTRODUCTION

An understanding of rheology is extremely important for the proper application of automotive coating materials. Hence, it is necessary to know the viscosity of these coatings over a very wide range of shear rates (typically from 0.001 to 10,000 sec-1). Viscosity, however, is known to change as a function of the shear rate.[1] Therefore, a single viscosity measurement at a particular shear rate is inadequate in determining the rheology and application properties of the coating material. Usually, the viscosity can be obtained for high shear rates without difficulty. In most cases, the viscosity at high shear rates is equal or close to its Newtonian value. However, there are very few instruments which can be used to measure the viscosity of coating materials at ultra-low shear rates (i.e., below 0.1 sec-1). In addition, instruments which can be used to measure low shear rate viscosities are often too expensive for many laboratories or for quality control purposes.

Patton[1] developed a method for the viscosity measurement of paints in the shear rate range of 0.001 to 1.0 reciprocal seconds using a cone/plate spring relaxation technique. With his method, a relatively inexpensive and routine procedure could be used to measure and interpret the viscosity of coating materials over a wide range of low shear rates. Smith[2] refined the data analysis associated with this method by the application of a high speed computer instead of a tedious graphical procedure. His computational method was based on a quadratic equation coupled with successive substitution to carry out the viscosity calculation. No model is implied in Patton's method, and Smith's general method is also empirical, although he described a modified approach using a power law model. In the absence of any model, viscosities cannot be predicted beyond the limits of the actual data. In Smith's general method, the calculated viscosities can be obtained only within four data points of the extremes because of the curve-fitting algorithm used. On the other hand, if data can be fitted to an adequate mathematical model which describes both kinds of limiting behavior (i.e., power law and Newtonian behavior) as well as the region in between, then the paint can be characterized over the whole range. There is one model which is reported to describe the behavior of paint over the entire viscosity range. It is the Casson equation[3]:

$$[\eta_\gamma]^n = [\eta_\infty]^n + [\tau_o/\gamma]^n \tag{1}$$

Presented by Dr. Kuo at the 62nd Annual Meeting of the Federation of Societies for Coatings Technology in Chicago, IL, October 25, 1984.

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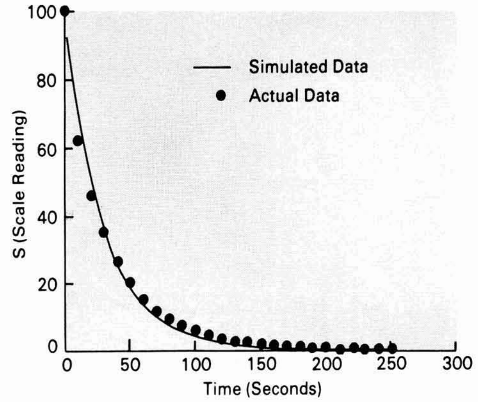

Figure 1—Comparison between the experimental data and the computer simulated data using equation (1) with the following parameters: A = 94.15; B = 0.0318; C = 0.5

where

τ_o = yield value,
γ = shear rate,
η_γ = viscosity at shear rate γ,
η_∞ = limiting viscosity at high shear rate,
n = exponent, typically close to 0.5

This expression approaches Newtonian behavior at high shear rates and power law behavior at low shear rates, where $\eta \propto \tau_o/\gamma$. It also will fit in the intermediate range when the exponent n is properly adjusted. Although in principle this model could be applied to the fitting of experimental data, in practice it is not as convenient as the one described here. This one, like the Casson model, also reflects the two kinds of limiting behavior, and adequately fits the region in between. Our model resembles the Bingham model.

EXPERIMENTAL

The apparatus used in this experiment consisted of an eight-speed Brookfield Synchro-Lectric Full View dial viscometer,[4] an ultra-low viscosity adapter, and a constant temperature bath (temperature range from −30 to +120°C). The experimental procedure for measuring the viscosity of paint is described below:

(1) Set the bath to control the temperature.

(2) Place 16 cc of paint solution into the cylindrical sample holder.

(3) Insert the cylindrical spindle into the sample holder.

(4) Rotate the spindle for 5 sec at 3 rpm then let the spring relax to zero (unstrained state) so that the history of agitation of the paint immediately preceding the viscosity measurement is carefully controlled.

(5) Manually twist the spring to a scale reading of 100, then let it relax to zero while taking readings at set time intervals.

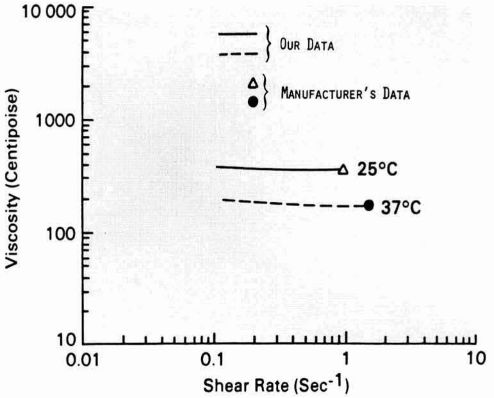

Figure 2—Viscosity-shear rate profile of standard material (S-200)

MATHEMATICAL ANALYSiS

The approach for converting the raw data to a viscosity profile over a wide range of shear rates requires a suitable mathematical function which describes the behavior of the raw data. Therefore, we developed a mathematical model which assumes that the time, t, and the scale reading, S, can be approximated by an equation with three parameters (i.e., A, B, and C) where,

$$S = A\exp(-Bt) + C \tag{2}$$

This is a logical equation to model the raw data since all spring relaxation data for the different paint systems that we studied exhibit an exponential decay and reach a constant value, C, as the time scale becomes larger,[2] as shown in *Figure* 1. To determine the parameters A and B, we needed a set of partial differential equations with respect to each parameter as follows:

$$\partial s/\partial A = \exp(-Bt) \tag{3}$$

and

$$\partial s/\partial B = -At\exp(-Bt) \tag{4}$$

From these three equations, we were able to obtain the parameters A, B, and C through the Gauss-Newton numerical method coupled with a non-linear least squares grid search.[5] There was a good overall fit between the actual raw data and the simulated results since the criterion for numerical convergence was set at less than 1×10^{-4} (see *Figure* 1). Once the parameters A, B and C were obtained, we could then relate equation (2) to the viscosities and shear rates.[1,2]

The relationship between the scale reading and the shear stress is

$$\tau = KS, \tag{5}$$

where τ is the shear stress (dyne/cm^2), and K is a characteristic constant for the viscometer. The apparent shear rate (γ_a, sec-1) is proportional to the speed of rotation (N, revolutions/minute) through a viscometer constant M

$$\gamma_a = MN \tag{6}$$

The angular velocity (W, radian/sec) is related to the rate of change of the scale reading such that

$$W = (-6.2832/L)dS/dt \tag{7}$$

where L is 115.4 (the number of scale graduations in a complete revolution). The speed of rotation, N, and the angular velocity are related by

$$N = 9.5492(W) \tag{8}$$

Combining equations (6) and (8) gives the apparent shear rate

$$\gamma_a = -60(M/L)dS/dt \tag{9}$$

The apparent viscosity, η_a (in centipoise), can be computed as:

$$\eta_a = 100(\tau)/\gamma_a \tag{10}$$

RESULTS AND DISCUSSION

The viscosity-shear rate relationships were plotted on a log-log scale so that the variables could be visualized and interrelated over an extended range. The accuracy of our viscosity measurements and analysis were verified with a viscosity standard at two different temperatures (25 and 37°C). The results showed an excellent agreement between our calculated and the manufacturer's stated value (387 and 170 centipoise at 25 and 37°C, respectively) as shown in *Figure* 2.[6] It should be noted that the standard value was measured for steady state conditions at medium shear rate which corresponds to our asymptotic value at higher shear rate.

Furthermore, our model was implemented for Smith's data.[2] The result shows a good general agreement in the magnitude of the viscosity with his point-by-point smoothing method (*Figure* 3). However, the calculated shear rates have shifted to a lower range with our model. In addition, our viscosity profile shows a slightly concave curvature which is also shown by Smith when he used a steady state method to obtain the viscosity profile for an acrylic latex (*Figure* 4). The deviation in shear rate between Smith's model and ours may arise from Krieger's Couette corrections for finite gap concentric cylinder viscometers,[7] which Smith incorporated but we did not. The lack of a Couette corrections in our calculation seems to lead to lower shear rate values. Therefore the shear rates discussed in this paper are "apparent shear rates" and the viscosities calculated from them are "apparent viscosities." This is justified without losing the utilities of our model, since similar practice in capillary melt rheology of polymers has been previously applied. In that case, the Rabinowitsch correction[8] to get true shear rates is rarely made, also leading to "apparent" quantities. It does not pose a problem in either field, providing quantities are correctly labeled and no attempts are made to compare corrected and uncorrected data.

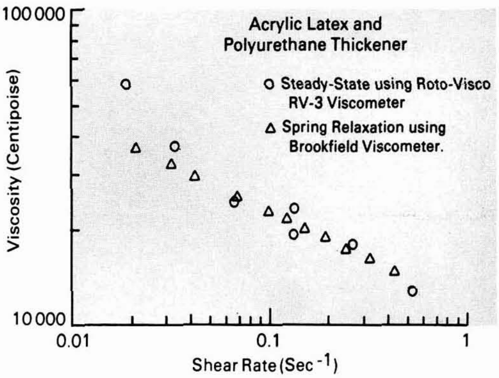

Figure 4—Comparison of spring relaxation and steady-state results shown by Smith[2]

Our model was then coupled with the spring relaxation technique to obtain the viscosity profile of a non-aqueous dispersion (NAD) lacquer. The general characteristics of the viscosity curve for the NAD lacquer closely resemble published results (*Figure* 5).[1,2,9,10] The viscosity decreases as the shear rate increases (<0.1 sec-1). When the shear rate is increased further, the viscosity begins to level off and reaches a Newtonian value. The viscosity values for high shear rates (>10 sec-1) are not accessible via this technique, which is limited by the spring constant and the intrinsic viscosity of the paint.

Phenomenologically, in this model [see equation (1)] the exponential term represents Newtonian limiting behavior when Aexp $(-Bt) >> C$, and the constant C reflects the tendency to approach a yield stress value. The

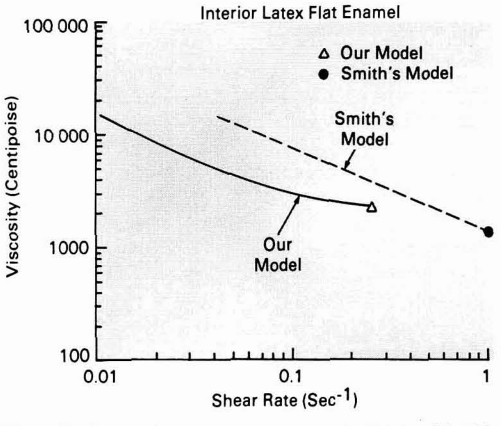

Figure 3—Comparison of our Three Parameter model with Smith's Point-by-Point model[2]

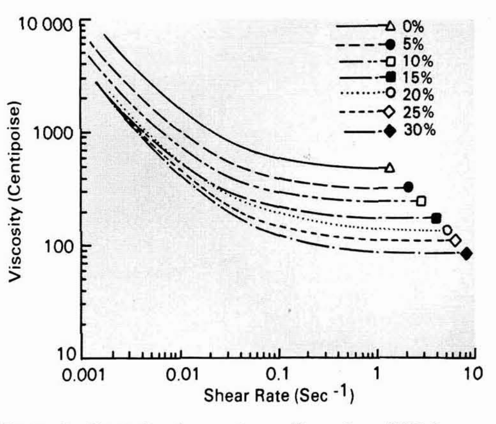

Figure 5—Viscosity-shear rate profiles of an NAD lacquer with various percentages of thinner

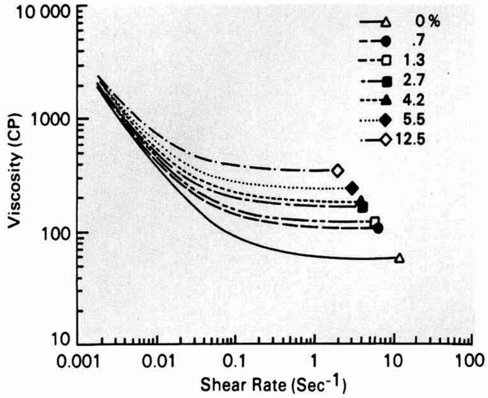

Figure 6—Viscosity-shear rate profiles of an NAD lacquer with various percentages of solvent evaporated

pre-exponential constant A is closely related to the initial value of the spring displacement before release, though in practice it is not identical to it. Thus it is not a material parameter in the same sense as B and C.

A series of viscosity profiles for the NAD lacquer was also determined for various amounts of added thinner (*Figure* 5). The data shows that the viscosity profile systematically shifts to higher values when the thinner content decreases. On the average, at higher shear rates, the viscosity increases by 30% when the level of thinner is decreased by 5%. However, at the lower shear rates, the viscosity variation between samples becomes less significant as the level of thinner increases.

The viscosity profile extends to the higher shear rate range as the solvent concentration is increased. This is due to the faster rate of spring relaxation for more dilute solutions. As a result the viscosity data is available at higher shear rates for dilute solutions than for concentrated solutions.

From a practical standpoint, the optimum paint flow condition during application corresponds to the viscosity curve with 25% thinner.[11] However, the viscosity of the paint will increase after application because it is not only affected by a decrease in the shear rate, but also by evaporation of solvent. From our experience, it is not unusual to lose as much as 50% of the solvent during the application process. Therefore, the viscosity of the paint after application corresponds to another viscosity curve with lower solvent content (about 10% thinner) at lower shear rates.

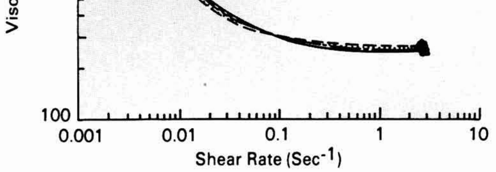

Figure 7—Viscosity-shear rate profiles of an NAD lacquer with 10% thinner at various temperatures

A second series of viscosity profiles for NAD lacquer was determined while gradually evaporating the multicomponent solvents (*Figure* 6). The reason for obtaining these results is to understand the viscosity change due to evaporation of solvents in addition to the shear rate change during application of the coatings. The results show that the viscosity change at high shear rate is very similar to previous results with increasing levels of thinner. However, the variation in viscosity diminishes as the shear rate decreases. This in turn explains why excessive sag rarely takes place during application of NAD lacquer system when the paint film thickness is less than 65 microns.

A series of viscosity profiles for NAD lacquer with 10% thinner (*Figure* 7) were then determined at various temperatures (from 25 to 45°C). The profiles are essentially unchanged with changing temperature. These results explain why temperature variation between 25 to 35°C during application in our laboratory had little effect on the appearance of the NAD lacquer.

SUMMARY

To predict the paint flow behavior of a coating during and after applicaton, we have developed a new mathematical model to determine its viscosity over a wide range of shear rates. The experimental data was collected through a spring relaxation technique using a Brookfield viscometer to measure drag forces that exist in the coating material. This data was then transformed into viscosity profiles by means of a series of computer programs based on our newly developed model. This method was checked with both a viscosity standard and with previously published data.[2,6] The agreement and discrepancies of our results with published results were also discussed. The viscosity profiles of a non-aqueous dispersion (NAD) lacquer at median (10 sec-1) to ultra-low (0.001 sec-1) shear rates were determined. The important findings on the NAD lacquer are: The entire paint viscosity curve for both power-law and Newtonian region can be obtained with one set of data.

(1) The viscosity of coating materials decreases as the shear rate increases to an asymptotic value at high shear rates.

(2) The viscosity profiles shift to lower values as the amount of thinner increases.

(3) The viscosity variation due to evaporation of solvents diminishes as the shear rate decreases.

(4) The viscosity of NAD lacquer is insensitive to temperature variation.

ACKNOWLEDGMENT

The author would like to thank Mr. Tadeusz B. Pietrzyk, of the G.M. Research Laboratories, for his excellent assistance in obtaining experimental data and providing technical suggestions. I would also like to express my gratitude to Dr. Robert W. Johnson, of DeSoto, Inc., for his scientific discussions and suggestions on this work.

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New Cellulosic Polymers For Rheology Control of Latex Paints

Kathryn G. Shaw and Dianne P. Leipold
Hercules Incorporated*

A process has been developed to enhance the rheological properties of cellulosics and other water-soluble polymers by chemically bonding small amounts of aliphatic hydrocarbon moities to the polymer backbone. This patented technology has created a new family of rheological modifiers. Hydrophobic modification of water-soluble polymers is exhibited in a number of macroscopic properties, such as increased solution viscosity, increased surface activity, and altered rheological properties.

Hydrophobically-modified hydroxyethylcellulose (HMHEC) has been designed for use in latex paints. These polymers have retained many of the desirable characteristics of cellulosic thickeners, and have superior rheological properties. This paper emphasizes the polymer's properties in solution and in a crowded, highly interactive system, such as a latex paint. Solution behavior and surfactant-interaction studies were used to discern the thickening mechanism. Sophisticated steady shear rheology analysis, over a wide shear rate range, has been used to predict properties in a latex paint. Actual latex paint performance and application properties will also be discussed.

INTRODUCTION

Cellulosic thickeners have played an important role in the successful growth of latex paints in the architectural coatings industry. Their universality, consistent performance, and overall balance of properties have made cellulosics the ''thickener-of-choice'' for the past two decades. During this time period, latex paints have gained large market shares from solvent-based or alkyd paints. With improvements in technology, latex paints have equaled or surpassed alkyd paints in many performance characteristics. One area in which alkyd paints have maintained an advantage is their flow behavior. In recognition of the industry's demands, considerable research effort has been expended to develop a latex paint thickener with improved rheological properties. Several new classes of thickeners have been introduced to the industry during recent years.

The properties of cellulosic polymers can be altered by hydrophobic modification. Hydrophobically-modified hydroxyethylcellulose (HMHEC) derivatives appear useful in many applications, including latex paints. The particular HMHEC composition to be discussed in this paper† has been shown to associate with the other components of a latex paint system. This associative behavior allows rheology to be controlled by variation in paint raw materials; this is a significant change from the rheology control available with traditional cellulosics.

CHEMICAL AND PHYSICAL PROPERTIES OF HMHEC

Chemical Composition

The concept behind HMHEC is to extend the chemistry and properties of hydroxyethylcellulose (HEC) by chemically bonding small amounts of long chain alkyl groups to the hydrophilic polymer backbone.[1,2] The physical properties of unmodified hydroxyethylcellulose and hydrophobically-modified hydroxyethylcellulose are considerably different. The hydrophobic modification is exhibited in a number of macroscopic properties, such as increased solution viscosity, increased surface activity, and altered rheological properties.

Presented at the 62nd Annual Meeting of the Federation of Societies for Coatings Technology in Chicago, IL, October 25, 1984.

*Hercules Plaza, Wilmington, DE 19894

†The HMHEC composition under discussion is WSP D-330, Hercules Incorporated, Wilmington, DE.

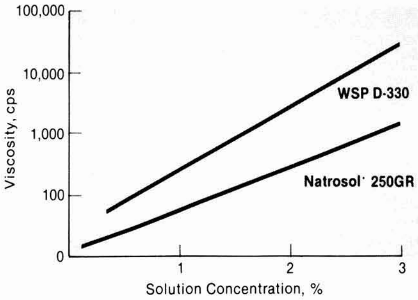

Figure 1—Brookfield viscosity (30 rpm) vs solution concentration

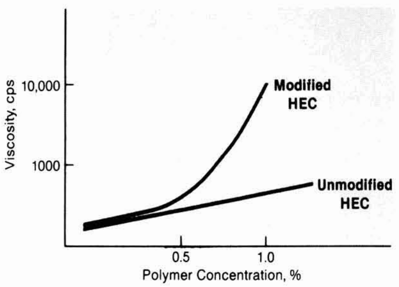

Figure 3—Critical polymer concentration

Although hydrophobically-modified, the HMHEC developed for latex paint is a nonionic water-soluble polymer. This is an advantage in latex paints since nonionics can be used over a wide pH range and, unlike polyelectrolytes, are compatible with charged species.

Solution Behavior

Solutions of HMHEC are considerably more viscous than solutions of the unmodified polymer. Brookfield viscosity measurements shown in *Figure* 1 compare HMHEC and a similar molecular weight (MW) unmodified HEC.* To explain this behavior, it is necessary to consider the thickening mechanisms of both.

Hydroxyethylcellulose builds viscosity in a solution through chain entanglement and hydrogen bonding with water molecules. Bonds between the polymer backbone and water molecules cause the polymer chain to extend, thus increasing the solution viscosity.

HMHEC builds viscosity through two mechanisms: hydrogen bonding with water molecules (as with traditional cellulosics); and association of the hydrophobic groups.

The hydrophobes tend to cluster into aggregates, as depicted in *Figure* 2. The association arises from a driving force to minimize the disruption of the water structure by the hydrophobe. This leads to increased interchain interactions. The net effect is a highly increased apparent molecular weight, and thus increased viscosity.

The hydrophobe aggregates behave much like surfactants, in that they effectively form only above critical concentrations. The plot of viscosity vs polymer concentration dramatically demonstrates the existence of a critical polymer concentration (*Figure* 3). Below the critical point, the modified and unmodified HEC polymers (same molecular weight) have a similar viscosity profile. Above the critical polymer concentration, the HMHEC shows a significant viscosity increase. The aggregation of hydrophobes at a critical concentration is analagous to the formation of micelles by low molecular weight surfactants at the critical micelle concentration. This is not to say that the polymers have a typical micellar structure. Rather, they are aggregated into a large network bound together by clusters of hydrophobes.

The surface tension of HMHEC solutions also provides evidence of hydrophobic association. Solutions of HEC have a surface tension of approximately 67 dynes/cm^2, only slightly lower than that for pure water. Surface tensions of 55 to 65 dynes/cm^2 are typical for HMHEC solutions.

Further confirmation of the network concept is seen in the behavior of HMHEC when nonionic surfactants are added (*Figure* 4). As nonionic surfactant concentration is increased, solution viscosity increases, and is followed by a decrease. If the simplifying assumption is made that the average aggregation number of the nonionic surfactant does not change, then one can observe for a number of systems that the peak viscosity occurs at a ratio of approximately one polymer chain for every two micelles.[3] This suggests a polymer-bridged micelle network. Above the surfactant critical micelle concentration, there are more surfactant micelles. Assuming that polymer-bound hydrophobes are incorporated in these micelles, fewer polymer chains are tied to a given cluster, causing a loosening of the polymer network and producing a lower solution viscosity. Beyond this point, the solution viscosity reaches a constant level and is not affected by the surfactant concentration.

It should be pointed out that this behavior occurs only at low surfactant and polymer concentrations and is discussed here to verify the polymer network concept. Latex paints contain much higher levels of both surfactant and polymer and would not be expected to show variations in paint viscosity with changes in the surfactant level.

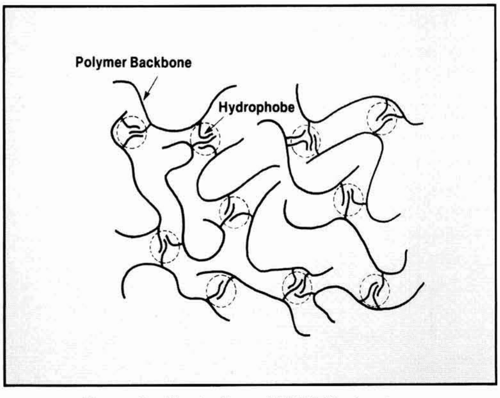

Figure 2—Illustration of HMHEC structure

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*Natrosol® 250 GR. The grades of HEC referred to throughout this paper are from the Natrosol product line, Hercules Incorporated.

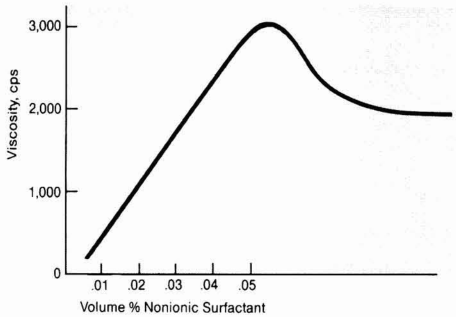


Figure 4—Effect of nonionic surfactant on 0.1% HMHEC solution viscosity

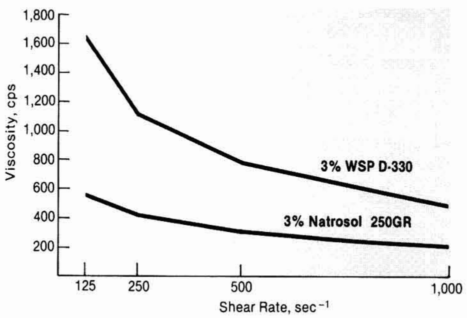


Figure 5—Viscosity vs shear rate for HEC and HMHEC solutions

Solutions of HMHEC are highly pseudoplastic, or shear-thinning, as shown in *Figure* 5. At low shear rates, the solution viscosity is high due to association of the hydrophobes. This association breaks down quickly (and reversibly) under shear, producing rapid viscosity drop. The amount of pseudoplasticity is greater for HMHEC than for HEC.

HMHEC AS A LATEX PAINT THICKENER

Hydrophobically-modified hydroxyethylcellulose polymers retain the benefits of traditional cellulosics and offer improved rheology while avoiding many of the problems of synthetic associative thickeners. HMHEC has been evaluated in a wide range of paints, including interior and exterior, flat and semi-gloss. The results of these evaluations indicate that this HMHEC composition is best suited for use in interior and exterior flat paints. Results presented in this paper are based on paints made with vinyl-acrylic and all-acrylic latexes. The long term stabilities observed indicate that no latex compatibility problems exist.

EXPERIMENTAL

Latex paints were prepared using the latex suppliers formulations found in *Tables* 1, 2, and 3. The interior flat paint based on Polyco 2161 latex was prepared at 50 and 63 PVC, 21 and 30 NVV as is depicted in *Table* 1. The tests which were conducted are listed below; test details are provided in Appendix I.

Interior/Exterior Flat Paints
Spatter
Leveling
Sag resistance
Brushing viscosity
Thickening efficiency
Biostability
Heat stability
Shelf stability
Freeze-thaw stability
Gloss
Hiding (contrast ratio)
Scrub resistance

Interior Semigloss Paints
Color development
Gloss
Hiding (contrast ratio)
Scrub resistance

DISCUSSION OF RESULTS

Latex Paint Thickening Mechanism

Hydroxyethylcellulose thickens a latex paint primarily by building viscosity in the aqueous phase. HMHEC also thickens the aqueous phase of the paint, but substantial viscosity is built through association with the paint components, such as latex and pigment particles. Many of the unique characteristics of HMHEC, such as the combination of improved rheology and good stability, can be attributed to its thickening mechanism.

The thickening efficiency of HMHEC generally falls between that of HEC-250 HBR and HEC-250 MBR, depending on the paint formulation. It should be pointed out that HMHEC has a lower molecular weight than typical paint grades of HEC. Good thickening efficiency is achieved despite the lower MW, reflecting the associative nature of HMHEC.

Latex Paint Rheology

Shear Rate Effect on Viscosity: Aqueous solutions of HMHEC are more pseudoplastic than those of unmodi-

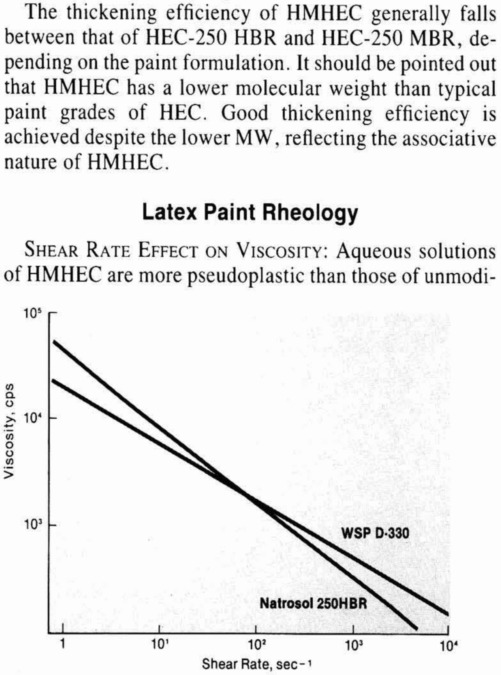


Figure 6—Paint viscosity vs shear rate for WSP D-330 and Natrosol 250 HBR in an interior flat paint

Table 1 — Interior Flat White and Light Tint Base Based on Polyco 2161 Vinyl-Acrylic Latex

Material	63 PVC, 30 NNV Lbs.	63 PVC, 23 NVV Lbs.	50 PVC, 30 NVV Lbs.	50 PVC, 23 NVV Lbs.
Water	200.0	200.0	200.0	200.0
Potassium tripolyphosphate	2.0	2.0	2.0	2.0
Ross & Rowe 551	2.0	2.0	2.0	2.0
Tamol 731	5.0	5.0	5.0	5.0
Hercules defoamer SGL	2.0	2.0	2.0	2.0
Ethylene glycol	20.0	20.0	20.0	20.0
Carbitol acetate	10.0	10.0	10.0	10.0
Titanium dioxide Ti-Pure R-901	175.0	175.0	175.0	175.0
Camel-CARB calcium carbonate	150.0	150.0	150.0	150.0
Iceberg clay	125.0	125.0	125.0	125.0
Silica 1160	25.0	25.0	25.0	25.0
Igepal CO-610	3.0	3.0	3.0	3.0
Polyco 2161	200.0	200.0	308.0	308.0
Merbac 35	0.5	0.5	0.5	0.5
3% Thickener solution or H_2O	251.0	505.0	354.6	671.1
	1170.5	1424.5	1382.1	1698.6

fied HEC. However, paints thickened with HMHEC exhibit rheology which is more Newtonian than the rheology of paints thickened with HEC. Shear rate profiles have been studied using several methods of measurement:

(1) Shear rate range of 0.01 to 100 sec^{-1}, using a Rheometrics Mechanical Spectrometer with the cone and plate sensor system.

(2) Shear rate range of 100 to 10,000 sec^{-1}, using a Haake Rotovisco RV-3 Viscometer with the cone and plate sensor system.

(3) Shear rate range of 1000 to 100,000 sec^{-1}, using the Tekmar HVA 6, a high pressure capillary viscometer.

The capillary type viscometer does not have the problems of the cone and plate viscometers, such as sample fractionation and drying. Therefore, the capillary viscometer is more accurate in the high shear range. The results of these three techniques were combined to produce a viscosity profile over the shear range to which paints are exposed, typically considered to be 0.1 to 10,000 sec^{-1}. The high shear rates (10,000 sec^{-1}) are encountered during brush or roller application. Low shear (0.1 sec^{-1}) reflects the forces within the paint during leveling.

Paint shear rate profiles clearly demonstrate that hydrophobic modification of HEC has improved the paint rheology.

The viscosity profiles shown in *Figure* 6 are for 63 PVC, 30 NVV interior vinyl acrylic flat paints, (*Table* 1) thickened with HMHEC and HEC-250 HBR to the same Krebs-Stormer viscosity (KU). HMHEC has significantly higher viscosity at high shear rates. Under brush or roller application, greater film build and better hiding will be achieved with HMHEC.

At low shear conditions, HMHEC imparts lower viscosity and therefore better leveling. The leveling improvement is illustrated in *Figure* 7, using photographs of Leneta leveling charts. Most importantly, the leveling advantage is achieved without sacrificing sag resistance.

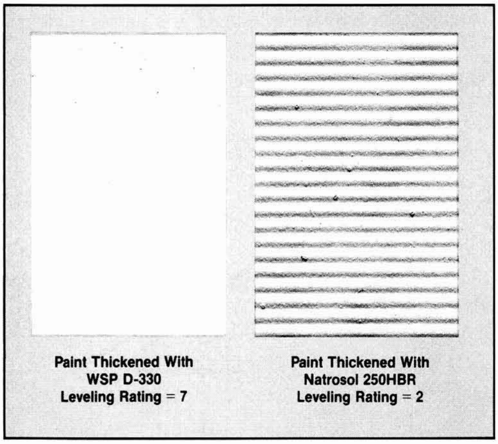


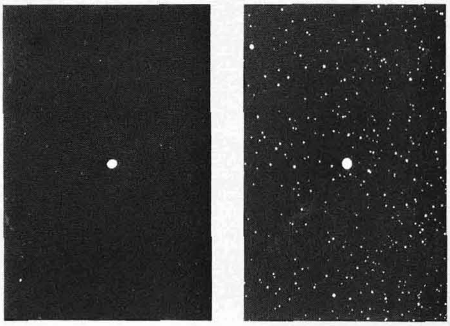
Figure 7—Leveling properties of WSP D-330 and Natrosol in an interior flat paint

Table 2 — Interior White Semi-Gloss Based on Rhoplex AC-417 All-Acrylic Latex

Material	Lbs.
Propylene glycol	140.0
Tamol SG-1	14.9
Hercules defoamer SGL	3.5
Water	43.8
Ti-Pure R-901	420.0
Silica 1160	43.8
Hercules defoamer SGL	4.8
Propylene glycol	17.5
Texanol	37.8
Super-Ad-It	1.8
Triton GR-7M	0.9
Rhoplex AC-417	875.0
3% Thickener Solution or Water	297.0
	1900.8

Table 3 — Exterior Flat Paint, Formulation Suggestion E-1398, Federal Specification TT-P-19C, Amendment #1

Material	Lbs.
Water	308.0
HMHEC	3.5
Tamol 850	6.0
Potassium tripolyphosphate	1.0
Dowicil 75	0.5
Tergitol NP-10	3.0
Ethylene glycol	20.0
Skane M-8	2.0
Hercules defoamer SGL	3.0
Texanol	12.0
Ti-Pure R-900	250.0
Zinc oxide—HORSEHEAD XX503	50.0
Talc-Nytal 300	125.0
UCAR 503	401.0
28% Ammonium hydroxide	2.0
	1187.0


Interior Paint Thickened With WSP D-330

Interior Paint Thickened With Natrosol 250HBR

Figure 8—Comparison of spatter resistance

The rheological improvements of HMHEC compared to HEC will depend on the paint formula to some extent. Typically, the brushing viscosity improvements will tend to be larger than the leveling improvements.

Spatter Resistance: HMHEC has outstanding spatter resistance. The photographs in *Figure* 8 compare the spatter of moderate quality interior vinyl acrylic paints thickened with HEC-250 HBR or HMHEC. The paints were applied to a vertical substrate using a ¼″ nap roller. Spatter was caught on a black panel, placed horizontally beneath the application area. The paint thickened with HMHEC produced virtually no spatter.

Stability Properties

The viscosity stability of paints thickened with HMHEC is quite good. Unlike other associative thickeners, little viscosity change or phase separation is seen in shelf stability, heat stability, or freeze-thaw stability testing (*Table* 4). These results reflect the fact that HMHEC is capable of thickening the aqueous phase and does not depend entirely on association to build paint viscosity.

HMHEC has biostability equal to that of biostable HEC grades. This biostability is the result of the manufacturing process used to produce both polymers.

Color Properties

HMHEC has color acceptance and color development properties similar to HEC. HMHEC was designed with particular attention to these properties. The interactive nature of associative thickeners can cause problems when colorant is added to the paint. Associative thickeners tend to destabilize the fragile balance of surfactants and dispersants in the system, leading to colorant flocculation. HMHEC has good color acceptance, with little or no pigment flocculation. The formulation shown in *Table* 2 was tinted, at a rate of 3.5 oz/gal with phthalo blue and lampblack universal colorants (Colortrend from Nuodex, Inc.). These tints were added to the thickened paint which was then shaken for 10 minutes. A 5 mil wet film was drawn down on Leneta form 1B and rub-ups were made immediately. Paint rub-ups were compared using a Hunter D-25 Colorimeter. The Δ E values showed little change from 1.31 vs 1.40 with phthalo blue and 1.17 vs 0.90 with lampblack for HEC and HMHEC, respectively.

Film Properties

In the dried paint film, HMHEC behaves like HEC. Gloss and scrub resistance properties of paints thickened with HMHEC are equivalent to those of the corresponding paint thickened with HEC (*Table* 5). In exterior paints, wet adhesion and weathering properties are also similar.

EFFECT OF PVC AND NVV ON PAINT PROPERTIES

Trade sales formulations vary widely in pigment volume concentration (PVC) and nonvolatile volume (NVV) as each manufacturer works to fill the needs of his market. Since HMHEC is an associative thickener, the properties it imparts to paint will vary as the ratio of pigment to latex and the total number of particles change. Paint properties such as brushing viscosity, leveling, and sag were studied across a range of PVC and NVV levels, as was polymer thickening efficiency. The paint results discussed here are for the interior, moderate quality flat paint described in *Table* 1.

Interior flat paints were prepared with Polyco 2161 vinyl-acrylic latex from Borden. The PVC level varied

Table 4 — Stability Properties of HMHEC and HEC 63 PVC Vinyl-Acrylic Flat Paint

Polymer	Viscosity Retention 4 Week Biostability	Viscosity Retention 4 Week Heat Stability	Viscosity Retention 4 Week Shelf Stability
HEC-250 HBR	87%	102%	99%
HMHEC	92%	107%	103%

Table 5 — Film Properties of HMHEC and HEC

Polymer	63 PVC V-Acrylic Flat Hiding	63 PVC V-Acrylic Flat Gloss	63 PVC V-Acrylic Flat Scrub Cycles	25 PVC Acrylic Semi-gloss Hiding	25 PVC Acrylic Semi-gloss Gloss	25 PVC Acrylic Semi-gloss Scrub Cycles
HEC-250 HBR	0.96	2.4	176	0.94	36.3	725
HMHEC	0.94	2.4	153	0.95	34.2	822

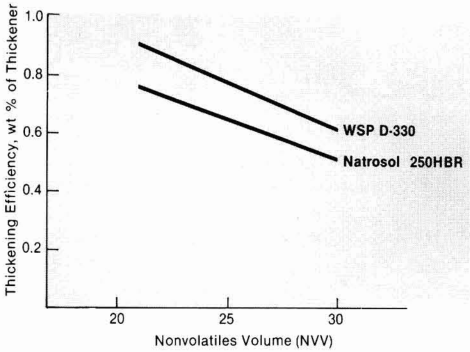


Figure 9—Thickening efficiency vs nonvolatiles volume in an interior flat paint at 63 PVC

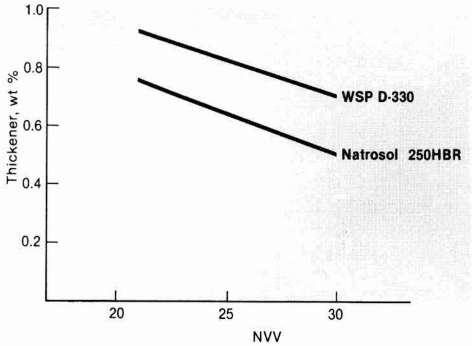


Figure 10—Thickening efficiency vs NVV in an interior flat paint at 50 PVC

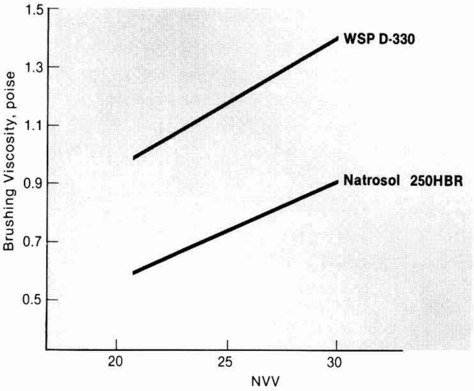


Figure 11—Brushing viscosity (10,000 sec^{-1}) vs NVV in an interior flat paint at 63 PVC

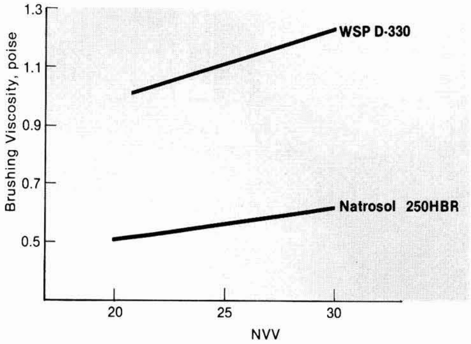


Figure 12—Brushing viscosity (10,000 sec^{-1}) vs NVV in an interior flat paint at 50 PVC

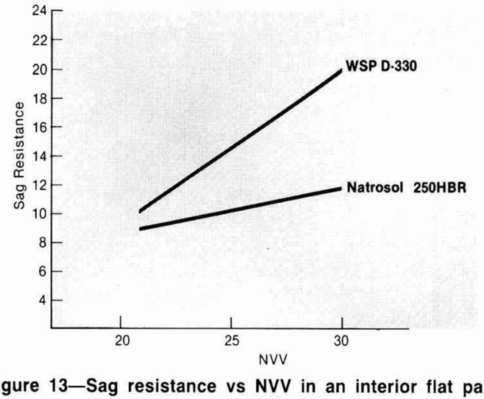


Figure 13—Sag resistance vs NVV in an interior flat paint at 63 PVC

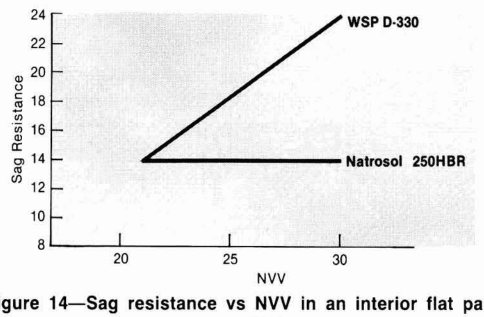


Figure 14—Sag resistance vs NVV in an interior flat paint at 50 PVC

from 50 to 63% and the volume solids (or nonvolatiles volume, NVV) from 21 to 30%. In all cases, HMHEC was compared to HEC-250 HBR. Paints were thickened to 100± 2 KU.

Thickening Efficiency

(Figures 9 and 10) At 63 PVC, HMHEC was about 20% less efficient in thickening the paint to 100 KU than was HEC-250 HBR across the NVV range. At 50 PVC the performance of HEC remained unchanged while HMHEC lost about 10 to 15% of the efficiency at 63 PVC. This indicates a strong pigment association; replacing pigment particles with latex particles reduced thickening efficiency. The association of HMHEC with pigment particles will be discussed in more detail later.

Brushing Viscosity

(Figures 11 and 12) Brushing viscosity was measured at 10,000 sec^{-1} with an ICI cone and plate viscometer. As NVV increased from 21 to 30%, brushing viscosity increased for all systems. HMHEC consistently offers the highest brushing viscosity. At both 50 and 63 PVC the brushing viscosity of a paint thickened with HMHEC is 50 to 100% higher than that of a paint thickened with HEC-250 HBR.

Sag Resistance

HMHEC offers significantly better sag control than HEC-250 HBR, especially at higher NVV levels. Lower PVC paints all show greater sag resistance across the range of nonvolatiles content. Sag resistance of the associative thickeners is more highly influenced by NVV than sag resistance of HEC-250 HBR; note the steeper slopes for HMHEC in *Figures* 13 and 14.

Leveling

Sag and leveling are often regarded as properties that oppose one another. Thus one might think that HMHEC, which offers better sag resistance than HEC-250 HBR, would show poorer leveling. This is not the case. Paints thickened with these polymers level better across the NVV range at both PVC's shown (*Figures* 15 and 16). The best case occurs in a high-PVC, low-volume solids paint where leveling approaches the maximum value of 10.

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These studies of paint properties have shown that the associative nature of HMHEC:

(1) Changes thickening efficiency at different PVC's, unlike HEC;

(2) Increases brushing viscosity at 10,000 sec^{-1} 50 to 100% over HEC;

(3) Improves sag resistance and leveling of paint while not affecting the excellent film properties normally observed with cellulosic-thickened paints.

PAINT INGREDIENTS AND HMHEC PROPERTIES

The previous section has shown that the properties of paint thickened with HMHEC will vary as the composition of the paint varies. The influence of pigment type,

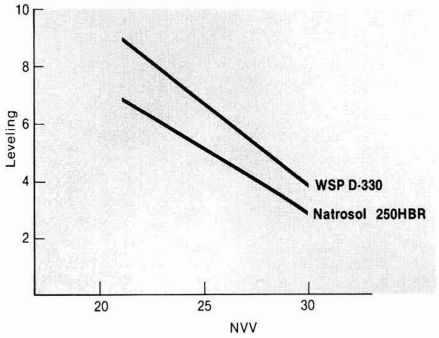

Figure 15—Leveling vs NVV in an interior flat paint at 63 PVC

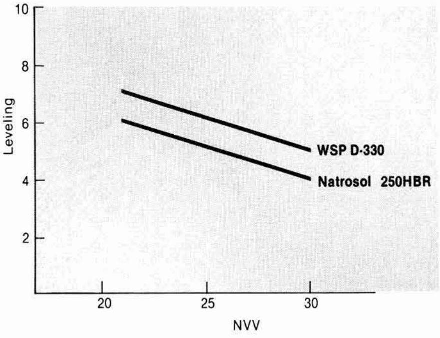

Figure 16—Leveling vs NVV in an interior flat paint at 50 PVC

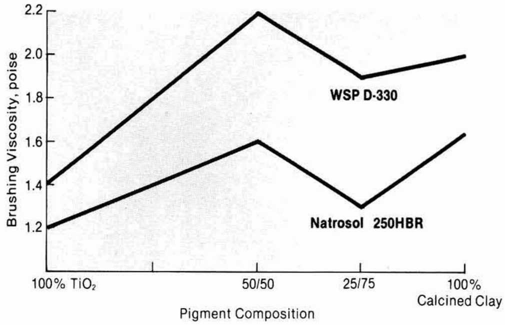

Figure 17—High-shear viscosity vs pigment composition as pigment varies from 100% TiO_2 to 100% calcined clay

latex, and surfactant HLB on paint properties has been examined and will be discussed in the following sections.

Pigment Type

As mentioned earlier, HMHEC thickens paint not only by thickening the aqueous phase through hydrogen bonding but also by interactions with pigment and latex particles.

Pigment interactions can be analyzed by using polymer solutions and pigment dispersions. The viscosity of a solution is measured. The solution is mixed with a pigment dispersion and allowed to equilibrate. The mixture is then centrifuged to separate the pigment particles and the viscosity of the aqueous phase is measured. If the viscosity is the same as the polymer solution, little or no interaction with the pigment has occurred. If the viscosity is lower, polymer has adsorbed on the pigment particles. The viscosity of a 1% HMHEC solution is 400 to 500 cps. After mixing with a pigment dispersion and centrifugation, the viscosity of the aqueous phase falls to less than 50 cps. Centrifugation conditions were not responsible for the viscosity decrease; a 1% polymer solution showed no viscosity reduction after centrifugation. Thus, HMHEC associates with pigment particles in preference to remaining in the aqueous phase. This has been shown for TiO_2, clay, and calcium carbonate dispersions.

This association can be exploited to produce desirable properties in a flat latex paint. Naturally, changes in the pigment system will alter both high and low shear rheology. The associative nature of HMHEC magnifies the changes which are normally seen in a paint thickened with HEC. Pigment composition was varied in a 63 PVC, 32 NVV flat vinyl-acrylic paint thickened with HEC-250 HBR or HMHEC. *Figures* 17 through 20 show changes in brushing viscosity and leveling as the pigment composition is altered. Pigment substitution was made on an equal volume basis. The increases in brushing viscosity were not at the expense of thickening efficiency.

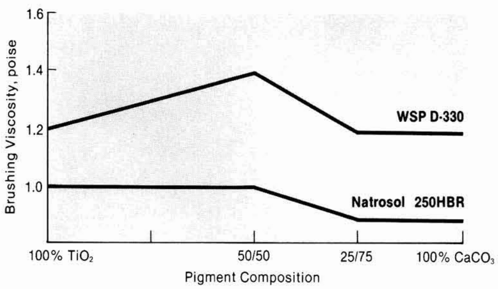

Figure 19—High-shear viscosity vs pigment composition as pigment varies from 100% TiO_2 to 100% calcium carbonate

These data indicate that HMHEC associates more strongly with calcined clay than with either TiO_2 or calcium carbonate. The association is responsible for the larger increase in brushing viscosity seen with the HMHEC-clay combination than is seen with the other pigment-thickener combinations. This interaction also causes a slight reduction in leveling compared to the HEC control. However, the leveling could be improved by increasing the amount of either extender pigment.

Latex Type

Latexes differ from one another not only in monomer composition but also in type and amount of protective colloid, surfactant HLB and charge, and particle size. These factors all affect thickener-latex association. Although results at this point are very preliminary, a few general trends have been seen. Again using a centrifugation study, latex interactions were examined by mixing polymer solution with various vinyl-acrylic latices, labeled L-1 through L-4 in *Table* 6. Little adsorption on the latex particles was evidenced, regardless of the surfactant used for latex stabilization. Rather, the surfactants used for stabilization of the latex interact with HMHEC resulting in either decreased (negative interactions) or in-

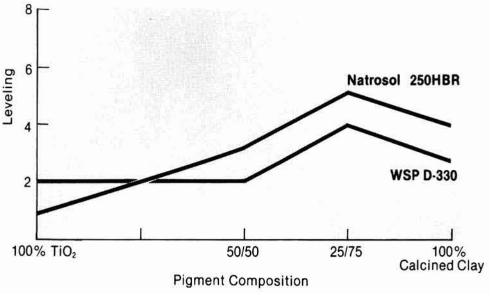

Figure 18—Leveling vs pigment composition as pigment varies from 100% TiO_2 to 100% calcined clay

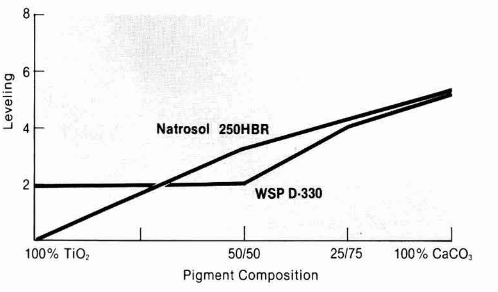

Figure 20—Leveling vs pigment composition as pigment varies from 100% TiO_2 to 100% calcium carbonate

Table 6 — Interaction of HMHEC with Vinyl-Acrylic Latex and Latex Surfactants

	System Viscosity (cps) Latex Number			
System	**L-1**	**L-2**	**L-3**	**L-4**
10% latex + 0.5% HMHEC ...	19.8	24.0	37.1	76.2
Post centrifugation supernatent	14.4	19.8	64.3	59.2
0.5% HMHEC solution	19.5	19.5	19.5	19.5

creased (positive interactions) solution viscosity compared with the viscosity of HMHEC in distilled water. Interestingly, the "positive" interaction between latex surfactants and HMHEC (resulting in increased solution viscosity) improves the paint brushing viscosity.

A variety of commercially available vinyl acrylic and acrylic latices were evaluated in a 63 PVC, 32 NVV interior flat paint (*Table* 1) and a 38 PVC, 25 NVV exterior flat paint (*Table* 3). It is recognized that a latex is chosen for the required film properties and not to enhance thickener performance, yet the trends which were observed may be of interest to those evaluating HMHEC. These trends can be summarized as follows.

(1) In vinyl-acrylic interior flats HMHEC has thickening efficiency equal to that of HEC-250 MBR. In acrylic interior flats and in exterior flats, regardless of latex type, HMHEC is 10 to 20% more efficient than HEC-250 HBR.

(2) In interior flats HMHEC provides higher brushing viscosity than other cellulosics, regardless of latex. In exterior flat paints HMHEC provides about 20% higher brushing viscosity than HEC-250 HBR.

(3) In general, leveling of both interior and exterior flat paints is better when HMHEC is the thickener. The leveling improves two to five units over that seen in HEC thickened paints.

Surfactant/HLB

A series of surfactants with HLB's ranging from 8.8 to 17.8 were used at 0.3% by weight in a 63 PVC, 21 NVV flat paint thickened with HMHEC. As HLB decreases, thickening efficiency and leveling both improve. Surfactant HLB has no effect on the thickening efficiency of paints prepared with HEC. *Table* 7 presents the data to support these points.

Table 7 — Influence of Surfactant HLB on Paint Properties

	HEC-250 HBR			HMHEC		
Surfactant/HLB	**Leveling**	**ICI**	**Wt%**[a]	**Leveling**	**ICI**	**Wt%**
Igepal CO-430/8.8	5	0.6	0.74	7	1.0	0.80
Igepal CO-610/12.2	6	0.6	0.76	6	1.2	0.92
Igepal CO-730/15.0	6	0.7	0.77	5	1.2	0.99
Igepal CO-897/17.8	7	0.6	0.74	5	1.2	0.99

[a] Percent thickener needed to achieve 95 KU.

As a consequence of the fact that more thickener is required in the paints with higher HLB surfactant, the brushing viscosity will typically rise. Thus high shear viscosity can be manipulated at the expense of thickening efficiency and leveling. This is an advantage that the associative cellulosic, HMHEC, has over conventional HECs.

To highlight this section, the performance of HMHEC can be maximized by judicious selection of extender pigments and use of low HLB surfactants to maximize leveling or high HLB surfactants to further increase brushing viscosity.

Table 8 — Interior Flat Paint Demonstrating Pigment-Thickener Interaction

	Weight	Volume
Water	291	34.90
KTPP	2	0.10
Ross & Rowe 551	2	0.23
Tamol 731......................	5	0.56
Hercules 501 defoamer............	2	0.27
Ethylene glycol..................	20	2.18
Carbitol acetate..................	10	1.19
Ti-Pure R-901...................	318	9.30
Iceberg clay	203	9.32
Igepal CO-897	12.9	0.40
Polyco 2161	200.0	22.00
Merbac 35......................	0.5	0.05
	1,066.4 Lb.	80.5 Gal.
Add the following slurry to the letdown:		
WSP D-330.....................	8.5	0.77
Propylene glycol.................	87	9.40
Water	73	8.76
	1,234.9 Lb.	99.43 Gal.

The properties observed with this paint were:

Viscosity, (KU)	101
Brushing viscosity, (poise)	2.4
Spatter (10 = Best, 0 = Worst)...........................	8
Leveling (10 = Best, 0 = Worst)	1
Sag resistance (4-24 mils)	15
Scrub cycle to failure..................................	69
Contrast ratio	0.97
Two week heat stability (40°C), viscosity retention %	100

A prototype interior flat paint formulated for high pigment-thickener interaction and the properties it exhibits when it is thickened with HMHEC are shown in *Table* 8.

SUMMARY

Hydrophobically-modified hydroxyethylcellulosics are unique polymers, introducing a new concept to the latex paint industry. Rheological measurements and paint evaluations have confirmed the associative nature and improved rheological characteristics of HMHEC polymers. Formulation studies offer guidelines for optimization of thickening efficiency, brushing viscosity, sag, and leveling properties.

These associative cellulosic polymers combine the desirable characteristics of improved paint rheology with the widely recognized benefits of traditional cellulosics.

ACKNOWLEDGMENTS

There were many people at Hercules Incorporated who made important contributions to this study, their involvement was critical and is appreciated. The principal investigators were: E.W. Binkley, E.F. Bock, T.C. Bradley, N.H. Conner, D.H. Craig, W.C. Crawford, A.J. Desmarais, P.E. Foster, D.S. Keselica, K.E. Longmoore, C.F. Lu, R.D. Royce, E.W. Schwarz, K.E. Steller, and A.W. Warrington.

References

(1) U.S. Patent No. 4,228,277
(2) U.S. Patent No. 4,243,802
(3) Landoll, L.M., "Nonionic Polymer Surfactants," *J. Polym. Sci., Polym, Chem. Ed., 20*, No. 2, 443-55 (1982).
(4) Hercules Bulletin VC-493D, "Natrosol B. Superior Viscosity Stability for Latex Paints." Appendix.

APPENDIX I: Details of Test Methods

Stability

(1) Shelf stability	—250 g of each sample in 8 oz. Squat jars monitored for pH, viscosity, appearance at 2 week, 4 week, 3 month, 6 month intervals.
(2) Biostability	—250 g of each sample innoculated with 1 mL aliquot of cellulase enzyme to produce 0.1 ppm enzyme level. Monitored for pH, viscosity at 1 day, 1 week, 2 week, 1 month intervals.[4]
(3) Freeze-thaw stability	—250 g of each sample in Squat jars stored at −5°C for 1 week (refer to ASTM D2243). Post tested for specular gloss at 85°, and hiding at 6 and 72 hour intervals, pH.
(4) Heat stability	—250 g each sample in Squat jars stored at 50°C for 2 weeks. Monitored for viscosity and appearance retention, pH at end of 6 hour temperature acclimation.

Application Properties[4]

(1) Leveling	—See ASTM D4062-81.
(2) Anti-sag (sag resistance)	—Drawdown method using medium range Leneta blade (4-24 mL) on Leneta chart #7B.
(3) Spatter	—(Also Roller Performance) 3″ roller, ¼″ nap, 1 pass/second for 30 cycles, using black plastic catch panel.
(4) ICI brushing visc.	—ICI Rotoviscometer read in "poise".
(5) Color development	—3.5 ounce/gallon: colorant/sample paint (phthalo blue, lampblack). Rub up on Leneta form 1B.

Film Properties

(1) Gloss	—85° reading using Gardner Model GG-7526 on 7 mil (wet) drawdown.
(2) Hiding power	—3 mil (wet) drawdown on Leneta form 9B based on contrast ratio.
(3) Scrub resistance	—See ASTM D2486-7^{4}a.

APPENDIX II: Raw Materials Suppliers

Raw Materials	Suppliers
Coalescing Aids	
Carbitol® Acetate	Union Carbide Corp.
Texanol®	Eastman Chemical Products, Inc.
Defoamers	
Hercules Defoamer SGL. Hercules 501 Defoamer	Hercules Incorporated
Dispersants	
Tamol® 731, 850, SG-1	Rohm and Haas Co.
Latexes	
Polyco® 2161	Borden Chemical, Thermoplastics Div.
Rhoplex® AC-417	Rohm and Haas Co.
UCAR® 503	Union Carbide Corp.
Mildewcide	
Skane® M-8	Rohm and Haas Co.
Pigments	
Camel-CARB® Calcium Carbonate	Flintkote Stone Products Co.
1150 Amorphous Silica	Illinois Mineral Co.
HORSEHEAD® XX503 Zinc Oxide	Gulf & Western Natural Resources Corp.
Iceberg® Clay	Burgess Pigment Co.
Nytal® 300 Talc	R.T. Vanderbilt Co., Inc.
Ti-Pure® R-900, R-901	E.I. DuPont de Nemours & Co.
Preservatives	
Dowicil® 75	Dow Chemical Co.
Merbac® 35	Merck Chemical Div.
Super-Ad-It®	Rohm and Haas Co.
Surfactants	
Igepal® CO-610, CO-897	GAF Corp.
Ross & Rowe 551	Ross & Rowe, Inc.
Triton® GR-7M	Rohm and Haas Co.
Tergitol® NP-10	Union Carbide Corp.

Dispersion And Classification Effects In a Three-Roll Mill

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Influence of the degree of particle dispersion on flow properties and the classification effect in the roll nip were investigated for roll milling of highly viscous suspensions. Seventeen kinds of commercial powders were dispersed into a linseed oil varnish with a three-roll mill, and the changes of the flow properties were measured. The rheological differences of these suspensions were classified into four groups and were discussed qualitatively in the light of the Casson's equation of viscosity.

Changes of densities and particle sizes of sample pastes which were scraped off the apron roll were measured to investigate the classification effect. It was found that low density samples having fine particles were scraped off at the beginning of scraping and that densities as well as particle sizes increased towards the end of scraping. The degree of classification could be correlated with the parameters obtained from the simulation.

INTRODUCTION

A three-roll mill is used in processing the dispersion of pigment into a highly viscous vehicle, such as paints, printing inks, and metal pastes for micro circuits. The high shear stress and grind force are exerted on the mill base during passing through two close clearance nips, resulting in the high quality dispersion to the desired level.

The production rate, power consumption, and pressure distribution in a roll mill have been studied by Maus, et al.,[1] Patton,[2] Murakami, et al.,[3-5] and other workers.[6-8] The dispersion performance of a roll mill has been studied by Taylor and Zettlemoyer,[9] Carr, et al.,[10] and Murakami, et al.[11]

The flow properties of highly viscous suspensions vary with the degree of pigment dispersion. Therefore, it becomes difficult to obtain the desired rheological properties and to confine the scattering of viscosity data within a practical limit. Unfortunately, few studies are available in this field.

Since particles larger than the nip clearance can neither disperse easily nor pass through the roll nip, they are accumulated in the feed bank[2,12] (see *Figure* 1(b)). In normal operation, to reduce such a classification effect larger particles are dispersed first in a wider clearance and the nip clearance is reduced gradually. The classification effect in the roll nip is important for the optimum roll milling operation but this has not been studied quantitatively.

In this paper, the rheological changes of the product suspensions with particle dispersion and the classification effect were investigated to obtain the basic data for the study on dispersion performance of a roll mill. The classification effect was also simulated with a micro computer.

EXPERIMENTAL APPARATUS AND PROCEDURES

Three-Roll Mill

A three-roll mill with a fixed center roll of diameter $D = 12.7$cm as shown in *Figure* 1(a) was used and operated at a feed roll speed of $0.418 s^{-1}$. The roll speed ratio of the three rolls was 1:2.13:5.19.

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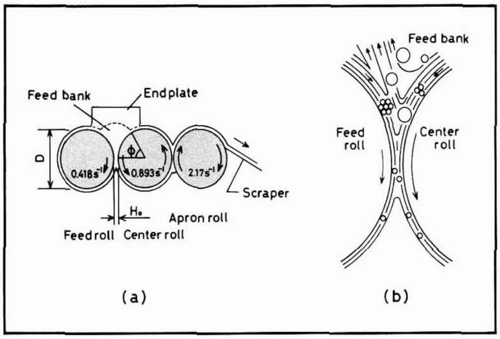


Figure 1—(a) Schematic diagram of a three-roll mill; (b) classification effect in a roll nip

CHANGES OF FLOW PROPERTIES OF SUSPENSIONS WITH PARTICLE DISPERSION[13]: Seventeen kinds of powders, having different primary particle shapes and various physical properties, were used in the experiment. The properties of these powders and volume fractions of their suspensions are listed in *Table* 1. Linseed oil varnish ($\mu_v = 7$Pa·s at 30°C) was used as the Newtonian vehicle.

The powder was first premixed with linseed oil varnish and then milled repeatedly by a three-roll mill. The product suspension was sampled after every pass through the mill and its flow properties and fineness were measured by a cone-plate viscometer and a grind gauge, respectively. The dispersed condition of the particle in suspension was observed with both an optical microscope and an electron microscope[14] (TEM, 200kV).

CLASSIFICATION EFFECT[15]: Fly ash powder ($\rho_p = 2240$kg/m^3) was used to supply spherical particles and linseed oil varnish ($\mu_v = 0.7$-8Pa·s, $\rho_v = 956$kg/m^3) was used as a vehicle.

The premixed suspension of the total weight W_0 (0.25-0.35kg) was supplied between feed and center rolls and was sampled 10 times (Samples 1-10) by 1/10 of the total weight scraped off the apron roll. The average production rate, Q, was calculated with the scraping time, t_m, as follows,

$$Q = W_0/\rho_0 t_m L \tag{1}$$

The distance between end plates, L, was set to 10cm. The density, ρ_c, and the particle size distribution of the sample which was scraped from the apron roll were measured with a pycnometer and a photosedimentation method, respectively. Since the differences in the density of the Samples 1 to 7 were small, the densities of Samples 2, 4, and 6 were not measured but were evaluated by the mean value of the densities of Samples 1 and 3, 3 and 5, and 5 and 7, respectively.

SIMULATION MODEL OF A CLASSIFICATION IN A ROLL NIP

Due to classification in the roll nip, low density samples containing fine particles are scraped off at the beginning of scraping and the sample density and particle size increase towards the final stage. The following model is proposed for the classification by assuming that the particles are rigid spheres and the classification occurs only in the feed nip.

(1) When the premixed suspension is supplied to the feed nip, the feed nip clearance is set to the starting value.

(2) The particles smaller than the clearance pass through the nip together with vehicle; however, the larger

Table 1—Properties of the Particles Used

Group	Pigment	Particle Size[a]	Shape[b]	Volume Fraction[a] (density/kg·m^{-3})
1	Bentonite	0.02-2μm	Flake	0.036 (2600)
	Talc		Flake	0.036 (2600)
	Kaolin-A (for china)		Flake	0.13 (2000)
	B (for paper coating)		Flake	0.036 (2600)
	C		Cylinder	0.036 (2600)
	D (for insulator)		Cylinder	0.036 (2600)
	Mica (synthetic mica)		Flake	0.13 (2000)
	NaA1 (OH)$_2$ CO$_3$		Sphere	0.036 (2600)
2	Silica-A (sp. surface area 200m^2/g)	8-30nm	Sphere	0.042 (2200)
	B (sp. surface area 300m^2/g)		Sphere	0.042 (2200)
	C (sp. surface area 380m^2/g)		Sphere	0.042 (2200)
	D (precipitated silica)		Sphere	0.042 (2200)
	E (hydrophobic silica)		Sphere	0.042 (2200)
3	Asbestos-A (aspect ratio 200, sp. surface area 60m^2/g)	~25nm dia.	Fiber	0.038 (2450)
	B (sp. surface area 300m^2/g)		Fiber	0.04 (2300)
	C (hydrophobic asbestos)		Fiber	0.038 (2450)
4	Organophilic bentonite (hydrophobic bentonite)	~0.5μm	Flake	0.059 (1550)

(a) The density and the size of particles are cited from suppliers' catalogues and literatures.
(b) The shapes were observed by electron microscopy.

particles are rejected and return to the bank circulation flow.

(3) Since the vehicle is scraped off more, the viscosity of bank suspension increases and the force separating rolls increases.

(4) As the deflection of roll bending increases, the clearance becomes wider so that larger particles manage to pass through the nip.

(5) The phenomena of (2) - (4) are repeated until the bank suspension is thoroughly scraped off.

The simulation method of the classification according to the above model is stated in the following:

When the suspension is supplied between feed and center rolls, the feed nip clearance, H_0, becomes wider than the initial clearance, H_{0I}. The viscosity of bank suspension, μ, force separating rolls, F, and the mean deflection of roll bending, w_m, must be known to evaluate the value of H_0. From the preliminary experiment, it is found that the value of μ can be calculated by

$$\mu = \mu_v[1 + 4.15/(\frac{1}{\phi_{vB}} - \frac{1}{0.435})] \tag{2}$$

in the suspension of fly ash in linseed oil varnish. The force separating the rolls is calculated with the dimensionless force separating rolls, N_F, defined by $FH_0/\mu u_m DL$. The value of N_F is obtained by the following simplified equations[5] in terms of the dimensionless number ξ_0 ($= \sqrt{D/H_0}\sin\phi$).

$$N_F = 0.0233\xi_0 + 0.52 \quad \xi_0 \geq 10 \tag{3}$$

$$N_F = 0.762\xi_0^{1/3} - 0.9 \quad \xi_0 < 10 \tag{4}$$

The value of ϕ is the angle between the nip center and the point where the bank contacts with the roll, as shown in *Figure* 1(a), and is calculated from the volume of the bank suspension.

Hummel[7] and Murakami[16] obtained the deflection of roll bending for a cylinder roll. In this study, the deflection was obtained by the method of superposition with the more realistic assumption that the roll had three different cross sections. When the roll dimensions and the distance between end plates are determined, the mean deflection, w_m, can be calculated with the force separating rolls, F, as $w_m = \text{const.} \times F$. The value of F can be obtained by equations (3) and (4) and the relationship of $F = N_F\mu u_m DL/H_0$, in which the value of $H_{0I} + 2w_m$ is substituted into H_0. Consequently, the value of w_m is given as

$$w_m = \tfrac{1}{4}[(H_{0I}^2 + 23.18 \times 10^{-10} N_F \mu u_m DL)^{1/2} - H_{0I}] \tag{5}$$

for the roll dimensions in this experiment as shown in *Figure* 2 and the condition of $L = 0.1$m. The value of H_0 just after being supplied by the suspension is given by the equation

$$H_0 = H_{0I} + 2w_m \tag{6}$$

The volumetric flow rate through the nip per unit time[3] can be obtained by

$$q = \lambda H_0 u_m \tag{7}$$

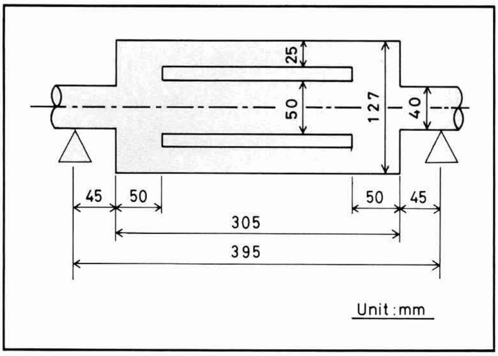


Figure 2—Roll dimensions of a three-roll mill

Now, the density of suspension which passes through the nip, ρ_c, is obtained in the following manner. The particle size distribution of suspension can be represented by the Rosin-Rammler equation

$$R_w = \exp(-k_1 D_p^{k_2}) \tag{8}$$

where the constants of k_1 and k_2 represent the particle size level and the sharpness of distribution, respectively. The cumulative weight fractions of particles larger and less than the size of H_0, i.e., R_L and R_S, are obtained by the following equations.

$$R_L = \exp(-k_1(H_0 \times 10^6)^{k_2}) \tag{9}$$

$$R_S = 1 - R_L \tag{10}$$

The weight of particles which pass through the nip is $q\rho_B\phi_{wB}R_s$, and the weight of vehicle is $q\rho_B(1-\phi_{wB})$. The weight of larger particles which do not pass through the nip is $q\rho_B\phi_{wB}R_L$. The volume of them, $q\rho_B\phi_{wB}R_L/\rho_p$, is replaced by another suspension of equal volume. In the replaced suspension, the volume of the particles larger than the clearance, $(q\rho_B\phi_{wB}R_L/\rho_p)\phi_{vB}R_L$, is also returned to the bank circulation flow. Considering that this was repeated four times, the weight of smaller particles which pass through the nip is obtained as $q\rho_B\phi_{wB}R_s + q\rho_B f_s$ and the weight of vehicle which passes through the nip is

$$q\rho_B(1-\phi_{wB}) + \rho_v[q\rho_B\phi_{wB}R_L/\rho_p - q\rho_B f_s/\rho_p]$$

where

$$f_s = \phi_{wB}\phi_{vB}R_L R_S(1 + \phi_{vB}R_L + \phi_{vB}^2 R_L^2 + \phi_{vB}^3 R_L^3)$$

The particle weight fraction of the suspension which passes through the nip is obtained as the following:

$$\phi_{wc} = \frac{\phi_{wB}R_S + f_s}{\phi_{wB}R_s + f_s + (1-\phi_{wB}) + \rho_v(\phi_{wB}R_L - f_s)/\rho_p} \tag{11}$$

The value of ρ_c is given by

$$\rho_c = [(\frac{1}{\rho_p} - \frac{1}{\rho_v})\phi_{wc} + \frac{1}{\rho_v}]^{-1} \tag{12}$$

Some part of the suspension which passes through the nip transfers to the apron roll and is removed by the scraper. The weight of vehicle, W_v^*, and particle, W_p^*, which still remain in the bank are found by subtracting the weight of scraped suspension from the initial weights of W_v and W_p. Thus,

$$W_v^* = (W_p + W_v)(1-\phi_{wB}) - \frac{qLC_fC_a\rho_c(1-\phi_{wc})e_t}{(1-C_a+C_ae_t)} \tag{13}$$

$$W_p^* = (W_p + W_v)\phi_{wB} - \frac{qLC_fC_a\rho_c\phi_{wc}e_t}{1-C_a+C_ae_t} \tag{14}$$

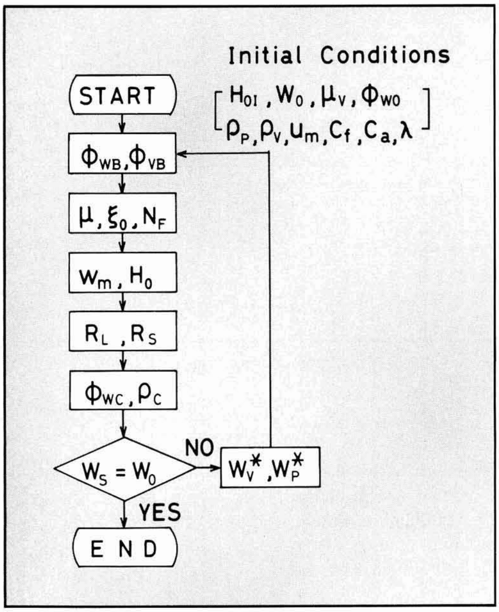


Figure 3—Computational procedure of the simulation

where the term of $qLC_fC_a\rho_ce_t/(1-C_a+C_ae_t)$ represents the weight of scraped suspension per unit time.[2]

The sample density, ρ_c^*, which passes through the nip after unit time can be calculated in a similar way. The new values of ϕ_{vB}^* and ϕ_{wB}^* are given by equations (13) and (14) and μ^* and H_0^* are given by equations (2)-(6). The new values of R_L^* and R_S^* are obtained from the values of R_L' and R_S', that is

$$R_L' = \exp(-k_1(H_0^* \times 10^6)^{k_2}) \tag{15}$$

$$R_S' = 1 - R_L' - \frac{qLC_fC_a\rho_c\phi_{wc}e_t}{W_p(1-C_a+C_ae_t)} \tag{16}$$

The values of R_L^* and R_S^* are given by reducing the sum of R_L' and R_S' to unity as

$$R_L^* = R_L'/(R_L' + R_S') \tag{17}$$

$$R_S^* = R_S'/(R_L' + R_S') \tag{18}$$

The above calculations must be repeated until the total scraped weight, W_s, becomes equal to the supplied weight, W_0. Then the value of Q is calculated by equation (1). Changes of the scraped sample densities for the various operating conditions are evaluated by these calculations. Calculation procedure of this simulation is shown in *Figure* 3.

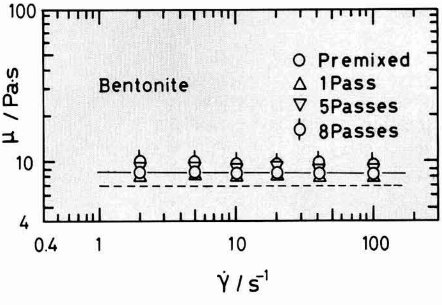


Figure 4—Change of flow curve of bentonite suspension with roll milling (dashed line represents the viscosity of vehicle)

RESULTS AND DISCUSSION

Changes of Flow Properties Of Suspensions with Particle Dispersion

From the experimental results with a grind gauge and an optical microscope, it was confirmed that the dispersion state of particles was improved as the number of roll mill passes increased. Therefore, the change of flow properties of suspensions are discussed on the basis of the fact that the dispersion state is improved with repeated roll milling.

When the powder and vehicle were premixed, the viscosity of premixed suspensions became higher than that of the vehicle and showed various rheological behaviors. The flow properties of these suspensions were changed variously after roll milling depending on the physical properties of particles. Depending on the physical properties of particles, these changes of flow properties are qualitatively discussed in the light of Casson's equation of viscosity, which is represented as

$$\tau^{1/2} = \tau_c^{1/2} + (\mu_c \cdot \dot{\gamma})^{1/2} \tag{19}$$

The Casson viscosity, μ_c, is known as the viscosity at very high shear rate where the flocculated structures are completely broken down.[17] Thus, the Casson viscosity is considered to be affected only by the apparent particle volume fraction. The yield stress, τ_c, is considered to be proportional to the amount of active points which bind the particles together by contacting or bridging with adsorbed water. Therefore, a kind of structure and the apparent volume fraction, respectively, are considered to be reflected on the yield stress and Casson viscosity. The experimental results were classified into four groups, as shown in *Table* 1, and were discussed qualitatively.

(Group 1) Clay Suspensions

The premixed suspensions of these clays were Newtonian and the flow properties did not change with roll milling. A typical result of bentonite suspension is shown in *Figure* 4. In *Figure* 4, the viscosity of the sample passed one time is lower than that of the premixed suspension and the viscosities of 5- and 8-passed suspensions increased. This occurred because the volume fraction of each sample differed a little by a classification effect in the roll nip.

It is known that a dilute suspension which does not contain interactive particles becomes Newtonian and that its viscosity depends on the particle concentration, particle shape, and the amount of stagnated vehicle caught in agglomerate particles. In this experiment, the particle concentration and the particle shape were changed little after roll milling. In addition, the amount of stagnated vehicle is considered to be negligible since the clays have simple shapes and are well wetted with the vehicle. Thus, the viscosities of these clay suspensions are considered to keep constant values.

(Group 2) Silica Suspensions

The five silica suspensions were non-Newtonian fluids at premixing but were changed to Newtonian fluids with lowered viscosities as roll milling was repeated. The apparent viscosity and the Casson plot for silica-D suspensions are shown in *Figures* 5 and 6.

Figure 6 shows that the high yield stress in the premixed sample decreases remarkably with roll milling and the Casson viscosity decreases a little as roll milling is repeated. These behaviors were also observed in other silica suspensions. The final viscosity after five passes was 13-16 Pa·s for all silica suspensions. In the case of hydrophobic silica (silica-E), non-Newtonian behavior remains after roll milling but the Casson viscosity is the same as others. Non-Newtonian property of premixed suspensions increases in order of silica-C>D>E>B>A due to the effect of specific surface area.

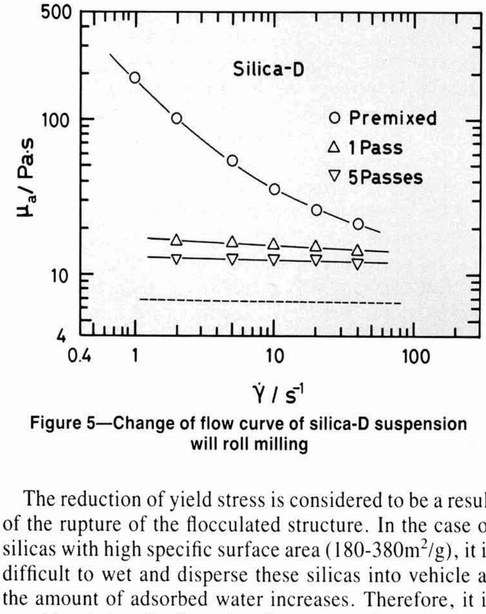


Figure 5—Change of flow curve of silica-D suspension will roll milling

The reduction of yield stress is considered to be a result of the rupture of the flocculated structure. In the case of silicas with high specific surface area (180-380m^2/g), it is difficult to wet and disperse these silicas into vehicle as the amount of adsorbed water increases. Therefore, it is considered that the flocculated structures formed at premixing, of which the amount is proportional to the amount of adsorbed water and specific surface area, are broken down through roll milling to decrease the yield stresses.

The electron micrographs of premixed and 5-passed silica-D suspensions are shown in *Figure* 7. Very large agglomerate particles were found in the premixed suspension but were dispersed to small particles in the 5-passed suspension.

(Group 3) Asbestos Suspensions

The apparent viscosities of three asbestos suspensions were lowered with roll milling similar to silica suspensions but the non-Newtonian property still remained. As observed with the optical microscope, agglomerate particles of about 120-240 μm were in complicated contact with each other. It is thought that these agglomerate particles are broken down to decrease the contacts of large agglomerates by roll milling, so that the yield stress decreased. Suspensions showed non-Newtonian properties after roll milling probably because the aspect ratio is still long enough to be flexible.

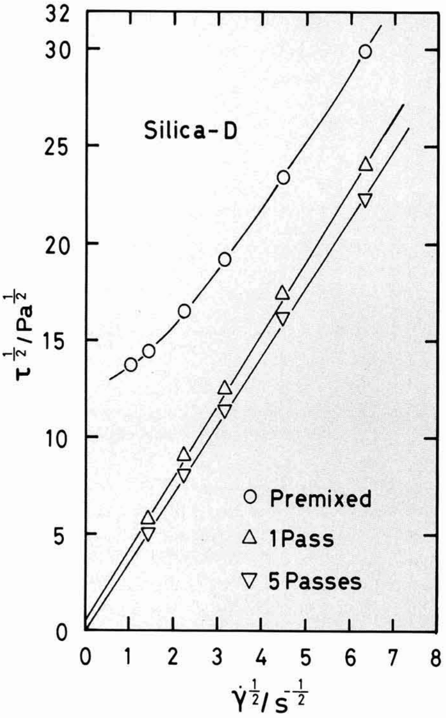


Figure 6—Casson's plots for silica-D suspension

(Group 4) Organophilic Bentonite Suspension

The organophilic bentonite suspension was Newtonian at premixing, but became non-Newtonian after roll milling. The flow curves and the Casson plot are shown in

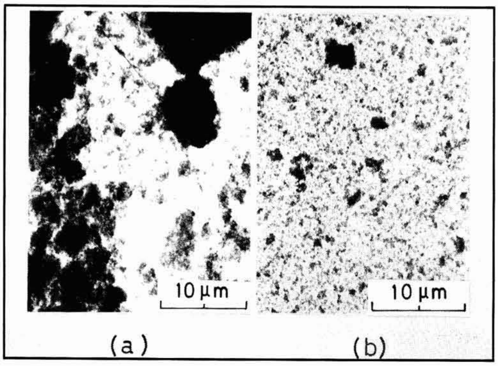


Figure 7—Electron micrographs of premixed, (a) and 5-passed, (b) silica-D suspensions

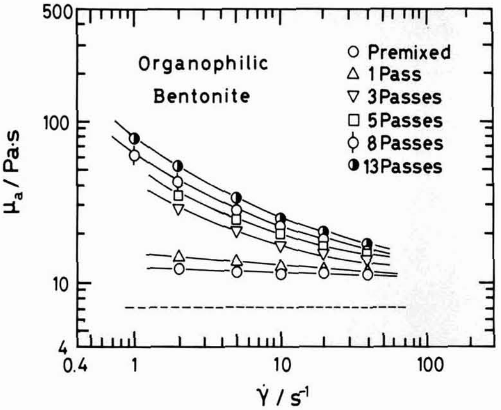


Figure 8—Change of flow curve of organophilic bentonite suspension with roll milling

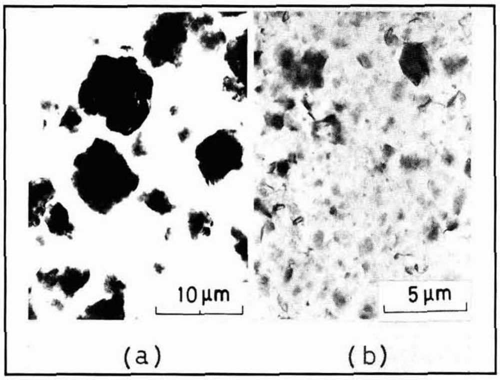


Figure 10—Electron micrographs of premixed, (a) and 10-passed, (b) organophilic bentonite suspensions

Figures 8 and 9. It was found that the Casson viscosity did not change after one pass through the mill and that only the yield stresses increased. The reason for unchanged Casson viscosity is probably that the organophilic bentonite was well wetted with the vehicle and the amount of the stagnated vehicle was negligible as similar to clay suspensions. M'Ewen and Pratt [18] proposed the structure model of bentonite particles in water in which the particles were linked at their ends by edge to edge contact. Similar structures are expected to form in organophilic bentonite-linseed oil varnish systems, and are responsible for the increase in the yield stress. The electron micrographs of the premixed and 10-passed suspensions are shown in *Figure* 10. Many primary particles are found in the 10-passed suspension. The yield stress is thought to increase as the number of active edges of the primary particles increases with roll milling.

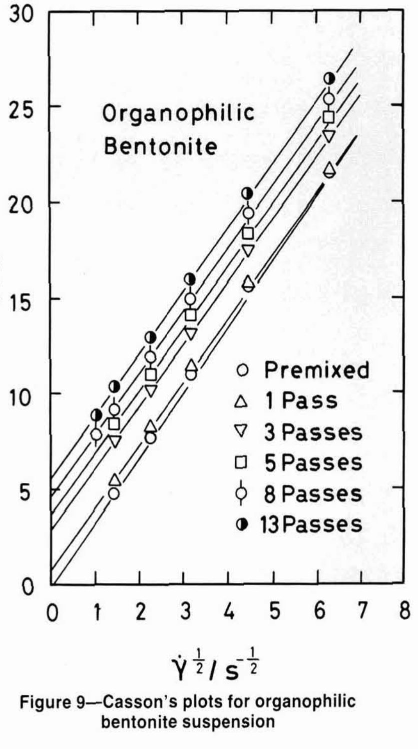


Figure 9—Casson's plots for organophilic bentonite suspension

The result of Casson plots may predict that the apparent volume fraction does not change. It is supposed, however, that the spacing of the crystal lattice plane of organophilic bentonite extends in vehicle as that of bentonite extends in water, changing the apparent volume fraction. For the purpose of understanding this, the spacing of the crystal lattice plane of the organophilic bentonite in linseed oil varnish was measured by X-ray diffraction method. It was found that the spacing of the lattice plane of the particle in the premixed suspension was wider than that of dry powder but there was no further change in 8 passed suspensions through the mill. Therefore, we can conclude that the yield stress increases not because more vehicle enters into the crystal layer in repeated roll milling but because the primary particles form some structures.

Simulation Results for Classification

The following values were adopted in calculation: the properties of fly ash and linseed oil varnish in the experiment condition, transfer fractions $C_f = 0.764$, $C_a = 0.798$ which are obtained from roll speed ratio,[3] theoretical value of $\lambda = 1.30$ and 100% scraping efficiency, $e_t = 1$. The examples of simulated results for the value of ρ_c are shown in *Figure* 11, which shows that the values of ρ_c/ρ_0 are lower than unity at the beginning and increases towards the end. The degree of classification increases as the average production rate, Q, or averaged clearance decreases. The amount of W_0 does not affect the shape of the curve of ρ_c/ρ_0. The classification in the roll mill was not investigated quantitatively and the parameter which controls the degree of classification was not discussed previously. In this study, the dimensionless number, S, defined by equation (20), is introduced as the parameter of the degree of classification.

$$S = \sum_{i=1}^{n} \frac{|\rho_{ci}/\rho_0 - 1|}{n} \qquad (20)$$

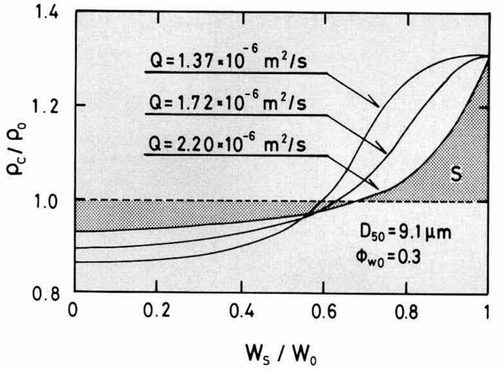


Figure 11—Changes of scraped sample densities by simulation

This parameter is based on the sample density which can be measured easily. The value of S is equivalent to the area surrounded by the curve of density change and the line of $\rho_c/\rho_0=1$ for a large value of n. In the case of $Q=2.2\times10^{-6}\text{m}^3/\text{m}\cdot\text{s}$, the value of S is equivalent to the shadowed area in *Figure* 11. The value of S equals zero when the classification does not occur, and it increases as the degree of classification increases. The values of S can be correlated with the value of $D_{50}u_mC_fC_a/Q$ which corresponds to the ratio of representative particle size to the averaged clearance.

The following were found from the simulation: (1) The curve, S, is not affected by the value of k_1 which represents the particle size level. (2) The curve, S, does not change with the value of μ_v; it changes with the value of ϕ_{w0} but the correlation curve of S/ϕ_{w0} becomes almost independent of ϕ_{w0}.

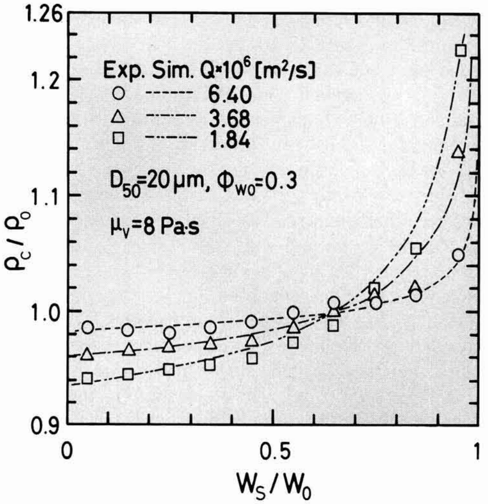
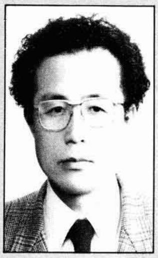


Figure 12—Experimental and simulated results for the changes of density of scraped samples

Experimental Results for Classification

The experimental results of scraped sample densities are shown in *Figure* 12. The experimental values of ρ_c/ρ_0 are lower than unity at the beginning and increase towards



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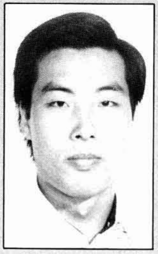

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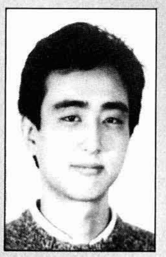

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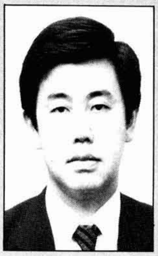

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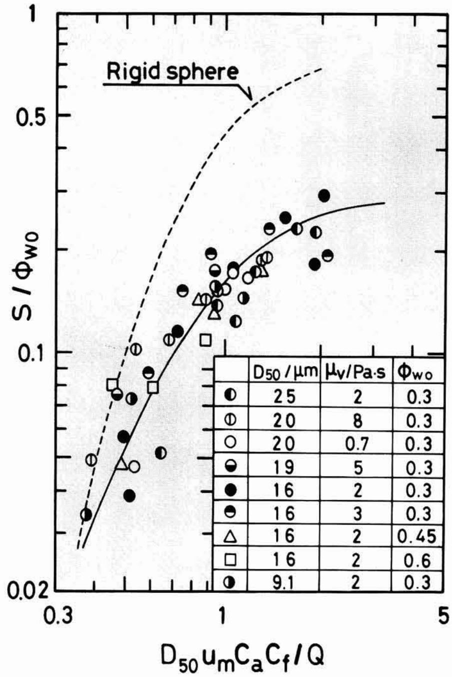
the end, as shown in *Figure* 11. The dotted and dot-and-dash lines in *Figure* 12 are the calculated lines as mentioned later. The values of S were calculated by equation (20) with experimental values of densities substituted. All results of S for various particle size level, μ_v and ϕ_{w0}, are plotted in *Figure* 13. The values of S are scattered a little but have a tendency as represented by the solid line. The sharpness of the particle size distributions is almost the same for all premixed suspensions in this experiment, and thus the values of S with various particle size levels can be represented by a single curve. The experimental values deviate to the right-hand side from the dotted line of simulation in which rigid sphere particles (*Figure* 13) and $e_t = 1$ are assumed. The deviation of experimental values from the simulated value increases with increasing value of $D_{50}u_mC_fC_a/Q$. This deviation is thought to occur because the dispersion of particles proceeds and the scraping efficiency decreases as the clearance decreases or the value of $D_{50}u_mC_fC_a/Q$ increases. On the contrary, in the conditions of small values of D_{50} and wide clearances or small values of $D_{50}u_mC_fC_a/Q$, the particles are difficult to disperse so that the experimental values approach the simulated line. The dispersion of particles and the reduction of scraping efficiency were assumed so that the value of S agrees with the experimental values. The results of modified simulation are shown in *Figure* 13 by the solid line. The modified simulation of density changes is compared with the experimental values in *Figure* 12. From the simulation results, it was found that the shape of curve of density change depends not on the particle dispersion and the reduction in scraping efficiency but the values of S and ϕ_{w0}. Therefore, the calculated values represent well the experimental values in *Figure* 12 because the viscosity of bank suspension, the force separating rolls and the amount of roll bending are properly estimated.



	D_{50}/µm	μ_v/Pa·s	Φ_{wo}
◐	25	2	0.3
⦶	20	8	0.3
○	20	0.7	0.3
◒	19	5	0.3
●	16	2	0.3
◓	16	3	0.3
△	16	2	0.45
□	16	2	0.6
◑	9.1	2	0.3

Figure 13—Experimental results for S/ϕ_{wo} with various conditions of μ_v, D_{50} and ϕ_{wo}

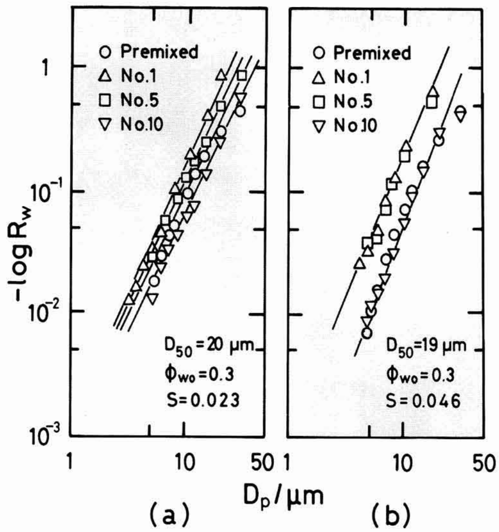


Figure 14—Changes of the particle size distribution of scraped samples

By the classification in the roll nip, the particle size distribution was also changed. The typical results for the changes of particle size distribution are shown in *Figure* 14. Samples 1, 5, and 10 correspond to the samples of $W_s/W_0 = 0\text{-}0.1$, 0.4-0.5, and 0.9-1.0, respectively, *Figure* 14 (a) and (b) show the results of low and high degree of classification, respectively. In *Figure* 14(a), the particle size of the Sample 1 is finer and that of Sample 10 is larger than that of the premixed sample. The particle size of the scraped sample at the end becomes larger than that of premixed sample classified as slightly dispersed. In *Figure* 14 (b), the particle size of Sample 1 becomes very fine and that of Sample 10 remains at the same level of the premixed sample. The changes of particle size, shown in *Figure* 14, correspond well to the density changes in *Figure* 12.

SUMMARY

Seventeen kinds of powders were dispersed into linseed oil varnish with a three-roll mill and changes in the flow property of these suspensions were measured. Various changes in flow properties with particle dispersion were classified into four groups according to the physical properties of particles. These rheological differences were discussed qualitatively according to Casson's equation of viscosity.

The classification effect in the roll mill was then investigated by the simulation and the experiment. Densities of samples scraped off the apron at the beginning were lower than the premixed sample density and increased towards the end of scraping. Changes in the particle size distributions were also seen. The degree of classification was represented by the value of S, defined on the basis of density changes. The values of S were well correlated by the ratio of 50% particle size by weight oversize to averaged minimum nip clearance. The changes of scraped sample densities were represented by the simulated values.

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NOMENCLATURE

C_a = Transfer fraction of the total flux through the apron nip which transfers to the faster roll, (—)

C_f = Transfer fraction of the total flux through the feed nip which transfers to the faster roll, (—)

D = Roll diameter, (m)

D_p = Particle diameter, (μm)

D_{50} = 50% Particle diameter by weight oversize, (m)

e_t = Scraping efficiency, (—)

F = Force separating rolls, (N)

H_0 = Minimum nip clearance, (m)

H_{0I} = Initial minimum nip clearance, (m)

k_1,k_2 = Constants in Rosin-Rammler equation, equation (8)

L = Effective roll length, (m)

N_F = Dimensionless force separating rolls ($=FH_0/\mu u_m DL$), (—)

Q = Average production rate, ($m^3/m{\cdot}s$)

q = Total flux through the nip, ($m^3/m{\cdot}s$)

R_L = Cumulative weight fraction of the particles of which size is larger than the minimum nip clearance, (—)

R_S = Cumulative weight fraction of the particles of which size is smaller than the minimum nip clearance, (—)

R_w = Cumulative oversize fraction by weight, (—)

S = Dimensionless number defined by equation (20)

t_m = Scraping time, (s)

u_m = Averaged roll speed of feed and center roll, (m/s)

W_p = Weight of the particles in the suspension, (kg)

W_s = Total weight of the scraped samples, (kg)

W_v = Weight of the vehicle in the suspension, (kg)

W_0 = Total weight of the suspension, (kg)

w_m = Mean deflection of the roll bending, (m)

$\dot{\gamma}$ = Shear rate, (1/s)

λ = Dimensionless total flow rate through the nip, (—)

μ = Viscosity, (Pa·s)

μ_a = Apparent viscosity of non-Newtonian fluid, (Pa·s)

μ_c = Casson's viscosity, (Pa·s)

μ_v = Vehicle viscosity, (Pa.·s)

ξ_0 = Attaching point between the feed bank and the roll ($=\sqrt{D/H_0}\sin\phi$), (—)

ρ_B = Density of the bank suspension, (kg/m^3)

ρ_c = Density of the scraped sample, (kg/m^3)

ρ_p = Particle density, (kg/m^3)

ρ_v = Vehicle density, (kg/m^3)

ρ_0 = Density of the premixed suspension, (kg/m^3)

τ = Shear stress, (Pa)

τ_c = Yield stress, (Pa)

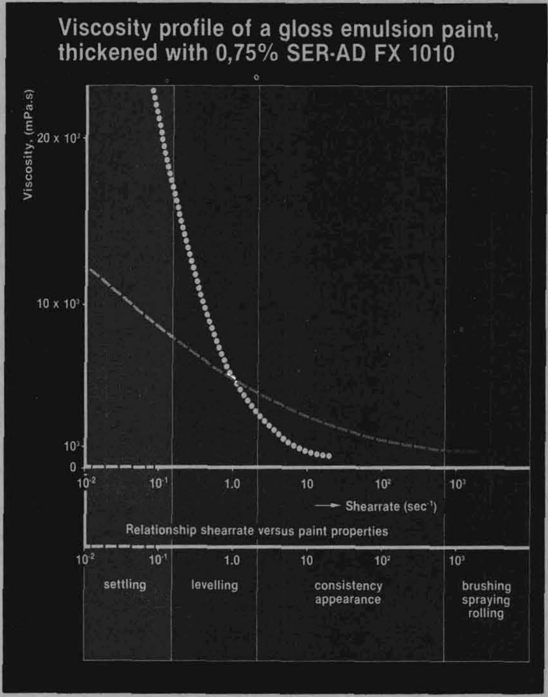
ϕ = Bank contact angle, (deg)

ϕ_{vB} = Particle volume fraction of the bank suspension, (—)

ϕ_{wB} = Particle weight fraction of the bank suspension, (—)

ϕ_{wc} = Particle weight fraction of the scraped sample, (—)

ϕ_{w0} = Particle weight fraction of the premixed suspension, (—)



Viscosity, (mPa.s)
20 x 10³
10 x 10³
10³
0
10⁻²
10⁻¹
1.0
10
10²
10³
→ Shearrate (sec⁻¹)
Relationship shearrate versus paint properties
10⁻²
10⁻¹
1.0
10
10²
10³
settling
levelling
consistency appearance
brushing spraying rolling

Study of Interactions Between Wood And Water-Soluble Organic Solvents

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Interactions between small cross-sectional wafers of basswood, eastern white pine, and radiata pine and several water-soluble organic solvents were investigated with the primary interest focused on the penetration and swelling of cell-wall capillaries. The water-soluble solvents used were ethylene glycol monobutyl ether (EGMBE), diethylene glycol monobutyl ether (DEGMBE), and ethylene glycol. Cell-wall capillary penetration was ascertained by measuring the residual volumetric swelling of the wood wafers after treatment and redrying.

Results have shown that these water-soluble organic solvents, when applied in aqueous solution, both penetrate and swell wood cell-wall capillaries, and can become entrapped to such an extent that prolonged oven drying does not remove them. The likelihood of this entrapment was found to increase with large molecular size and low evaporation rate of the solvent, and low relative humidity. The bulking is only temporary, however, because leaching with liquid water easily removes trapped solvent molecules.

INTRODUCTION

An important component of most water-borne polymer systems is a water-miscible organic solvent such as alcohol, glycol, or glycol ether (*Table* 1). These materials are sometimes called cosolvents or coupling solvents as they are able to dissolve both organic resins and water simultaneously, thus serving to "couple" them together. McEwan[1] stated that most resins require these solvents, despite other resin solubilizing measures, to increase the dissolving power of the aqueous phase to a commercially acceptable level. Grant[2] noted that, in addition to contributing to resin solubility, the organic solvents are important in controlling the rheology, viscosity, and wetting properties of water-borne polymer systems.

It has been reported that wood and cellulosic fibers can entrap organic solvents within the cell-wall capillary pore structure (Mease,[3] Wiertelak and Garbaczówna,[4] and Merchant[5]). Each of these researchers treated wood or cellulosic fibers with organic solvents by either direct soaking or a solvent-exchange. They found that the solvents did not evaporate completely even when dried for prolonged periods at temperatures over the boiling point particular to the solvents. The commonly accepted explanation for this is that before the organic solvent has completely evaporated the cell wall capillary pore structures shrink to the point where they are too small to allow the organic solvent to diffuse through them, thus trapping the remaining solvent. A combination of molecular size and evaporation rate generally determines the likelihood of an organic solvent being entrapped in a wood cell wall capillary.

Kajita, et al.[6] studied the interaction of wood with organic solvents by measuring the total heat of wetting of wood by solvents. They found considerably lower heats of wetting for many alcohols, polyhydric alcohols, and ether alcohols than for water, indicating that these solvents are not as readily attracted and adsorbed by the wood cell wall.

As a result of the work by Côté and Robinson[7] and Smith[8] it was suspected that, under particular circumstances, the water-soluble solvents used in water-borne

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systems could be trapped in the wood cell wall. This entrapment would produce a residual swelling, or a temporary bulking effect, complicating the interpretation of information obtained when treating wood with water-based resins. To determine the exact extent of this entrapment, swelling experiments were undertaken.

Small cross-sectional wood wafers were impregnated with water and aqueous solutions of three water-miscible solvents and then exposed to different procedures including: air, oven, and vacuum drying, drying at different relative humidities, and drying after soaking in water. Heat-of-wetting experiments were performed with basswood wood flour at several moisture contents with aqueous solutions of the same solvents to determine their attraction characteristics to cellulose.

EXPERIMENTAL

Basswood (*Tilia americana* L.) and eastern white pine (*Pinus strobus* L.) boards, obtained from local sawmills, and radiata pine (*Pinus radiata* D. Don.), obtained from the Flecto Co., Oakland, CA, were machined into square billets 20 mm on a side, with the growth rings oriented parallel to one edge. Cross-sectional wafers, 4 mm in thickness to facilitate penetration along the grain, were cut sequentially from these billets and assigned to treatment groups for each bulking experiment. The wafers were oven dried before being measured and treated. Impregnation of wafers with solvents was accomplished via vacuum impregnation followed by a three-day soaking period to allow for diffusion of material into cell wall capillaries.

Swelling was followed by measuring volumetric changes, which are the sums of the tangential and radial changes. Total volume measurements, which include the longitudinal dimension, are not used in wood studies because of negligible longitudinal swelling and shrinking, as suggested by Kelsey and Kingston.[9] The dimensions of each wafer were measured to 0.01 mm in two places with a dial gauge micrometer and the mean was calculated. In several of the later experiments a mercury immersion procedure was used to determine total volume changes. In this procedure a jar of mercury is placed on an electronic balance, a wafer is submerged completely in the mercury, and the weight of mercury displaced by the wood wafer recorded to 1 mg. The wafer volume is obtained by dividing the displaced weight by the density of mercury. This method is more accurate and rapid than the volumetric determinations with the dial gauge micrometer.

In the first experiment, 10 each of oven dry basswood and radiata pine wafers were swollen via vacuum impregnation with 0, 25, 50, 75, and 100 percent-by-weight aqueous solutions of ethylene glycol mono butyl ether (EGMBE), diethylene glycol monobutyl ether (DEGMBE), and ethylene glycol. The resultant swelling was determined by micrometer measurements. Then wafers swollen with water and the 25% solvent solutions were exposed to 10 days of air drying, one day of oven drying at 105°C, three days of vacuum-oven drying at 105°C and 26 inches Hg vacuum, three days of water-soaking in which the water was changed four times, seven more days of air drying, and then another day of oven drying. The air drying following saturation was an attempt to simulate normal conditions of use. The oven drying followed by the vacuum-oven drying was meant to remove any water and as much solvent as possible. Since all of these solvents are water soluble the water soaking step was carried out to remove any unevaporated solvent left in the wood. The final air and oven drying were intended to show if any of the bulking previously found was retained after leaching with water.

To determine whether relative humidity affects the evaporation from and residual volumetric swelling of wood treated with aqueous organic solutions the following experiment was performed. Twenty each of oven-dry basswood and white pine wafers were swollen with water and with 20% by weight EGMBE and DEGMBE aqueous solutions. The wafers of each treatment group were divided into four groups for drying, one group of five wafers

Table 1—Typical Water-Soluble Organic Solvents

	Chemical Structure	Molecular Weight	Boiling Point°C	Heat of Vaporization BTU/760mm	Evaporation Rate/Butyl Acetate = 100	Vapor Pressure @ 20°C, mm Hg
Water	HOH	18	100	1074	16	17.5
Ethylene glycol mono ethyl ether (EGMEE)	$C_2H_5OC_2H_4OH$	90	136	192	32	3.75
Ethylene glycol mono butyl ether (EGMBE)	$C_4H_9OC_2H_4OH$	118	171	162	6	0.59
Diethylene glycol mono butyl ether (DEGMBE)	$C_4H_9(OC_2H_4)_2OH$	162	230	130	0.01	0.01
Ethylene glycol	$HOCH_2CH_2OH$	62	198	371	0.1	0.1
Isopropanol	$\begin{matrix}CH_3\\CH_3\end{matrix}CHOH$	60	82	286	101	34
n-Butanol	C_4H_9OH	74	118	141	45	4

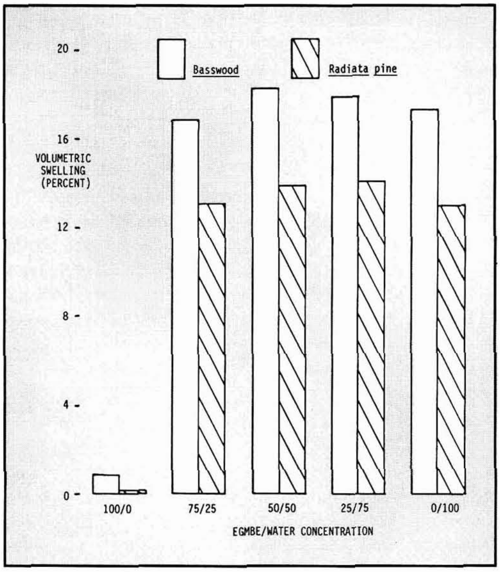

Figure 1—Maximum volumetric swelling (oven-dry to saturation) of basswood and radiata pine with varying EGMBE/water concentrations

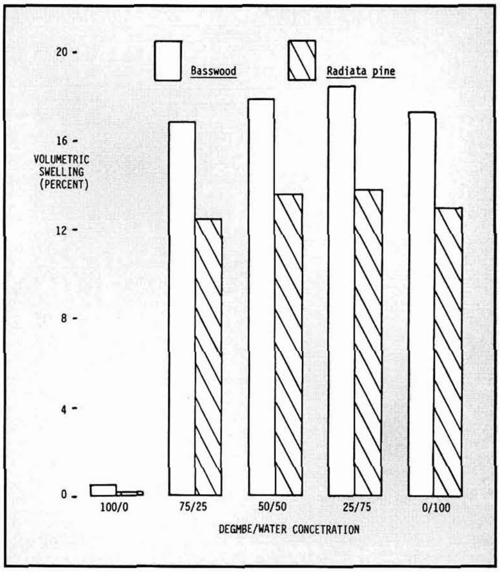

Figure 2—Maximum volumetric swelling (oven-dry to saturation) of basswood and radiata pine with varying DEGMBE/water concentrations

each to a drying oven at 105°C and to conditioning cabinets set at 25°C and 90, 63 and 35% relative humidity, and dimensional changes were measured until equilibrium was reached.

To answer the question of whether the retention of organic solvents in wood is due to a strong physical attraction to cellulose or simply a mechanical entrapment, heat of wetting experiments were performed with water, 20% EGMBE, and 20% DEGMBE aqueous solutions. Basswood wood flour was conditioned to 0% moisture content in a vacuum oven and to 5.6, 6.3, 8.9, and 13.4% moisture content in conditioning chambers. Three runs were made for each treatment at each condition.

These experiments were carried out in a controlled-environment room where the temperature was held at 25.0 ± 0.2°C and the relative humidity held at 40 ± 3%. A simple calorimeter consisting of a large Dewar vessel enclosed in an insulated cylindrical metal case was used to measure heat of wetting. The heat generated by the wetting was calculated from the temperature rise of the calorimeter and the heat capacities of the various components in the calorimeter (Skaar[10]). This total heat, divided by the dry weight of the wood flour particles, is the heat of wetting.

RESULTS AND DISCUSSION

Stamm[11] reported that some organic solvents, which swell wood considerably less than water, do swell wood more in high aqueous concentrations than it is swollen by water alone. Ethylene glycol mono ethyl ether (EGMEE), a common cosolvent, was one of the solvents he used to illustrate this point. It swelled Sitka spruce cross-sections only 87% as much as water alone but swelled them slightly more than water when in a 50% aqueous concentration. The three solvents used in this study—EGMBE, DEGMBE, and ethylene glycol—have shown similar results with basswood and radiata pine.

As shown in *Figures* 1 and 2, the first two solvents cause virtually no swelling of oven-dry wood while ethylene glycol swells it to the same extent as water (*Figure* 3). When compared to Stamm's[11] results noted above, an interesting relation between molecular size and swelling ability appears. EGMBE and DEGMBE with molecular

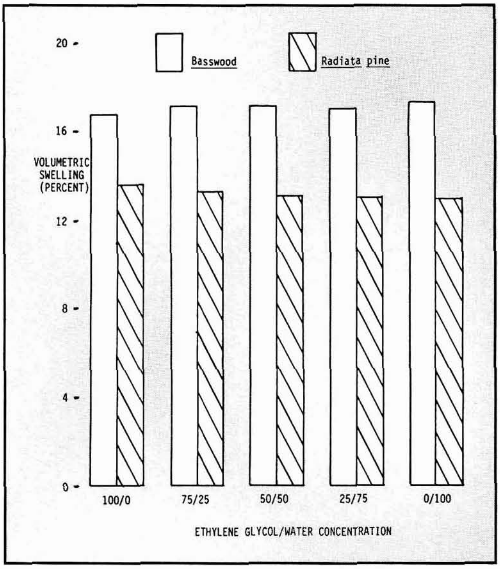

Figure 3—Maximum volumetric swelling (oven-dry to saturation) of basswood and radiata pine with varying ethylene glycol/water concentrations

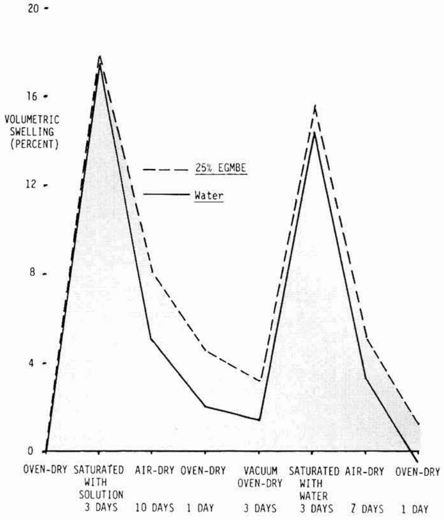

Figure 4—Residual volumetric swelling of basswood initially swollen with 25% EGMBE in water and subsequently exposed to varying conditions

weights of 118 and 162, respectively, do not swell oven-dry wood. EGMEE with a molecular weight of 90 swells wood 87% as much as water and ethylene glycol with a molecular weight of 62 swells wood about the same as water. Rosen,[12] studying interactions of alcohols and organic acids with wood, found a similar increase in wood-swelling ability with decreasing molecular size. This is an indication of the existence of wood cell wall capillaries, that, upon oven drying, shrink to a size that does not allow penetration by larger molecules.

That aqueous solutions of EGMBE and DEGMBE swelled both basswood and radiata pine greater than water alone indicates that these solvents penetrate wood cell wall capillaries. Apparently, a certain amount of water is required as an initiator to swell the capillary openings to the extent that permits these larger molecules to enter. This phenomenon was discussed by Hermans[13] who observed that glycerine in aqueous solutions could penetrate into pulp fibers only after the fibers had first been penetrated and swollen with water. The significance of this phenomenon is that swollen wood cell-wall capillaries are able to admit molecules that are too large for penetration when the wood is dry. Hence, it is possible that relatively large molecules could be physically entrapped within a cell-wall capillary if they are within the capillary and do not completely evaporate before the capillary shrinks upon drying.

Aqueous/organic solvent solutions often swell wood to a greater extent than water. Stamm[11] suggested that this is caused by the tendency of the organic solvent to diffuse into the cell wall because of a concentration gradient, when the work required to displace solvent exceeds the work required to open up the cell wall structure. The further opening of the cell wall structure that causes this additional swelling probably involves the creation of new and/or enlarging of existing cell wall capillaries thus leaving the wood more absorptive than it was before.

Figures 4, 5, and 6 show the swelling and shrinking behavior of basswood wafers treated with water and aqueous/organic solvent solutions upon exposure to various drying conditions. The presence of all three solvents considerably reduces the shrinkage of wood even after air-drying for 10 days. DEGMBE and ethylene glycol, owing to their extremely low vapor pressure and evaporation rate (*Table* 1), are especially noticeable in this regard. Upon oven drying at 105°C, although shrinkage does occur, each of the organic solvent treatments still shows considerable residual volumetric swelling (temporary bulking). Evidence of mechanical entrapment of the or-

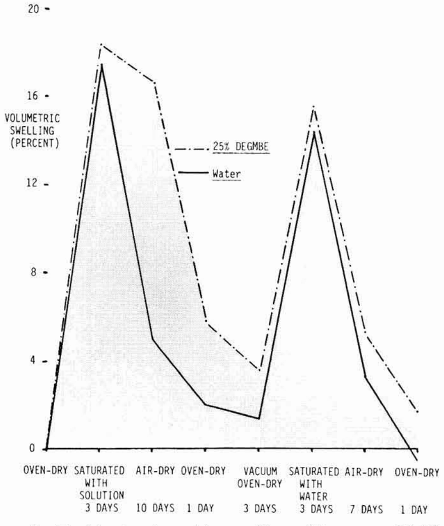

Figure 5—Residual volumetric swelling of basswood initially swollen with 25% DEGMBE in water and subsequently exposed to varying conditions

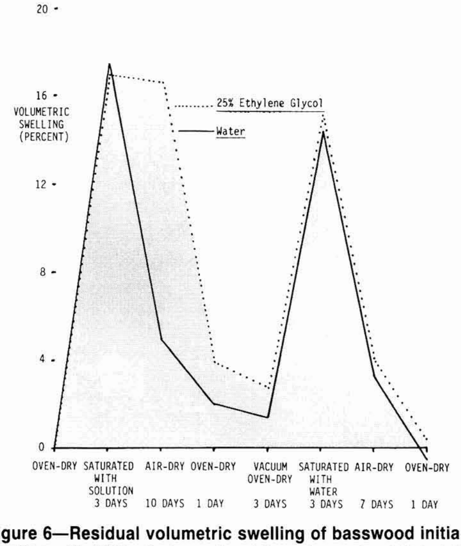

Figure 6—Residual volumetric swelling of basswood initially swollen with 25% ethylene glycol in water and subsequently exposed to varying conditions

ganic solvents in constricted cell-wall capillaries is shown by the fact that ethylene glycol, a smaller molecule than the other two, loses more of its cell-wall swelling than do the two glycol ethers.

Upon saturating the wafers with distilled water the entrapped organic solvents, which are completely water soluble, leach out of the swollen capillaries. Subsequent air and oven drying result in practically no bulking.

It was observed when working with wood treated with water-miscible solvents that greater residual swelling of the wood cell walls occurred when oven drying followed a relatively short air drying period. It was speculated that relative humidity could have an effect on the amount of solvent retention. For example, at low relative humidities wood cell wall capillaries would shrink relatively quickly and be more likely to trap slowly evaporating solvents like EGMBE or DEGMBE. At high relative humidities, however, the capillaries would remain in a swollen state and allow solvent to escape. Basswood and white pine wafers were treated with water and 20% solutions of the glycol ethers. They were subsequently dried at 25°C at 90, 63, or 35% relative humidity or in a drying oven at 105°C until equilibrium was reached. *Figures* 7-14 provide proof that relative humidity controls the likelihood of solvent entrapment by showing the greater amount of residual volumetric swelling of the glycol ether solution treated wafers over water treated wafers at lower humidities.

After equilibration at 90% relative humidity, basswood and white pine wafers treated with solutions of EGMBE and DEGMBE remain slightly more swollen than those treated with water alone (*Figures* 7 and 8). As previously discussed, this small increase is due to the increased absorptivity caused by higher initial swelling in those solvent solutions.

At 63% relative humidity, basswood retains significant amounts of DEGMBE (*Figure* 9) while white pine does not (*Figure* 10). This is due to the fact that a greater amount of DEGMBE was adsorbed into the basswood to begin with, as evidenced by its greater initial swelling over that of white pine, and the more porous nature of basswood allowed a more rapid drying and shrinkage of cell wall capillary openings. EGMBE did not bulk basswood or white pine at this humidity.

There was significant residual swelling of basswood and white pine by both glycol ethers at 35% relative humidity (*Figures* 11 and 12). Hence at a relative humidity of 35%, wood cell-wall capillary pore openings shrink to such an extent as to prevent the escape of both adsorbed solvents while DEGMBE can be retained at humidities as high as 63% in basswood (*Figure* 9).

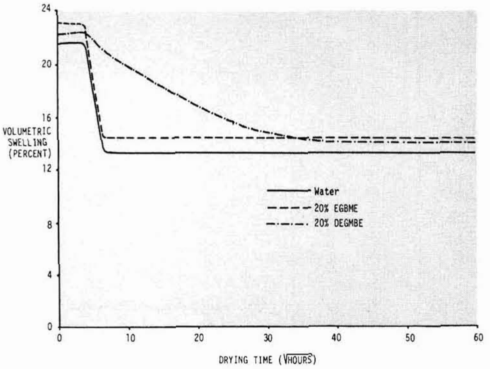

Figure 7—Residual volumetric swelling of basswood initially swollen with aqueous/organic cosolvent solutions and subsequently dried at 25°C, 90%RH

In the case of wafers subjected to oven drying, bulking is shown with both EGMBE and DEGMBE aqueous solution treated basswood and white pine. Again, greater bulking occurs in basswood because of its more porous nature and greater original amounts of adsorbed organic solvent. The inability of the water-treated wafers in this and other swelling studies to return to their original oven-dry dimensions after treatment and subsequent oven drying is due to shrinkage hysteresis (Skaar[10]). In this case (*Figures* 13 and 14), the shrinkage, which continues to below the original oven dry volume, is due to a breakdown of wood constituent material caused by extended exposure to the high temperature of the drying oven. Stamm[11] and the recorded weight loss of these wafers to well below their original oven-dry weight support this statement.

While relative humidity controls capillary pore size and thus solvent entrapment potential, the organic solvent must, in fact, be present within the wood cell wall in order to swell it originally. The evaporation rates of solvents or solvent-water mixtures determine to a large part the likelihood of solvents being trapped in wood cell-wall capillaries. Both of the glycol ethers used here have a low vapor pressure and a slow evaporation rate (*Table* 1). As such, they would be expected to evaporate slowly from wood. There are other factors to consider, however; EGMBE in aqueous solutions deviates from the ideal. It forms an azeotropic mixture with water and evaporates from such solutions with a relatively constant vapor phase concentration of 20% solvent and 80% water (Dow Chemical Co.[14]). The vapor pressure of the mixture is just above that of water alone and considerably above that of the solvent alone. Thus, EGMBE evaporates at a much faster rate from an aqueous solution than when it is straight solvent.

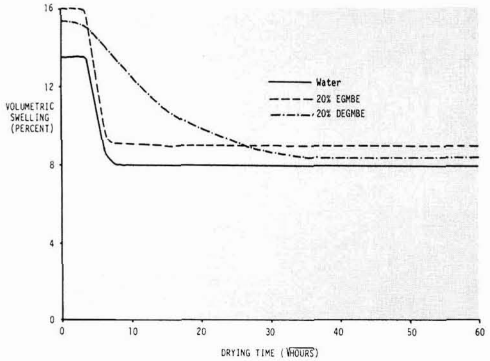

Figure 8—Residual volumetric swelling of white pine initially swollen with aqueous/organic cosolvent solutions and subsequently dried at 25°C, 90%RH

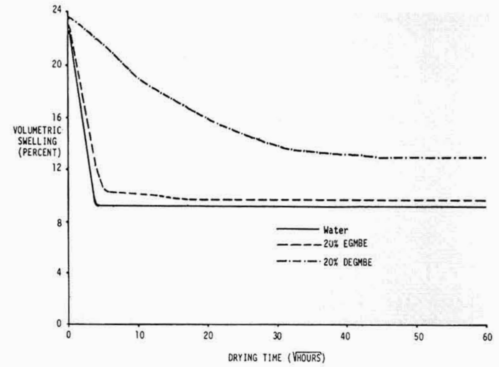

Figure 9—Residual volumetric swelling of basswood initially swollen with aqueous/organic cosolvent solutions and subsequently dried at 25°C, 63%RH

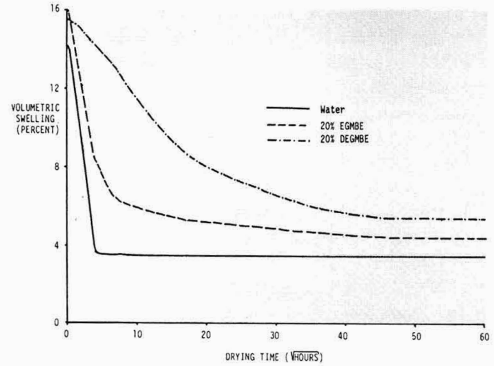

Figure 12—Residual volumetric swelling of white pine initially swollen with aqueous/organic cosolvent solutions and subsequently dried at 25°C, 35%RH

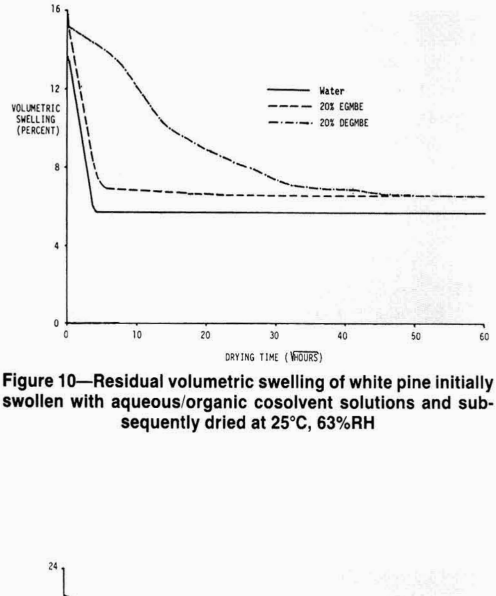

Figure 10—Residual volumetric swelling of white pine initially swollen with aqueous/organic cosolvent solutions and subsequently dried at 25°C, 63%RH

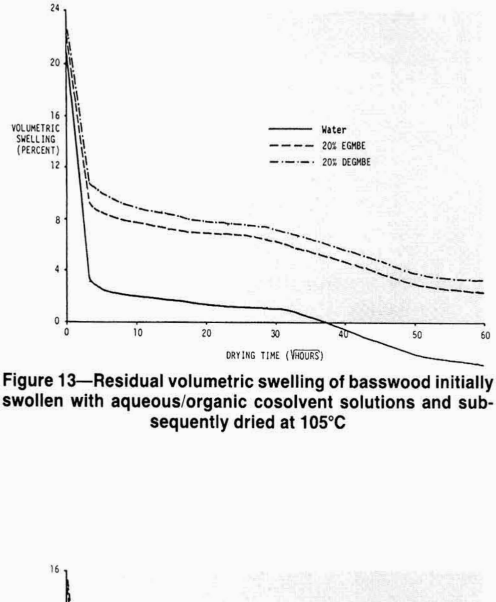

Figure 13—Residual volumetric swelling of basswood initially swollen with aqueous/organic cosolvent solutions and subsequently dried at 105°C

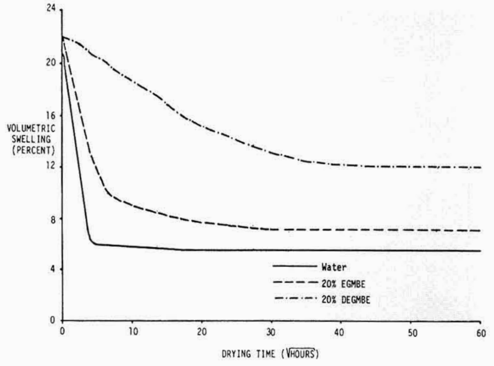

Figure 11—Residual volumetric swelling of basswood initially swollen with aqueous/organic cosolvent solutions and subsequently dried at 25°C, 35%RH

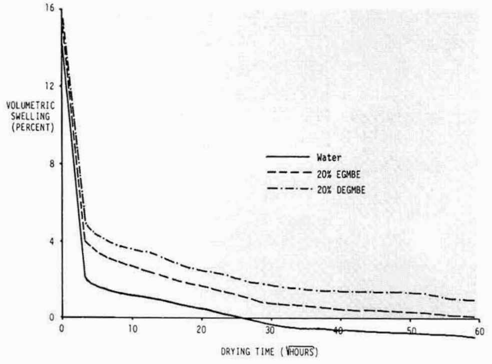

Figure 14—Residual volumetric swelling of white pine initially swollen with aqueous/organic cosolvent solutions and subsequently dried at 105°C

Table 2—Heat of Wetting (cal/g oven-dry wood) Of Basswood Wood Flour in Several Solvents

Percent Moisture Content	Water	Wetting Solution 20% EGMBE	20% DEGMBE
Oven-dry	15.5	13.5	12.6
5.6	7.2	6.3	6.0
6.3	6.8	5.9	5.8
8.9	4.8	4.2	4.3
13.4	3.0	2.6	2.6

DEGMBE, however, behaves differently as there are no known aqueous azeotropes (Stanley[15]). Behaving as an ideal solution when in an aqueous mixture, its evaporation rate is independent of that of water and dependent only upon temperature. Practical aspects of these characteristics indicate that it is a poor solvent to use in a system where wood is to be treated, since its slow evaporation rate increases the likelihood of solvent entrapment (*Figures* 7-14).

Due to the water component of an aqueous/organic solvent solution the ambient relative humidity can have a large effect upon the evaporation rate of the aqueous phase. The concept of critical relative humidity (CRH), introduced and discussed by Dillon[16] and Stratta, et al.[17] states that a CRH exists for particular aqueous binary solutions, above which the rate of water evaporation is reduced, thereby enriching the water concentration in the solution. Below this point the rate of water evaporation is increased, thereby enriching the solvent concentration in the solution. Air flow rate increases were found to lower the CRH value.

The CRH concept is important when dealing with the evaporation of organic solvents from wood. For example, at low humidities, particularly as found in an air-drying oven, the water evaporation rate would increase, serving to enrich the solvent concentration in contact with wood. This would increase the diffusion concentration gradient and force more solvent into cell-wall capillaries, increasing the likelihood and degree of solvent entrapment. *Figures* 7-14 illustrate clearly the increase in solvent entrapment and bulking at lower relative humidities.

Heat of wetting values were obtained for water, 20% EGMBE, and 20% DEGMBE at oven-dry, and 5.6, 6.3, 8.9, and 13.4% moisture content (*Table* 2). The values for 20% solvent solutions were between 80-90% of that found for water alone. These lower values substantiate the theory that the retained swelling, or bulking, observed with these organic solvents is due to a mechanical entrapment and not a greater bonding attraction.

CONCLUSIONS

Ethylene glycol monobutyl ether (EGMBE), diethylene glycol monobutyl ether (DEGMBE), and ethylene glycol, typical organic solvents in water-borne polymer systems for enhancing aqueous solubility, were found to interact with wood in a complex manner. When anhydrous, only ethylene glycol was able to penetrate and swell oven dry wood cell walls. Aqueous solutions of these solvents, however, readily swelled oven dry wood, often to a slightly greater extent than water alone. This is an indication that cell-wall capillaries in oven dry wood are of a size that allows the penetration of water and ethylene glycol molecules but not the larger molecules of EGMBE and DEGMBE.

After penetrating the wood cell-wall capillaries the low evaporation rates of these solvents made removal by simple air or oven drying difficult. The cell-wall capillary pore openings apparently shrink to such an extent upon drying as to prevent the escape of any adsorbed organic solvent molecules. Being water soluble, however, they are easily removed by leaching with liquid water.

The ambient relative humidity, which dictates the degree of swelling of wood cell-wall capillaries, was shown to control the likelihood of organic solvents becoming entrapped in wood cell walls. Total evaporation of DEGMBE can be prevented at humidities as high as 63%. EGMBE was trapped in wood cell-wall capillaries at 35% relative humidity.

Since organic solvents form an integral part of many water-borne polymer treating solutions and trapped solvent can be detrimental to the future performance of an applied polymer, further research in this area is needed.

ACKNOWLEDGMENT

This paper is based on studies undertaken by one of the authors (W.B.S.) for his Ph.D. dissertation at the SUNY College of Environmental Science and Forestry, Syracuse, NY. He gratefully acknowledges the financial support provided for this research by the Flecto Co., Inc., Oakland, CA.

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The newest fact in the Case for ARCOSOLV solvents: DPM Acetate

THE FACT IS ARCO Chemical Company is introducing the latest addition to our line of propylene-based glycol ethers and acetates, ARCOSOLV® DPM acetate. It is specially designed for those applications requiring a slow evaporating non-hydroxylic solvent.

THE FACT IS research on propylene glycol ethers and acetates shows no evidence of reproductive organ toxicity even at high exposure levels.

THE FACT IS a growing number of manufacturers have already moved from E-Series to P-Series solvents. They found ARCOSOLV solvents often could directly replace ethylene solvents in both performance and cost.

THE
CASE
FOR ARCOSOLV®
PROPYLENE GLYCOL ETHERS AND ACETATES

The CASE for ARCOSOLV Solvents

In view of these facts, ARCO Chemical presents a strong CASE for switching from E-Series products to ARCOSOLV propylene glycol products:

Cost

Similarity to the E-Series makes ARCOSOLV solvents a straightforward, economical reformulation choice.

Availability

Our strong raw materials position in propylene oxide and methanol, our dedicated production capacity, nationwide terminal network, and the addition of DPM acetate, make us ready to meet the needs of the marketplace.

Safety

Tests in the U.S., Japan and Europe have demonstrated that P-Series products have dramatically safer toxicological profiles than E-Series products.

Effectiveness

ARCOSOLV propylene glycol ethers and acetates offer solvency power for a wide range of substances, a good range of evaporation rates and excellent coupling and coalescing ability. Use the chart at left to compare properties.

Facts Make the CASE for ARCOSOLV Solvents

In Cost, Availability, Safety and Effectiveness, the CASE for ARCOSOLV ethers and acetates is a strong one. For more information—and details on our new DPM acetate—call ARCO Chemical Company today, toll-free, at 1-800-354-1500. In Pennsylvania, call 1-800-292-1500.

Typical Physical Properties

ARCO Chemical Nomenclature	Chemical Name	Molecular Weight	Evaporation Rate BuAc = 100	Solubility Parameter	Solubility % Wt. in water/ water in
Glycol Ethers					
ARCOSOLV® PM	Propylene Glycol Methyl Ether (PGME)	90.1	66	10.4	∞
ARCOSOLV® DPM	Dipropylene Glycol Methyl Ether (DPGME)	148.2	2	9.6	∞
—	Ethylene Glycol Ethyl Ether (EGEE)	90.1	32	9.9	∞
—	Ethylene Glycol Butyl Ether (EGBE)	118.2	6	8.9	∞
Glycol Ether Acetates					
ARCOSOLV® PMAC	Propylene Glycol Methyl Ether Acetate (PGMEA)	132.2	34	9.2	18.5/5.6
—	Ethylene Glycol Ethyl Ether Acetate (EGEEA)	132.2	20	9.4	23.8/6.5
ARCOSOLV® DPMAC	**Dipropylene Glycol Methyl Ether Acetate (DPGMEA)**	**190.2**	**<1**	**8.3**	**12.3/3.5**
—	Ethylene Glycol Butyl Ether Acetate (EGBEA)	160.2	3	8.6	1.1/1.6

ARCO Chemical Company ARCO
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Society Meetings

KANSAS CITY............. MAY

Federation Night

Officers elected to serve for the 1985-86 year are: President—Jerry Hefling, of Loctite Auto and Consumer; Vice-President—Steve Bussjaeger, of Davis Paint Co.; Secretary—Steve Johnson, of Cook Paint and Varnish Co.; and Treasurer—Roger Haines, of Farmland Industries, Inc.

Joseph Bauer, Federation President and Frank Borrelle, Executive Vice-President, gave an update on activities underway at the Federation level. A slide show presented by Mr. Borrelle featured the Federation officers, as well as information on the budget, publications, Spring Week meeting, scholarships being offered, the national Technical and Education Committee meetings, and the realignment of the Paint Research Institute. In addition, Mr. Borrelle provided a detailed report on the 50th Annual Paint Show to be held in St. Louis.

Two checks from the Society and the K.C. Paint and Coatings Association were presented to the University of Missouri-Rolla's Wouter Bosch Memorial Fund. Warren Manley accepted them for delivery to James O. Stoffer. Mr. Manley then reported from Dr. Stoffer that the University has three candidates for John Roland's position. He added that the Chancellor has granted increased funding to the department and included the department's own line of entry on the budget.

Jim O'Brien, of the Education Committee presented awards for the Science Fair displays to the following: Doug Stoltz from St. John La Lande School and his teacher, Mary Perrine; Tracy Voight from Indian Valley Elementary School and her teacher, Diane Hare; Bill Ethern, Todd Grago, Ryan Black, and Brian Killkenny and a parent for the teacher.

JERRY HELFING, *Secretary*

LOS ANGELES............ MAY

Awards Night

A moment of silence was observed for Jerry Andrews, of Product Technique and Trow Denowski, of Hughes Paint, both of whom died recently.

Romer Johnson, Awards Chairman presented 25-Year pins to the following members: Bill Ellis, retired from Chevron Research Co.; George Firth, Applied Plastics Co.; Walter Janssens, retired; Mel Lipscomb, Lipscomb Chemical Co.; Frank Peters, Dunn-Edwards Corp.; and Hiro Takesako, Pero Paint Co.

Outstanding Service Pins were then presented to: Lloyd Haanstra, Sinclair Paint Co.; Bob Hunter, retired; Jack Zywocienski, Sinclair Paint Co.; Anne Probizanski, Ampro Technologies; and Jan P. Van Zelm, Byk Chemie.

Nominating Committee Chairman, Lloyd Haanstra introduced the two candidates for the position of Secretary: Melinda Rutledge, of Allo Chemicals and Ted Venia, of Tavco Chemicals, Inc.

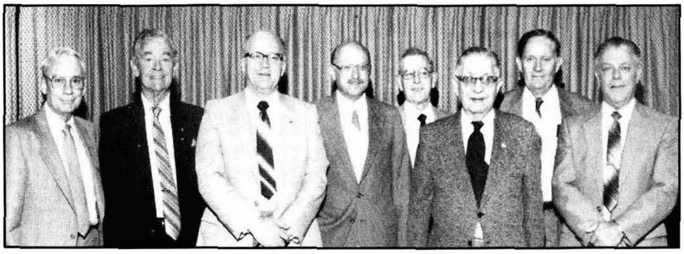
Environmental Chairman, Lloyd Haanstra reported that three pamphlets are available from the E.P.A.: "Highlights of the Hazardous and Solid Waste Amendments of 1984," "Requirements for Small Quantity Hazardous Waste Generators," and "Leaking Underground Storage Tanks."

Mr. Haanstra then told of the Architectural Task Force meeting held in April. During that meeting, a motion was passed to extend 380 Rule until September 1, 1989. Half the funding of the Architectural Task Force will be paid for by the districts, said Mr. Haanstra. The rest will have to come from industry. Mr. Haanstra also stressed the need for exposure rack space and asked the membership to complete the surveys dealing with Architectural Coatings for the District or ARB. The surveys, he pointed out, are needed to give the regulatory and industry people a good picture of the current position regarding how much emissions are generated by coatings.

The evening's technical presentation was given by Dan Dixon, of Englehard Corp. Mr. Dixon discussed "EXPOSURE STUDIES."

Exposure studies were done to determine which grade of clay blended with another extender would yield the best overall durability in exterior latex systems, explained Mr. Dixon. He added that if the data, from this recently completed five-year study, are analyzed in a more than traditional manner, numerous possibilities and choices may lie in store for the formulating paint chemist. In conclusion, Mr. Dixon said, if extender pigment limitations exist, such as a company that has chosen to go to an all-slurry system, the best recommendations can be made without discounting the attributions of those pigments of choice.

RAY DIMAIO, *Secretary*



NEW ENROLLEES in the Chicago Society's 25 and 50-Year Clubs present at the May meeting. Left to right: Victor Willis, Society Host; John Ulreich (50); Kenneth Coleman; Harold Peter; Eugene Murphy; Eugene Holda (50); Robert Zimmerman; and Herbert Meyer

PIEDMONT............... APR.

"Trends in the Furniture Industry"

Mel Hurowitz, of the Educational Committee, reported that he had received many applications from students for summer employment with participating member companies.

A slide presentation, "TRENDS IN THE FURNITURE INDUSTRY," was given by Nancy High, of the American Furniture Manufacturers Association.

Ms. High addressed the subject of imports and their effect on the domestic furniture industry.

STEVE LASINE, *Secretary*

PITTSBURGH .... MAY

"Computers in the Lab"

The new slate of officers for the 1985-86 year are: President—Joseph Mascia, Campbell Chemical Co.; President-Elect—Anthony Isacco, Puritan Paint and Oil Co.; Secretary—Mark Troutman, Bradley Paint Co.; and Treasurer—Ed Threlkeld, Ashland Chemical Co.

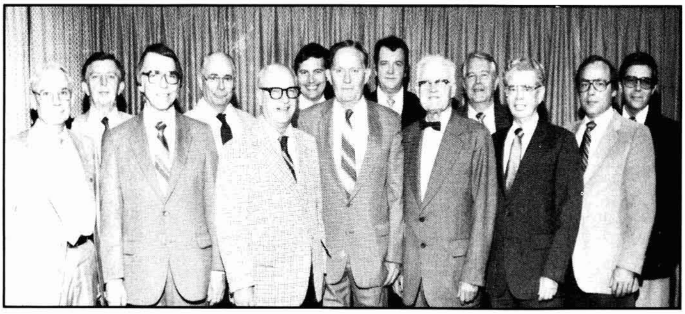
Paul Serra, of McWhorter, Inc., examined "THE USE OF COMPUTERS IN THE LAB."

Using the in-house computer system of McWhorter's as an example, Mr. Serra delivered a detailed presentation. He described two applications systems used by the firm: the formulation system and the information management system. Both are helpful in the lab, he added.

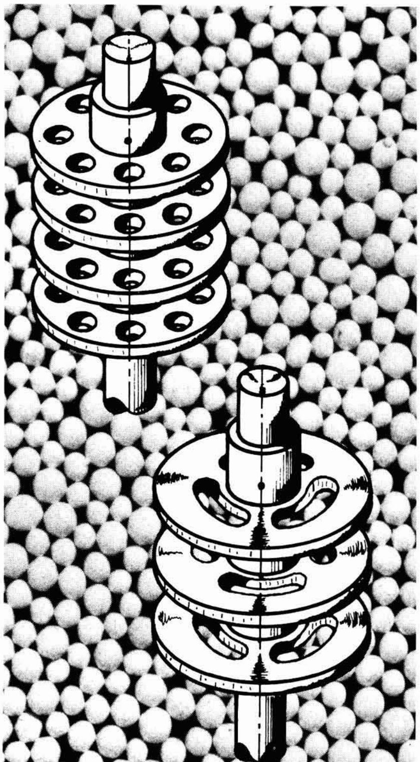
Detailing the formulation system, Mr. Serra said that it allows for the addition of new formulae, modification of existing formulae, and modification or continuation of temporary formulae. The program's menu, he said, provides a variety of functions including change, ratios, bulk, composition analysis, and labeling analysis. Coded instructions for production, volume, and pounds of each raw material, and quality control instructions are included in the report generated by the system. The final report also gives data on raw materials, which are listed alphabetically by product and producer, he explained.

Discussing the project management system, Mr. Serra stated that it reports on all facets of a project: description of a project, costs, time involved, potential sales, chemists assigned, and customers requesting information. He added that this system also keeps track of all assignments given to chemists as well as their progress being made.

ANTHONY J. ISACCO, *Secretary*



PAST-PRESIDENTS of the Chicago Society present at the May Awards Night meeting. Left to right: Victor Willis (1966); Walter Krason (1979); Gus Leep (1976); Raymond Pfohl (1969); Carroll Scholle (1958); Rick Hille (1981); Robert Zimmerman (1974); Fred Foote (1985); Warren Ashley (1955); Thomas Nevins (1975); Edward Boulger (1968); Bud Bartelt (1980); and Rick Kinney (1983)



Elections

BALTIMORE

Active

Adelsberger, William—Duron, Inc., Beltsville, MD.
Grinnan, Glossie—Ainsworth Paint & Chemical Corp., Baltimore, MD.
Gupte, Pradeep B.—Ainsworth Paint & Chemical Corp., Baltimore.
Hepner, Suzanne M.—Bruning Paint Co., Baltimore.
Karalis, Christopher—Benjamin Moore & Co., Colonial Heights, VA.
Krishnamoorthy, K.V.—Davis Paint Mfg. Co., Lynchburg, VA.
Kurnas, John—Sherwin-Williams Co., Baltimore.
Lisby, Alva Corbin—Ainsworth Paint & Chemical Corp., Baltimore.
Lyons, Mark—Duron, Inc., Beltsville, MD.
Morris, Loretta—Ainsworth Paint & Chemical Corp., Baltimore.
Oppenheim, Barry—McCloskey Varnish Co., Philadelphia, PA.
Peta, Thomas L.—C.J. Osborn Chemicals, Merchantville, NJ.
Raszewski, Lewis R.—Raszewski Consulting, Stevensville, MD.

Associate

DiMarcantonio, Rich—Tate Chemical Sales, Lutherville, MD.
Haight, Thomas K.—Union Chemicals Div., Richmond, VA.
Masciulli, Leo—Cardinal Color Inc., Paterson, NJ.
Oja, John J.—Seaguard Corporation, Portsmouth, VA.
Severino, Richard B.—Seegott Inc. of MD, Elkridge, MD.
Smith, James M.—Peltz Rowley Chemical, Millersville, MD.

C-D-I-C

Active

Gish, Lawrence E.—A.O. Smith Protective Ctgs., Florence, KY.
Gleason, James R.—Owens-Corning, Granville, OH.
McKinley, Larry—D&L Paint Co., Liberty, IN.
Morgan, R. Douglas—Ohio Sealer Div., Dayton, OH.
Wallace, Elah P.—Ohio Sealer Div., Dayton.

Associate

Overbey, G. Neal—Deeks & Co., Cincinnati, OH.

GOLDEN GATE

Associate

Priebe, Chet—M C Associates, French Camp, CA.

NORTHWESTERN

Active

Anderson, Eugene—Valspar Corp., Minneapolis, MN.
Hobbs, Jerry—Conklin Co., Inc., Shakopee, MN.
Thorsgaard, Ralph—Diamond Vogel Paints, Minneapolis.

Associate

Rowe, Richard—McWhorter Inc., Carpentersville, IL.

Elections

BIRMINGHAM

Active

Davies, William R.—Carrs Paints Ltd., Birmingham, England.

Morris, David—International Paint, Birmingham.

CHICAGO

Active

Brogan, Kern W.—Glidden Coatings & Resins, Chicago, IL.

McMahon, Victoria A.—Sherwin-Williams Co., Chicago.

Opsahl, Ross—Atlas Coatings Ltd., Addison, IL.

Osting, Nick L.—DeSoto, Inc., Des Plaines, IL.

Patel, Ron—Barrett Varnish Co., Cicero, IL.

Rossomando, Robert—Cellofilm Corp., Chicago.

Stewart, R.S.—Sherwin-Williams Co., Chicago.

Ziech, Helen R.—Rust-Oleum Corp., Evanston, IL.

Associate

Gallas, Rick—S.C. Johnson & Son, Inc., Racine, WI.

Romance, Todd W.—Mooney Chemical Co., Elgin, IL.

Severns, John D.—Bausch & Lomb, Schaumburg, IL.

Retired

Steiner, Hanus J.—Chesterton, IN.

CLEVELAND

Active

Beck, Charles K.—Coatings Development Co., Painesville, OH.

Bohland, Robert J.—Teledynie Monarch, Hartville, OH.

Komocki, David S.—Loctite Corp., Cleveland, OH.

Messerly, Mark T.—Man-Gill Chemical Co., Bedford, OH.

Runcis, John Arthur—Glidden Coatings & Resins, Strongsville, OH.

Sheehan, Timothy P.—Foseco Inc., Brookpark, OH.

Traffis, Lawrence A.—Sherwin-Williams Co., Cleveland.

Zimmer, David J.—Lord Corp., Erie, PA.

KANSAS CITY

Active

Cossins, Michael C.—Valspar Corp., Kansas City, MO.

Sutton, Karen S.—Valspar Corp., Kansas City.

NEW ENGLAND

Active

Baldvins, Jon O.—Markem Corp., Keene, NH.

Calligano, Dyan—Dryvit System Inc., West Warwick, RI.

Dussault, Laurie—Whittaker Corp., Haynes Div., Chicopee, MA.

Leman, Arthur A.—Touraine Paint, Inc., Everett, MA.

Mendoza, Carlos—Raffi & Swanson, Inc., Wilmington, MA.

Modrak, Robert G.—California Products Corp., Cambridge, MA.

Mumford, Ernest C., Jr.—American Seal Mfg. Co., Waterford, NY.

Reinhart, William—A.W. Chesterton Co., Groveland, MA.

Shearer, Charles C.—Raffi & Swanson, Inc., Wilmington.

Smith, Lisa—Dryvit System Inc., West Warwick.

Spice, Earl C.—Whittaker Corp., Haynes Div., Chicopee.

St. Laurent, Dennis—Whittaker Corp., Haynes Div., Chicopee.

Topor, Daniel—Whittaker Corp., Haynes Div., Chicopee.

Associate

Finck, Keith B.—GE Silicones, Framingham, MA.

Nuttle, Robert G.—D.N. Lukens Inc., Westboro, MA.

O'Keeffe, Dennis—Mattiace Petrochem, Glen Cove, NY.

Scanlon, Daniel—The New Jersey Zinc Co., Cumberland, RI.

PIEDMONT

Active

Carder, C.H.—Union Carbide Corp., Cary, NC.

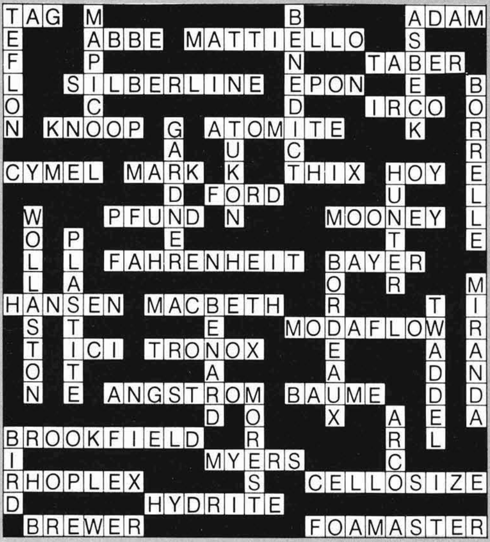
Patterson, Joseph R., Jr.—The Lilly Co., High Point, NC.

Woodruff, John D.—Whittaker, Clark & Daniels, Matthews, NC.

Associate

Busche, Jeff A.—Dow Chemical USA, Charlotte, NC.

Kline, Edward L.—Inland Leidy, Baltimore, MD.



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Solution to June "*CrossLinks*"

Federation of Societies for Coatings Technology

AUDIO/VISUAL PRESENTATIONS

(All A/V presentations include slides, cassette tapes and scripts)

CAUSES OF DISCOLORATION IN PAINT FILMS

Some of the common causes of paint discoloration, such as mildew, sulfide staining, dirt retention, and staining by cedar or redwood, are illustrated on houses and on painted panels. Chemical tests for distinguishing between these types of stains are shown. A test for distinguishing efflorescence and chalking of paint films is also described. 15 minutes (37 slides) **$40**

THE SETAFLASH TESTER

Produced by the Technical Committee, Birmingham Paint, Varnish and Lacquer Club

The Setaflash Tester offers the capability to quickly ascertain the flash point of a volatile product. This presentation describes the equipment and explains the procedures for determining flash point in two temperature ranges (ambient to 110° C; 0° C to ambient) by both the flash/no-flash method and the definitive method. 54 minutes (134 slides) **$100**

FEDERATION TRAINING SERIES ON TEST METHODS*

Volume II

(3 Lessons) Lessons vary from 7 to 11 minutes (79 slides ... **$70**

Lessons	***Producing Society***
A Simple Method to Determine Microbiological Activity	Philadelphia
A Salt Spray (Fog) Testing Cabinet	Golden Gate
Wet Film Thickness Gages	Golden Gate

*Volume I not available at this time.

HIGH SPEED DISPERSION

Produced by the Manufacturing Committee, Montreal Society for Coatings Technology

The program covers theoretical and practical techniques used for dispersion in paint plants, showing laboratory test equipment and plant scale manufacturing procedures. 20 minutes (60 slides) **$65**

INTRODUCTION TO RESIN OPERATIONS

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**

A BATCH OPERATED MINI-MEDIA MILL

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**

NOW AVAILABLE!

OPERATION OF A VERTICAL SANDMILL—(Produced by the Manufacturing Committee, Kansas City Society for Coatings Technology). This program describes the design and operation of a vertical sandmill, to assist in the training of plant personnel to operate such equipment. 14 minutes (73 slides). **$75**

☐ Causes of Discoloration in Paint Films **$40**

☐ The Setaflash Tester **$100**

☐ Volume II, Test Methods **$70**

☐ High Speed Dispersion **$65**

☐ Introduction to Resin Operations **$65**

☐ A Batch Operated Mini-Media Mill **$60**

☐ Operation of a Vertical Sandmill **$75**

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Two Workshops Offered by ACS in September, 1985

In conjunction with the American Chemical Society's Division of Polymeric Materials: Science and Engineering meeting being held in Chicago, September 7-8, 1985, two two-day workshops have been scheduled.

The workshop, "Modern Methods of Particle Analysis," (Sept. 7-8) is intended for scientists, engineers, analytical chemists, product development specialists, and technical professionals who need to characterize, quantitate, evaluate and qualify control particulates, particulate formulations, suspensions and dispersions, including latex, pigments, paints, and inks. Instrumentation demonstrations will be given for the following techniques: Photon Correlation Spectroscopy, Sedimentation Field Flow Fractionator, and Hydrodynamic Chromatography.

Subject matter discussed in the workshop includes an introduction to particle size analysis, classical methods, sedimentation methods, particle and droplet sizing, column chromatography methods, and field flow fractionation methods. Participants in the course should have a technical, chemical, or engineering degree, or equivalent experience, with some knowledge of chemistry and characterization methodology.

The Division is also sponsoring a symposium on "The Assessment of Particle Size Distributions," on September 9-10.

The second workshop, "Polymer Characterization by Infrared Spectroscopy," (Sept. 7-8) includes hands-on FT-IR Labs and Specialized Sampling Equipment, and is directed towards persons who need to analyze and structurally characterize polymers. It is intended to provide how-to-do-it instruction for newcomers to the field and provide an understanding of new technology for more experienced analytical spectroscopists.

Included in the course will be an introduction to polymer analysis; surface analysis, detection and identification of multiple layers; sampling accessory design and use; computer-assisted spectroscopy; and specialized state-of-the-art techniques. Instruction in Fourier transform spectroscopy, photoacoustic spectroscopy, and diffuse reflectance is planned.

Participants should have a chemical or engineering degree, or equivalent experience, with some knowledge of spectroscopy and polymers. For additional information, contact Dr. Theodore Provder, Glidden Coatings & Resins, Div. of SCM Corp., 16651 Sprague Rd., Strongsville, OH 44136.

ISCC to Hold Conference In Williamsburg, Feb. 9-12

"The Colors of History: Identification, Re-Creation, Preservation" will be the subject of the next Inter-Society Color Council Conference to be held in Colonial Williamsburg, February 9-12, 1986. Topics to be addressed at the conference include applications to architecture, textile re-creation, transportation (automotives and ships), and identification of dyes and pigments.

The conference is under the chairmanship of Robert J. Feller, of Carnegie-Mellon University. Registration forms are available from T.G. Webber, 1722 Forest Hill Dr., Vienna, WV 26105.

ASTM Forms New Task Group

ASTM Subcommittee D01.61 on Paint Applications Tools has initiated a new task group. Task Group D01.61.03 on Pressure-Fed Paint Roller Covers will characterize paint roller covers used with pressure-fed painting systems. For information or participation details, contact Subcommittee Chairman Frederick B. Burns, EZ Paintr Corp., 4051 South Iowa Ave., Milwaukee, WI 53207.

SSPC Schedules Annual Meeting & Symposium, Feb. 24-27

The 1986 Annual Meeting and Symposium of the Steel Structures Painting Council is scheduled for February 24-27, 1986, at the Peachtree Plaza Hotel, Atlanta, GA. The symposium topic will be "Techniques for Long-Term Protection of Steel Structures."

During the Annual Meeting, being held February 24-25, approximately 25 advisory committee sessions will be conducted dealing with coatings materials, surface preparation, applications, inspection and safety, and methods for improved performance of coatings systems.

The symposium follows on February 26-27, and will focus on coatings performance, economics of long-term protection, assuring quality of protection, and maintenance approaches and strategies.

Papers accepted for presentation will be compiled and issued as a SSPC publication of conference proceedings. Abstracts of approximately 200-300 words should be submitted no later than September 1, 1985, to Harold E. Hower, Director of Communications, SSPC.

For registration information, contact the SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213.

Data Sought for Guide to Coating Applications

The Federation has initiated preparation of a guide covering all phases of the manual and automatic application of architectural and industrial paints and coatings.

Manufacturers of application tools or equipment are invited to submit information on their products for consideration in the preparation of the guide. Any of the following will be welcomed:

- Complete literature.
- Instructions for proper use.
- Data on actual use and advantages.
- Photographs, diagrams, charts, graphs, etc., preferably between 4″ × 5″ to 8″ × 10″.
- Precautions, if any.

This material should be sent to the author: Sidney B. Levinson, SIDLEV Associates, P.O. Box 507, Cranbury, NJ 08512.

Book Review

THE PHTHALOCYANINES
Volume I: Properties
Volume II: Manufacture and Applications

Edited by
Frank H. Moser
and Arthur L. Thomas

Published by
CRC Press, Inc.
Boca Raton, FL
Vol. I: 248 pages, $73.00
Vol. II: 184 pages, $65.00

Reviewed by
Dr. Thaddeus L. Kolski
Retired from Du Pont Co.
Wilmington, DE

The authors have succeeded in gathering what appears to be everything written about phthalocyanines in technical journals and the patent literature during the period 1960-1975. The result is a meticulously complete compendium which will prove a valuable reference for the academic investigator or "pure" researcher interested in the preparation, properties, and chemistry of metal-free phthalocyanine and some 60-odd metal phthalocyanines.

This publication is presented as a literature search, with the text consisting of concise summaries or statements about each reference in the bibliography. With 2910 references and 237 pages of text, each reference is treated in most cursory fashion. The value of these two volumes would be enhanced greatly if more elaboration on the significance or relative importance of each entry were included. A compositional style which reports what has been compiled can save many hours of library searching for the subsequent investigator, but does not result in a palatable rendering for one trying to develop an understanding of phthalocyanine compounds.

Volume I is entitled "Properties," and consists of 19 chapters describing the chemistry and physics of phthalocyanines. Typical chapter headings are "Crystals," "Reactions," "Thermal Stability," "Radiation Chemistry," "Catalysis," "Physical Properties," "Lasers," "Magnetic Properties," and "Conduction." Volume II is given the title "Manufacture and Applications," but only two of the four contained chapters seem to belong here; Chapter 2 is devoted to pigment manufacture based on copper and metal-free phthalocyanines, and Chapter 3 deals with applications (catalysis, colorant uses, and other noncolorant uses) of all phthalocyanines. Chapters 1 and 4 cover preparation of all 63 phthalocyanines (few of which are commercially important), and polymeric forms of phthalocyanines; these two chapters would fit more logically in Volume I.

Phthalocyanine investigators will find Appendix I of particular value; this lists 81 additional references to review articles on 19 aspects (two of which are dyes and pigments) of these compounds.

Commercially, the largest use by far for phthalocyanine compounds is in preparation of pigmentary materials. Yet a relatively small portion of "The Phthalocyanines" will be of value to the coatings chemist. Volume I is of much greater interest to the physicist than the practical colorist. For the colorant specialist, Volume II contains, in addition to the chapters on "Manufacture" and "Applications," Appendix II which summarizes many standard laboratory test procedures for evaluation of phthalocyanine pigments. Appendix III lists phthalocyanine pigment and dye manufacturers and respective product trade names. This information came from the 1971 Third Edition of "Colour Index" and therefore is of limited present-day usefulness in view of the many product lines which have been discontinued or sold by pigments manufacturers in the past 14 years.

ORGANIC COATINGS SCIENCE AND TECHNOLOGY VOLUME 7

Edited by
Geoffrey D. Parfitt and
Angelos V. Patsis

Published by
Marcel Dekker, Inc.
New York, NY
432 pages, $75.00

Reviewed by
Thomas J. Miranda
Whirlpool Corp.
Benton Harbor, MI

This volume is the seventh in a series of collected papers presented at the Ninth International Conference in Organic Coatings Science and Technology annually in Athens, and includes results obtained from 19 invited and three contributed papers.

Contained in this volume are the latest developments in organic coatings presented by leading experts in the field. Emphasis includes works on new developments in the preparation and curing of resins, characterization of pigments and pigment/vehicle interactions, photodegradation of coatings, corrosion protection, and coatings defects. Two new approaches to crosslinking are cited; the crosslinking by condensation reactions and the use of gas curing. Descriptions of coating modification using plasma polymerization, metal preparation, adsorption on pigment surfaces, opaque polymers, and electrocoatings complete the volume.

This volume, like its predecessors, provides the coatings technologist with an excellent review of the current scientific and developmental advances being made in the field, and is recommended for those seeking an update on coatings developments.

Literature

Hydrocarbon Resins

Two new hydrocarbon resins are introduced in a product bulletin. Designed primarily as end-block reinforcing resins in the manufacture of pressure-sensitive adhesives where water-clear systems are required, these resins are designed to improve the system's high-temperature performance without deteriorating their tack and peel properties. Further information on the hydrocarbon resins can be obtained from Product Inquiry, Hercules Incorporated, Hercules Plaza, Wilmington, DE 19894.

Level Control

The applications for ultrasonic level controls are discussed in recently released literature. Used for monitoring the level of a filling or holding tank, the controls allow a manufacturer to modernize present equipment, automate a hand filling line, or custom design a machine for special products. For details, contact Beltron Corp., P.O. Box 893, Red Bank, NJ 07701.

Antimicrobial Guide

A comprehensive guide to the selection of antimicrobial preservatives is now offered. The guide includes applications, performance information, physical properties, and standard test results. To request literature kit No. Z10-18, write: ICI Americas Inc., Corporate Communications Dept., Wilmington, DE 19897.

Weighing Booklet

A 12-page, illustrated booklet discusses the correct operation of electronic analytical, semi micro- and micro-balances. Instructions and tips on balance location, selection of weighing tables, balance operation, and weighing errors due to physical phenomena are included. For a complimentary copy of "Weighing the Right Way," contact Mettler Instrument Corp., P.O. Box 71, Hightstown, NJ 08520.

Mixer-Dryer

A new line of double-cone mixer-dryers is featured in illustrated data sheets. The mixer-dryers have applications in the processing of ceramics, hard metals, specialty chemicals, pharmaceuticals, and plastics. The data sheets are available from Netzsch Incorporated, Grinding Dept., 119 Pickering Way, Exton, PA 19341-1393.

Titration Catalog

A 20-page, full-color catalog describes the many features and applications of a full line of titrators. The publication also discusses peripheral instruments, specialized expanded systems, and useful accessories to the line. For the free catalog, "The Mettler Family of Titrators," contact: Analytical Instruments Div., Mettler Instrument Corp., P.O. Box 71, Hightstown, NJ 08520.

Letters to the Editor

'Rocket Coatings' Launches Comments

To the Editor:

I read with a combination of fascination and sardonic amusement the announcement on page 17 of the May 1985 issue of JCT that "USAF Seeks Coatings for Rockets."

I could just imagine myself as a researcher, receiving the formidable assignment to develop a coating that must be durable; inhibit the corrosion of metal and composite motor cases for air launched rockets in a marine environment; prevent migration of notoriously migratory plasticizers; adhere to some classically abherent polymers; be stable and effective from "−65 deg to +145 deg F" (deg F? The metric system is scarcely inching its way along in the USAF); be made of non-hazardous, readily available materials, be easily processed in standard equipment and be capable of application by spray or flow coat.

My mind went racing through a hypothetical list of equipment that I would have to assemble, and techniques that I would have to use, to evaluate the resulting coatings in a vacuum, under vibration during flight, and in a humid environment. What a relief it was to read that "color is immaterial"!

But the point that really riveted my attention was the requirement that the coating be "reasonable in cost." How superfluous! How redundant! Who doesn't know the frugal ways of the USAF and its parent, the U.S. Department of Defense? Who can avoid being alert to the possible prohibitive increment of cost that a too-expensive coating could add to a rocket, its explosive charge, its launcher, and its electronic guidance and target-seeking systems? And what better place is there to make a start to overcome the public's misconceptions concerning waste in procurement than in the establishment of cost control for a product of the coatings industry?

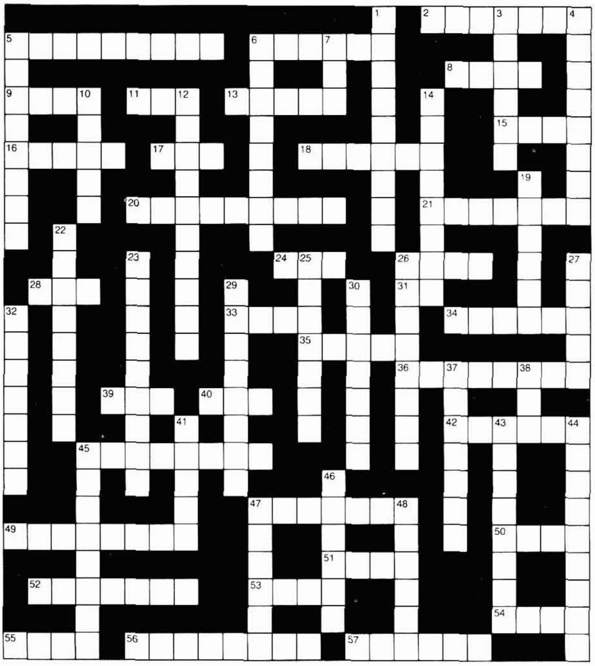
So, onward and upward with the Pentagon warriors who, it appears, are now also becoming worriers about the cost of coatings, not to mention the danger of hazardous materials, such as lead driers, for air launched rocket weapons.

Sid Lauren
Cleveland, OH

[Right, Sid! And the rockets' finish will be touched-up on-site with a $1,200 paint brush.—Ed]

CrossLinks

by Earl Hill



Solution to be published in September Issue

No. 7

ACROSS

2. Natural calcium carbonate mineral
5. Organic yellow pigment base (B______)
6. Plate to regulate flow (Mfg.)
8. Graining tool
9. A layman
11. Measures flash point (Abr.)
13. Wood characteristic
15. Used to fasten 23 Down
16. Type of painting
17. Solid slip additive
18. Staved container
20. Metal silicate mineral (T______)
21. Acid ester (Org. Chem.)
24. Synthetic elastomer (Abr.)
26. Pigment color
28. Host tree for lac insect
31. That is (Abr.)
33. *To touch at the edge*
34. Metal salt of 41 Down
35. Composition (frequently purity)
36. Travel back and forth (Pl.)
39. Wood decomposition
40. Surface area equation (Abr.)
42. Red form of shellac
45. Cobalt yellow pigment
47. Aggressive organic solvent (Chem.)
49. Benzene derived organic acid (B______)
50. Standards institute (Abr.)
51. To disk (Computer term)
52. Liquid coating, usually clear
53. Type of blender
54. To make warm
55. Marking or rubbing test (C______)
56. Reflectance ratio
57. *Inside ball mill surface*

DOWN

1. Mercuric sulfide (Syn.)
3. Hard siliceous substrate
4. Gaseous hydrocarbon C_2H_4
5. A banister
6. Marine crustacean
7. Air current inducing device
10. Surface film deterioration
12. Colloidal droplets aggregate (C______)
14. Smallest particle of a substance (Org. Chem.)
19. B______ oil (amyl acetate)
22. Breaking of a laminate (C______)
23. Narrow siding board
25. η-butane alcohol
26. Two rings in the structure (Org. Chem.)
27. A______ lanae
29. Microscopic plant bodies (Pl.)
30. *Grade of seed lac*
32. Turpentine ketone (C______)
37. Deep purplish red
38. Light yellow brownish color
41. Inorganic acid pigment base
43. Studious inquiry
44. Polymer chain steric order
45. Red pigment precursor (Org. Chem.)
46. P______r coating
47. Gum arabic (Syn.)
48. Refined oil from coconuts

Coming Events

FEDERATION MEETINGS

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

(Oct. 7-9)—63rd Annual Meeting and 50th Paint Industries' Show. Convention Center, St. Louis, MO.

1986

(May 13-16)—Federation "Spring Week." Seminar on 13th and 14th; Society Officers on 15th; and Board of Directors on 16th. Sheraton Station Square, Pittsburgh, PA.

(Nov. 5-7)—64th Annual Meeting and 51st Paint Industries' Show. World Congress Center, Atlanta, GA.

SPECIAL SOCIETY MEETINGS

(Nov. 5-6)—Symco '85. 15th Annual Chicago Society Coatings Symposium, "The Right Stuff." Knickers Restaurant, Des Plaines, IL. (Lonnie U. Haynes, Chairman, Hercules, Incorporated, 300 E. Schuman Blvd., One Energy Center, Suite 260, Naperville, IL 60540).

1986

(Apr. 2-5)—Southern Society. Annual Meeting. DeSoto Hilton Hotel, Savannah, GA. (Ronald R. Brown, Union Chemicals Div., P.O. Box 26845, Charlotte, NC 28213).

(Apr. 9-11)—Southwestern Paint Convention of Dallas and Houston Societies. Wyndham Hotel, near Houston Intercontinental Airport, Houston, TX. (Mike Winters, Ribelin Distributors, Inc., 7766 Blankenship, Houston, TX 77055).

(May 1-3)—Pacific Northwest Society, Annual Symposium. Marriott Hotel, Portland, OR. (Gerald A. McKnight, Rodda Paint Co., 6932 S.W. Macadam Ave., Portland, OR 97219).

1987

(Feb. 23-25)—Western Coatings Societies' Symposium and Show, Monterey Convention Center, Monterey, CA. (Barry Adler, Royell, Inc., 1150 Hamilton Ct., Menlo Park, CA 94025).

OTHER ORGANIZATIONS

(Aug. 26-28)—Advanced Colorimetry Course. Munsell Color Science Laboratory, Rochester Institute of Technology campus, Rochester, NY. (Martha Pschirrer, Munsell Color Science Laboratory, RIT, P.O. Box 9887, Rochester, NY 14623).

(Sept. 2-4)—Federation of Scandinavian Paint and Varnish Technologists. 11th Congress. SAS Hotel Scandinavia, Oslo, Norway. (Paal Ivan, Nodest Industries A/S, Boks 500, N-3001 Drammen, Norway).

(Sept. 2-6)—Short Course on "Films and Coatings for Technology." Davos Congress Center, Switzerland. (Continuing Education Institute—Europe, Rörtorpsvägen 5, S-612 00 Finspang, Sweden).

(Sept. 7-8)—Workshop on "Modern Methods of Particle Size Distribution." Sponsored by ACS Div. of Polymer Materials: Science and Engineering. Chicago, IL. (Theodore Provder, Glidden Coatings & Resins, Div. of SCM Corp., 16651 Sprague Rd., Strongsville, OH 44136).

(Sept. 7-8)—Workshop on "Polymer Characterization by Infrared Spectroscopy." Sponsored by ACS Div. of Polymer Materials: Science and Engineering. Chicago, IL. (Theodore Provder, Glidden Coatings & Resins, Div. of SCM Corp., 16651 Sprague Rd., Strongsville, OH 44136).

(Sept. 9-10)—Symposium on "The Assessment of Particle Size Distributions." Sponsored by ACS Div. of Polymer Materials: Science and Engineering. Chicago, IL. (ACS, 1155 Sixteenth St. N.W., Washington, D.C. 20036).

(Sept. 9-12)—Short Course on "Introduction to Coatings Technology." Sponsored by Eastern Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

(Sept. 9-13)—Short Course on "Nitride and Carbide Coatings." LSRH Research Center, Neuchatel, Switzerland. (Continuing Education Institute—Europe, "Rörtorpsvägen 5, S-612 00 Finspang, Sweden).

(Sept. 16-19)—Fifth Finishing Conference and Exposition of the Association for Finishing Processes of the Society of Manufacturing Engineers. Cobo Hall, Detroit, MI. (Public Relations Dept., AFP/SME, One SME Dr., P.O. Box 930, Dearborn, MI 48121).

(Sept. 17-19)—FINISHING '85. Cobo Hall, Detroit, MI. (AFP/SME, P.O. Box 930, Dearborn, MI 48128).

(Sept. 21-24)—Canadian Paint and Coatings Assn. 73rd Annual Convention. Clevelands House, Minnett, Ont. (CPCA, 515 St. Catherine St. W., Montreal, Que., Canada H3B 1B4).

(Sept. 30-Oct. 2)—12th International Naval Stores Meeting. Westin Peachtree Plaza Hotel, Atlanta, GA. (Douglas E. Campbell, Executive Director, Pulp Chemicals Assn., 60 E. 42nd St., New York, NY).

(Oct. 8-11)—XVIth Congress of AFTPV (French Assn. of Paint and Varnish Technicians), Strasbourg, France. (Congress Secretary, B.P. 1036, 68050 Mulhouse Cedex, France).

(Oct. 14-18)—European Conference on Applications of Surface and Interface Analysis. Veldhoven, The Netherlands. (ECASIA Conference Bureau: QLT Convention Services, Keizersgracht 792, 1017 EC Amsterdam, The Netherlands).

(Oct. 15-17)—ASTM Committee B-8 on Metallic and Inorganic Coatings. ASTM Headquarters, Philadelphia, PA. (Teri Carroll, ASTM, 1916 Race St., Philadelphia, PA 19103).

(Oct. 21-23)—Symposium on "New Chemistry for Product Diversification and Specialization in Coatings." Sponsored by Eastern Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

(Oct. 27-30)—Fire Retardant Chemicals Association Fall Conference. Pinehurst Hotel, Pinehurst, NC. (James D. Innes, FRCA, 851 New Holland Ave., P.O. Box 3535, Lancaster, PA 17604).

(Nov. 4-6)—National Paint and Coatings Association. 98th Annual Meeting. Hilton Hotel, New Orleans, LA. (Karen Bradley, NPCA, 1500 Rhode Island Ave. N.W., Washington, D.C. 20005).

(Nov. 6-8)—National Coil Coaters Association Fall Technical Meeting. Hyatt Regency Dearborn, Dearborn, MI. (Tony Carroll, NCCA, 1900 Arch St., Philadelphia, PA 19103).

(Nov. 15-17)—38th National Decorating Products Association Show. McCormick Place, Chicago, IL. (Lillian Smysor, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132).

(Nov. 18-19)—Seminar on "Fine Particles and Fillers—Overlooked Opportunities." Sheridan Park Conference Center, Mississauga, Ont., Canada. (H.G. McAdie, Ontario Research Foundation, Sheridan Park Research Community, Mississauga, Ont., Canada, L5K 1B3).

(Dec. 4-6)—Short Course on "Advanced Chemical Coatings for Technical Managers." Sponsored by Eastern Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

(Dec. 9-10)—Short Course on "Introduction to Paint Job Estimating." Sponsored by Eastern Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

(Dec. 11-13)—Short Course on "Update on Coatings for Painting Contractors." Sponsored by Eastern Michigan University. Ann Arbor, MI. (Alan Green, Technology Services Center, Eastern Michigan University, 150 Sill Hall, Ypsilanti, MI 48197).

1986

(Feb. 9-12)—"The Colors of History: Identification, Re-Creation, Preservation" Conference sponsored by Inter-Society Color Council. Colonial Williamsburg, VA. (T.G. Webber, 1722 Forest Hill Dr., Vienna, WV 26105).

(Feb. 24-27)—Steel Structures Painting Council Annual Meeting and Symposium. Peachtree Plaza Hotel, Atlanta, GA. (Harold W. Hower, SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213).

(Mar. 17-21)—Annual Meeting of Chemical Coaters Association. Georgia International Convention and Trade Center, Atlanta, GA. (CCA, P.O. Box 241, Wheaton, IL 60189).

(Apr. 5-6)—Workshop on "Size-Exclusion Chromatography." Sponsored by ACS Div. of Polymeric Materials: Science and Engineering. New York, NY. (Theodore Provder, Glidden Coatings & Resins, Div. of SCM Corp., 16651 Sprague Rd., Strongsville, OH 44136).

(Apr. 6-11)—"Advances in Size-Exclusion Chromatography" Symposium. Sponsored by ACS Div. of Polymeric Materials: Science and Technology. New York, NY. (Theodore Provder, Glidden Coatings & Resins, Div. of SCM Corp., 16651 Sprague Rd., Strongsville, OH 44136).

(Apr. 14-15)—ASTM Symposium on "Testing of Metallic and Inorganic Coatings," Chicago, IL. (Teri Carroll, ASTM Standards Development Div., 1916 Race St., Philadelphia, PA 19103).

(Sept. 7-12)—Symposium on High Solids Coatings. Sponsored by the ACS Div. of Polymeric Materials: Science and Engineering, Anaheim, CA. (George R. Pilcher, Hanna Chemical Coatings Corp., P.O. Box 147, Columbus, OH 43216).

(Sept. 8-13)—190th National Meeting. American Chemical Society. Chicago, IL. (ACS, A.T. Winstead, 1155 16th St. N.W., Washington, D.C. 20036).

(Sept. 9-11)—RadCure '86—Association for Finishing Processes of the Society of Manufacturing Engineers Conference and Exposition. Baltimore Convention Center, Baltimore, MD. (AFP/SME Public Relations, Society of Manufacturing Engineers, One SME Dr., Dearborn, MI 48121).

(Sept. 15-17)—13th International Naval Stores Meeting. Waldorf-Astoria, New York, NY. (Douglas E. Campbell, Executive Director, Pulp Chemicals Assn., 60 E. 42nd St., New York, NY).

(Sept. 21-26)—XVIIIth Congress of FATIPEC. (Federation of Associations of Technicians in the Paint, Varnish, and Printing Ink Industries of Continental Europe). Venice, Italy. (C. Bourgery, Secretary General of FATIPEC, 76 Blvd. Pereire, 75017 Paris, France-or-Amleto Poluzzi, AITIVA, Piazzale R. Morandi 2,20121 Milano, Italy).

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'Humbug' from Hillman

In June we published some of *Toronto Life's* reprints from "Zen and Now" as sent to us by Chris George. Here is something more to make you smile in recognition.

ZEN & NOW

Your First Wedding
(Circa 1969)

LOCATION: A cow pasture north of Metro at dawn.

GUESTS: Your pottery teacher, your yoga teacher, your guru, your weaving instructor, your carpenter, members of the goat-farming collective, your Aunt Wilma who works as a legal secretary on Bay Street, and your roommate from Upper Canada College.

OFFICIATING: Sri Charwanbabarajgurdilip.

READINGS: From Fritz Perls's "Gestalt Prayer," the *I Ching,* bride and groom's own poetry.

MUSIC: Inca flute and Sioux drums.

DRESS: The bride. Hand-embroidered, red polished cotton Afghan tribal wedding dress; Moroccan henna designs painted on hands and forehead; no shoes. Bouquet of black-eyed Susans picked that morning.

The groom: Clean work shirt, new jeans, old Kodiak boots.

FOOD: Picnic spread of vegetable curry, bulgur wheat salad, honey and yogurt in glazed pottery bowls, brown rice, dates, oatmeal and hash wedding muffins. Home-pressed cider.

HONEYMOON: Mountain climbing at Baniff.

Your Second Wedding
(Circa 1985)

LOCATION: St. James' Anglican Church at 4 p.m. Reception following at Saddle Bridge Country Club.

GUESTS: Your parents, your first husband or wife, your former in-laws, your children from your first marriage (as bridesmaids, best man or ring bearer), your bank manager, your lawyer, your squash partner, the couple you met on a winetasting tour of Burgundy, and your roommate from UCC.

OFFICIATING: The Reverend Robert Soames, BA, M.Sc., Ph.D,D.D.

READING: Genesis (1:26-28). The word "obey" is deleted from the exchange of vows.

MUSIC: Mendelssohn's Wedding March, played on organ.

DRESS: The bride. Ecru Alençon lace bodice over fitted ivory satin, Victorian neckline with a row of satin-covered buttons down the back and four satin-covered buttons at the wrist. Full train. Peau-de-soie ivory shoes with swiss dot panty hose by Christian Dior. Small drop-pearl tiara over tulle veil. Bouquet of white freesia, sweetheart roses and baby's breath. Blue satin garter, grandmother's ivory cameo pin.

The groom: Black, double-breasted tuxedo of goat's hair cashmere by Armani. Wing collar, black silk tie, patent leather slippers, boutonnière of white freesia.

FOOD: Sit-down dinner for 150. Mousseline of pike with radicchio salad, duck with Cointreau sauce and kiwi, potatoes dauphine, shiitake mushrooms. Four-tiered wedding cake with doily-wrapped individual servings for the groom's party.

HONEYMOON: Snorkelling in Aruba.

Remember the Victor Appleton novels of Tom Swift, the boy inventor? Kids devoured them, second only to Nick Carter, in the 20's through the 50's. In fervent nostalgia I have a 1928 copy of "Tom Swift and his Talking Pictures" sitting on top of my 1922 Victrola.

Well, the Albany International Research Co.'s Newsletter recently ran a contest to celebrate Tom's sage comments which were made with appropriately selected adverbs. Thanks to Ray Dickie for sending the following ten best gems.

The Ten Best

(1) "We need to increase the opacity", Tom said delightedly.

(2) "Of course it's a bicyclic amine", Tom said indolently.

(3) "Ruth should not have lighted a cigarette in the solvent storage area", Tom said ruthlessly.

(4) "Check this fabric on the Taber", Tom said abrasively.

(5) "The coating should have a matt finish", Tom said flatly.

(6) "Pity about Corfam", Tom said soulfully.

(7) "That chromatogram looks terrible", Tom said peakedly.

(8) "We need to conduct more trials", Tom said testily.

(9) "Let's try a U.V. initiated cure", Tom said radiantly.

(10) "The chances are only 50/50 that this triple by-pass operation will succeed", Tom said half-heartedly.

—Herb Hillman
Humbug's Nest
P.O. Box 135
Whitingham, VT 05361

Bring your RMC down and his satisfaction up...

MAINCOTE TL-5 waterborne acrylic polymer is an economical approach to high-gloss, tile-like coatings. You realize significant raw materials savings when formulating with MAINCOTE TL-5 polymer because it is a low priced epoxy crosslinker, less epoxy is required in formulations, and expensive solvents are replaced with water.

Saving on raw materials costs is just one benefit of MAINCOTE TL-5 polymer, which has performance characteristics similar to those of two-component, solvent-borne epoxy wall coatings used in institutional environments. Your customers will like the easy stain removal properties offered by coatings based on MAINCOTE TL-5. And, they'll enjoy low maintenance costs as a result of the ability to remove stains easily.

Other advantages of coatings based on MAINCOTE TL-5 polymer include not only high gloss, low odor, and easy cleanup, but also resistance to chemicals used in industrial cleaners.

Do yourself and your customer a favor . . . contact your Rohm and Haas technical representative today for details on MAINCOTE TL-5 polymer or write our Marketing Services Department, Independence Mall West, Philadelphia, PA 19105.

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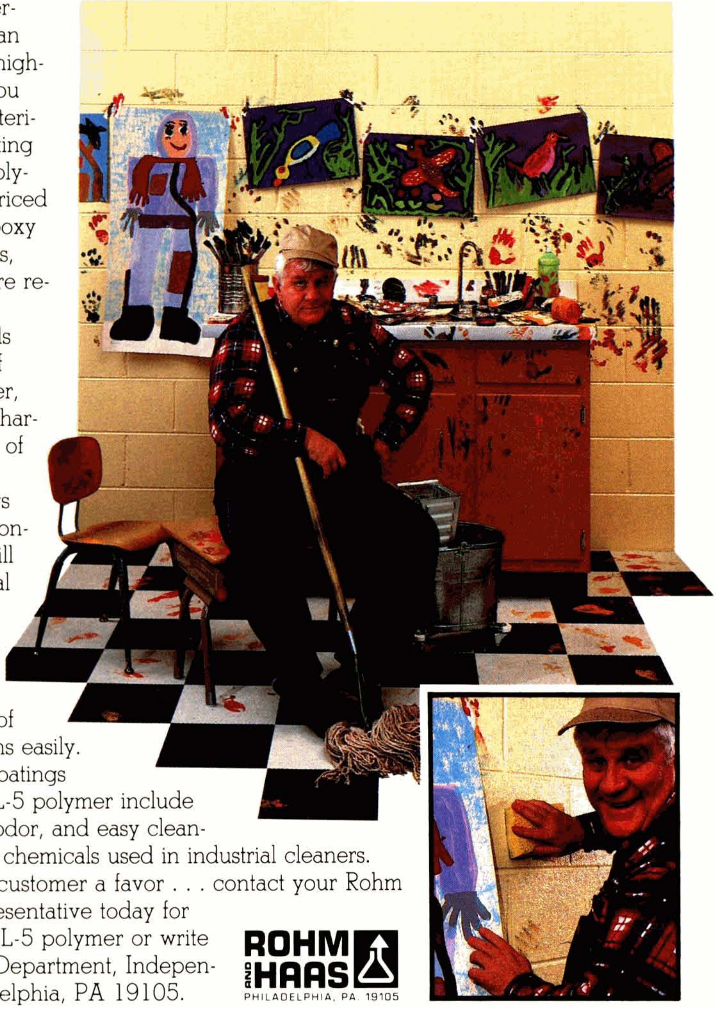
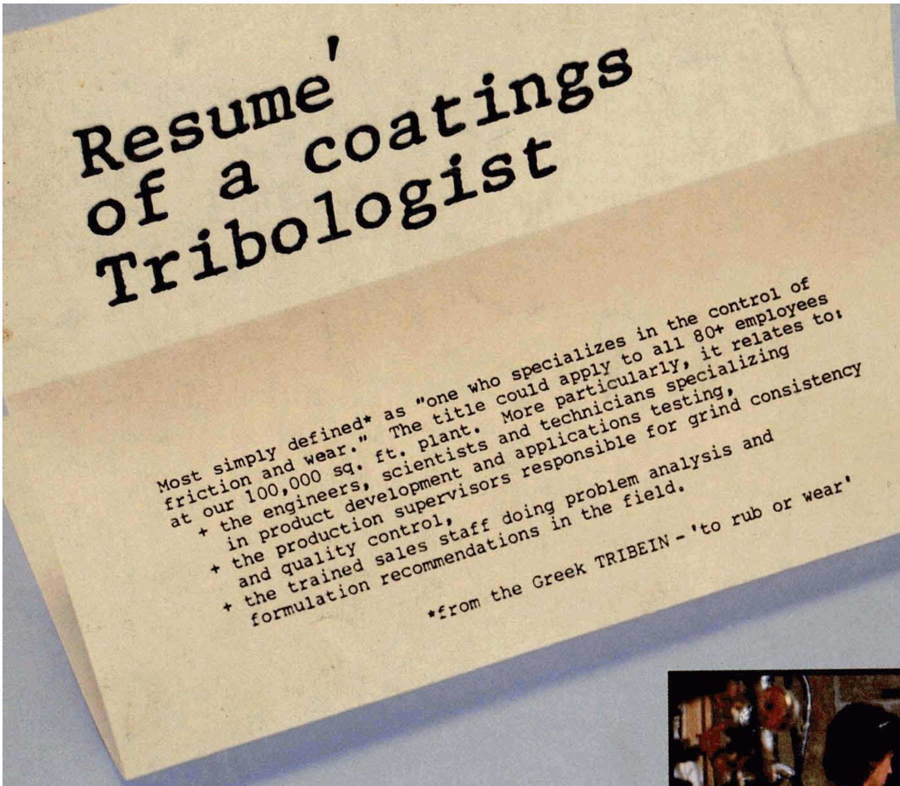




Resume' of a coatings Tribologist

Most simply defined* as "one who specializes in the control of friction and wear." The title could apply to all 80+ employees at our 100,000 sq. ft. plant. More particularly, it relates to:

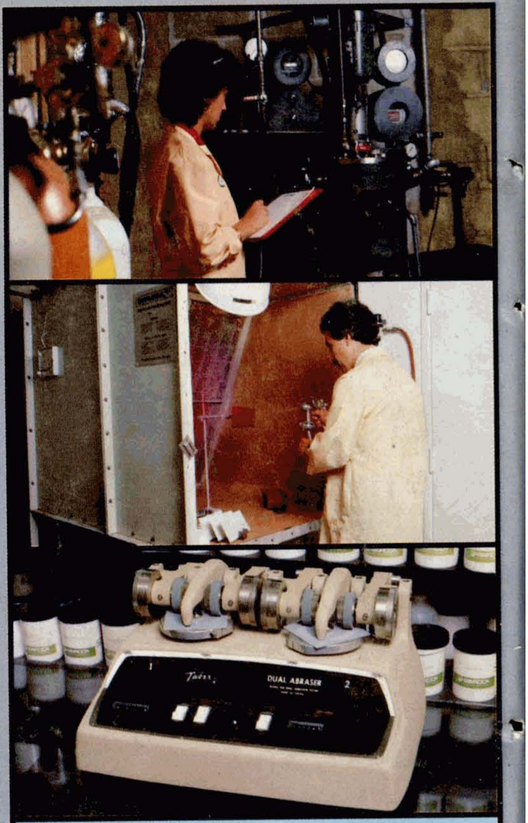
+ the engineers, scientists and technicians specializing in product development and applications testing,
+ the production supervisors responsible for grind consistency and quality control,
+ the trained sales staff doing problem analysis and formulation recommendations in the field.

*from the Greek TRIBEIN - 'to rub or wear'

We take polyethylene and PTFE raw materials and manufacture them into products that provide wear, mar, scuff, abrasion resistance, and other properties.

Why does Shamrock invest so much in sophisticated testing, elaborate manufacturing checks and balances, and exacting quality controls? Simply, to make certain that the small percentage of your formulation represented by our wide variety of stir-in powders, is consistent in performance! And, to make available a staff with the experience and ability to analyze your problems and help you solve them.

We care! And, we deliver...consistently and with quality! For samples and technical data, contact us or your nearby sales office/representative.



TOP: *Reactor produces developmental polyethylene waxes.* MIDDLE: *Samples are prepared by roller, brush, draw-down and spray application techniques.* BOTTOM: *Testing is conducted for slip and friction, rub and mar, and wear and abrasion.**

*Taber Abraser shown distributed by Testing Machines, Inc.

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