JOURNAL OF COATINGS TECHNOLOGY

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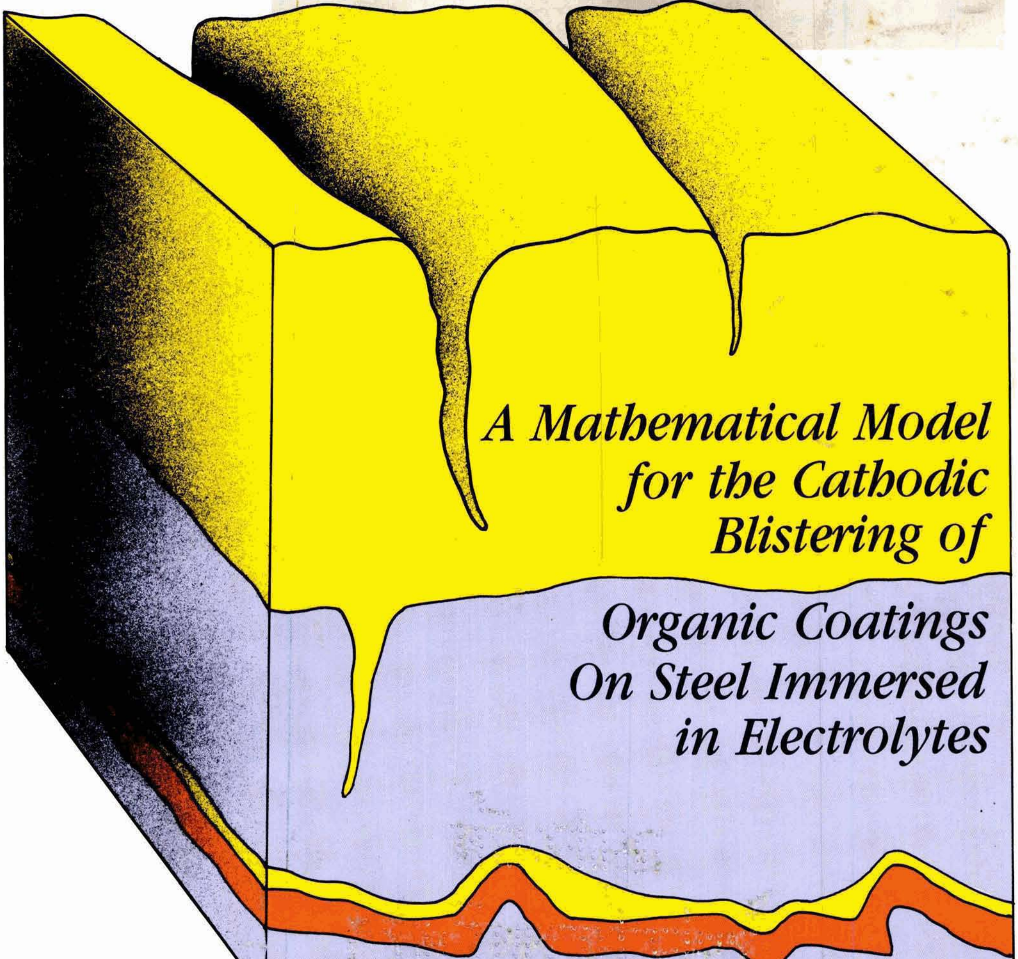

A Mathematical Model for the Cathodic Blistering of Organic Coatings On Steel Immersed in Electrolytes

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MARCH 1991

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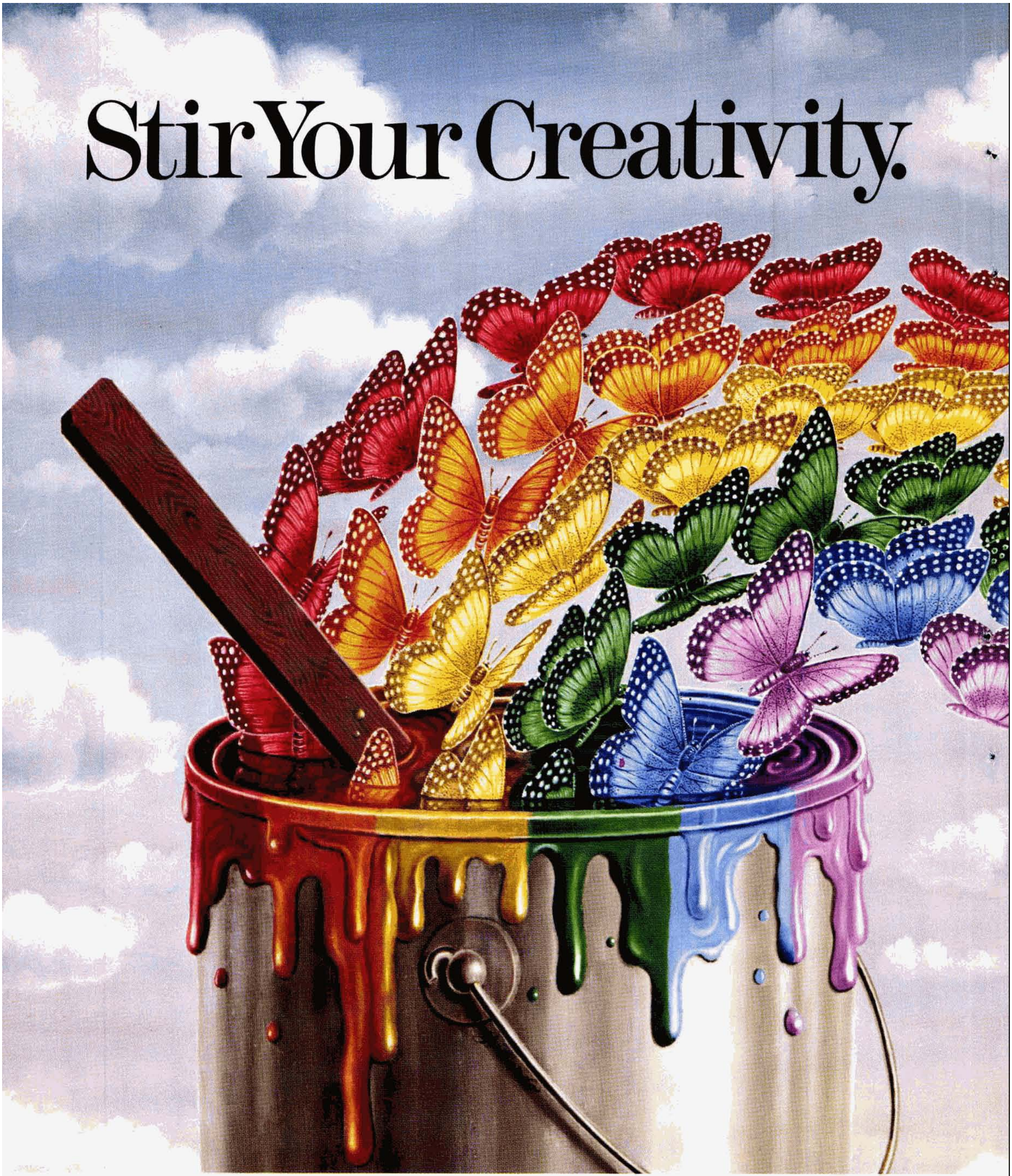

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Comment

As History Is Made

*"Work as if you were to live an hundred years,
Pray as if you were to die tomorrow."
—B. Franklin, Poor Richard's Almanac, 1757, May*

Benjamin Franklin, the pragmatist, was truly representative of the forceful, confident men who defined our nation's early history. Through such inventions as bifocal lenses, the institution of the nation's first fire department, and though his attempts to harness electricity, Philadelphia's "greatest citizen" sought practical solutions to persistent problems.

*"All must hang together, or assuredly, we shall all hang separately."
—B. Franklin, at signing of Declaration of Independence, July 4, 1776*

Ben Franklin, the visionary, exerted a profound influence over the citizens of the newly-formed nation. His passion for rational knowledge and concern for the future inspired him to found, among many institutions, the University of Pennsylvania, and act as a driving force in the planning of Pennsylvania Hospital.

With men such as Franklin in its past, the early colony of Philadelphia played a significant role in the shaping of America. Today's Philadelphia, with its sophisticated blend of the past, present and future, has been chosen as the site for the Federation's Spring Week events, May 13-17, at the Sheraton Society Hill.

It is with the same spirit of resourcefulness and foresight exemplified by Franklin, that the members of the Philadelphia Society addressed the task of planning the 1½ day Spring Week seminar. The theme of the meeting, "Formulating for the Future," will explore some of the technical and material advances that are opening alternate areas of development for the coatings industry. These advances offer new opportunities for designing coatings systems that will meet the demands for environmentally and performance-engineered products.

The Federation's Spring Week programs have gained a reputation for providing interesting, applicable information that has benefitted attendees. A recent example, "Modern Analytical Resources," was offered in Los Angeles in 1989. (*Abstracted versions of some of the presentations from this seminar are featured in this issue on page 19-26).*

Philadelphia, the city that nurtured the genius of Benjamin Franklin, welcomes all to explore its history, and offers the challenge of discovering methods of adapting to the coatings industry's future. Register now, using the form provided on page 12. After all, in the words of that famous scholar, diplomat, scientist and statesman:

*"Lost time is never found again."
—B. Franklin, Poor Richard's Almanac, 1748, January*

Patricia D. Viola

Patricia D. Viola,
Editor

Abstracts of Papers in This Issue

A MATHEMATICAL MODEL FOR THE CATHODIC BLISTERING OF ORGANIC COATINGS ON STEEL IMMERSED IN ELECTROLYTES—T.N. Nguyen, J.B. Hubbard, and G.B. McFadden

Journal of Coatings Technology, 63, No. 794, 43 (Mar. 1991)

A physical/mathematical model which describes blistering resulting from the corrosion of coated metals containing defects exposed to electrolytes has been developed. The model is based on the two-dimensional diffusion of cations through some arbitrary medium. Cations migrating along the coating/metal interface from the defect to the cathodic sites are assumed to be responsible for the formation of highly water-soluble corrosion products, leading to blistering. Solutions of the model were expressed in terms of dimensionless parameters. Concentration profiles between the blister and defect and cation flux into the blister as functions of time, blister size, distance between the blister and defect, ion diffusivity, and potential gradient were calculated. The predictions were related to available experimental data in the literature on cation uptakes and blistering rates for coated steel panels exposed to metal chloride solutions.

STRUCTURAL PAINTING IN EARLY AMERICA—M. Finnigan and T.T. Broome

Journal of Coatings Technology, 63, No. 794, 53 (Mar. 1991)

About 50 years ago, the restoration of Williamsburg, VA, and similar colonial landmarks caught the attention of historians, architects, and the paint industry. Authentic reproduction was their utmost concern. Much emphasis has been placed on reproducing furnishings and ornaments. However, to completely obtain a realistic effect in a restoration effort, thought must be given to the reproduction of the painted surfaces.[1] For the architect to achieve a true reproduction, he must rely on the paint manufacturer to supply material which accurately represents that used during the period. The paint industry must obtain information from historians concerning raw materials in use during the period in question. This knowledge is necessary for the craftsman to successfully produce the illusion of uninterrupted existence.[2]

This paper will attempt to bridge the gap between the historian and the craftsman by studying the history of early American painting. Hopefully, the craftsman will draw beneficial conclusions from the facts obtained in this study.

FACTORS AFFECTING TITANIUM DIOXIDE DISPERSION IN TRADE SALES PAINTS—A. Brisson and A. Haber

Journal of Coatings Technology, 63, No. 794, 59 (Mar. 1991)

The manufacture of alkyd and latex trade sales paints requires that their components be carefully combined so as to minimize any adverse effects. Because of the complexity of most paint systems, problems can be encountered during the manufacturing process, including rheological and colloidal problems. A variety of factors have been studied in terms of their effects on titanium dioxide dispersion in both latex and alkyd trade sales paints using the flocculation gradient technique. It will be shown that a good knowledge of the effect of these factors on pigment dispersion is essential to ensure a quality product.

EFFECT OF THE DI-IRON PHOSPHIDE CONDUCTIVE EXTENDER ON THE PROTECTIVE MECHANISMS OF ZINC-RICH COATINGS—S. Feliu, Jr. et al.

Journal of Coatings Technology, 63, No. 794, 67 (Mar. 1991)

Impedance measurements are primarily utilized in this paper to obtain information about the effect of replacement of part of the zinc by Fe_2P extender on the anti-corrosive properties of zinc-rich coatings. In particular, attention is focused on the performance of these coatings as porous electrodes (with a large anodic surface), and on the evolution of the barrier effect during coating exposure to a saline solution.

International Perspective of Industry Is Theme For Annual Meeting in Toronto, November 4-6

The 1991 Annual Meeting of the Federation of Societies for Coatings Technology will be held on November 4-5, at the Metro Convention Centre, in Toronto, Ontario, Canada. The theme of the meeting is "The International Coatings Environment: Today's Opportunity, Tomorrow's Challenge."

The theme reflects today's global coatings environment and its challenging proactive marketing and technology strategies. An opportunity today will be a challenge tomorrow if not addressed in a timely and effective manner.

To address this theme, programming will emphasize the international perspective and will focus on such areas as quality improvement, cutting edge technology, and environmentally and performance engineered products.

Also included in the program will be the Mattiello Memorial Lecture by one of the technical leaders in coatings research, Roon Awards Competition Papers, presentations from Federation Constituent Societies, and Seminars on new manufacturing technology, anti-corrosion coatings, and advanced topics in coatings research.

Program Chairman Gerry Parsons, of DeSoto Coatings Ltd., Mississauga, Ont., and his committee are developing a schedule of presentations. Serving on his committee are: John Lanning (Vice-Chairman), Courtaulds Coatings, Inc., Porter Paint Div., Louisville, KY; Mary G. Brodie, Strongsville, OH; Bob Deruiter, Reichhold Ltd., Toronto, Ont.; John Hall, Tioxide, Inc., St. Laurent, Que.; Peter Hiscocks, Ashland Chemicals, Mississauga, Ont.; George R. Pilcher, Akzo Coatings, Inc., Columbus, OH; and Roger Woodhull, California Products Corp., Cambridge, MA.

Paint Industries' Show

To be held in conjunction with the 69th Annual Meeting, the 56th Paint Industries' Show will feature the products and services of the suppliers to the international coatings industry. Currently, 180 companies have reserved over 64,000 net square feet of exhibit space, or 75% of the booth space available at the Convention Centre. *(See list of exhibitors accompanying story.—Ed.)*

Exhibit hours will be 10:00 a.m. to 5:30 p.m. on Monday, November 4; 8:00 a.m. to 5:30 p.m. on Tuesday, November 5; and, 8:00 a.m. to 12:00 Noon on Wednesday, November 6.

Hotels and Reservations

Nine hotels have reserved blocks of rooms for the Federation event. The Sheraton Centre Hotel and Royal York Hotel will serve as co-headquarters for the Annual Meeting and Paint Show. Other hotels include Bond Place, Holiday Inn-Downtown, Hilton International Toronto, King Edward, L'Hotel, Marriott Eaton Centre, and the Westin Harbour Castle. All housing will be processed through the Toronto Convention and Visitors Association. Housing information will be available to all members in April.

Special Airline Fares

American Airlines and Air Canada, in cooperation with the Federation, are offering special discount airline fares which afford passengers a 25-40% savings off their round trip and undiscounted day coach fares for travel to the FSCT Annual Meeting and Paint Industries' Show on the airlines' transborder system.

To take advantage of these discounts, you must purchase tickets at least seven days in advance and travel between October 28 and November 12, 1991. For American Airlines, telephone 1-800-433-1790 and ask for *STAR File #S-0201CN*; for Air Canada, telephone 1-800-361-7585 and ask for *File #917086*. The special fares are available only through these numbers.

Discounts are good for both direct and connecting flights to Toronto. If you use a travel agent, have your reservations placed through the toll-free numbers to obtain the same fare advantages. Both American and Air Canada have a variety of other promotional fares, some of which may represent even greater savings. When phoning for reservations, ask for the best discount applicable to your itinerary.

Registration Fees

Advance registration forms and information will be sent to all members in April. Advance fees are \$65 for members and \$80 for non-members. The fee for spouses' activities is \$60 in advance. Retired members and their spouses may register for the special advance only fee of \$25 each.

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

Host Committee

The Toronto Society will serve as the Host for the Annual Meeting. General Chairman of the 1990 Annual Meeting is Larry Ham, of Stochem, Inc. Assisting him are the following sub-committee chairpersons: *Information Services*—Sandy Palleschi, of Serif Coatings; *Program Operations*—Scott Harvey, of Chemroy Chemicals; *Registration Area*—Gordon Major, of Bethco Consultants; *FSCT Exhibit*—Arthur Hagopian, of Bapco, Inc.; and *Spouses' Program*—Marion Gauley, of L.V. Lomas.

Errata

The following photo caption appeared incorrectly in the January 1991 issue of the JCT. We are sorry for any inconvenience this may have caused.—Ed.

Members of the Federation Ad Hoc Building Committee include: Deryk Pawsey (Pacific Northwest); Colin Penny (Baltimore); James Geiger (Southern); James McCormick (Baltimore); and John Oates (New York)

1991 PAINT INDUSTRIES' SHOW
Current List of Exhibitors

Aceto Corp.
ACS-Datacolor
Advanced Coating Technologies
Advanced Software Designs
Air Products & Chemicals, Inc.
Allied Signal, Inc.
American Cyanamid Co.
Amoco Chemical Co.
Anachemia Solvents Ltd.
ANGUS Chemical Co.
Anker Labelers USA, Inc.
Aqualon Co.
Arco Chemical Co.
Aries Software Corp.
Ashland Chemical Co., IC&S
Atlas Electric Devices Co.

B&P Environmental Resources
BASF Corp.
Blackmer Pump Div., Dover Resources Co.
Bohlin Reologi, Inc.
Brookfield Engineering Labs., Inc.
Brookhaven Instruments Corp.
Buckman Laboratories, Inc.
Buhler, Inc.
Bulk Lift International, Inc.
Burgess Pigment Co.
Byk-Chemie USA
Byk-Gardner, Inc.

C B Mills, Inc.
Cabot Corp., Cab-O-Sil & Special Blacks Div.
Calgon Corp., Div. of Merck & Co., Inc.
Canada Colors & Chemicals Ltd.
The Carborundum Co.
Cardolite Corp.
Cargill, Inc.
Carroll Scientific, Inc.
Caschem, Inc.
Catalyst Resources, Inc.
Chemical & Engineering News
Chemical Marketing Reporter
Chemical Week
Ciba-Geigy Corp.
Coatings Magazine
Color Corp. of America
Colores Hispania, S.A.
Colorgen, Inc.
Consolidated Research, Inc.
Coulter Electronics, Inc.
CPI Purchasing Magazine
Cray Valley Products International
Crosfield Chemicals, Inc.
Custom Recovery Services, Inc.
Cyprus Industrial Minerals Co.

D/L Laboratories
Daniel Products Co.
Day-Glo Color Corp.
Degussa Corp.
University of Detroit
Dominion Colour Corp.
Dow Corning Corp.
Draiswerke, Inc.
Drew Chemical Corp.
DSA Consulting, Inc.
DSET Laboratories, Inc.
Du Pont Co.

E.C.C. America
Eagle Picher Minerals, Inc.
Eagle Zinc Co.
Eastern Michigan University
Eastman Chemical Products, Inc.
Eiger Machinery, Inc.
Elders Resources Chemicals Inc.
Elektro-Physik USA, Inc.
Elmar Industries, Inc.
Engelhard Corp., Spec. Min. & Colors Group
Epworth Manufacturing Co., Inc.
Etna Products Inc., Specialty Chemical Div.
Exxon Chemical Co.

Fawcett Co., Inc.
FCF-Bowers, Inc.
Federation of Societies for Coatings Technology
FMC Corp., Food & Phama-ceutical Div.
FMJ International
Freeman Polymers Div./Cook Composites & Polymers
H.B. Fuller Co.

Paul N. Gardner Co., Inc.
Georgia Kaolin Co., Inc.
B.F. Goodrich Co., Spec. Polym. & Chem. Div.
Goodyear Chemical Division
Guer-Tin Brothers Polymers

Halox Pigments, Div. of Hammond Lead Products
Harcross Pigments, Inc.
Henkel Corp., Process Chemicals
Hitox Corp. of America
Hockmeyer Equipment Corp.
Hoechst Celanese Corp.
Horiba Instruments, Inc.
Hüls America, Inc.
Hungarian Aluminium Corp.
Hunterlab

ICI Americas, Inc.
ICI Resins U.S.

Kenrich Petrochemicals, Inc.
King Industries, Inc.
Kronos, Inc.

Labsphere
Laporte Absorbents, Inc.
Leeds & Northrup, A Unit of General Signal
Liquid Controls Corp.
The Lubrizol Corp., Coatings Technologies

3M, Industrial Chemicals Div.
Macbeth Div., Kollmorgen Corp.
Malvern Minerals Co.
McWhorter, Inc.
The Mearl Corp.
Michelman, Inc.
Micro Powders, Inc.
Micromeritics Instrument Corp.
Mid-States Eng. & Mfg. Co.
Miller Manufacturing Co., Inc.
Millipore, Inc.
Milton Roy Co.
MiniFibers, Inc.
Minolta Corp.
Mississippi Lime Co.
University of Missouri-Rolla
Modern Paint & Coatings
Monsanto Co.
Moulders Supply Ltd.
Mountain Minerals Co., Ltd.
MTS Colormetrie (France), Klieve

Nacan Products Ltd.
Netzsch Incorporated
Neupak, Inc.
New Way Packaging Machinery, Inc.
Nicolet Instrument Corp.
Nippon Shokubai America, Inc.
NYCO

Obron Atlantic Corp.
Ortech International

P Q Corporation
Pacific Micro Software Engineering
Paint & Coatings Industry Magazine
Pen Kem, Inc.
Peninsula Polymers
Philips Container Co.
Phillips 66 Co., Specialty Chemicals
Pierce & Stevens Corp.
Plastican, Inc.
Poly-Resyn, Inc.
Premier Mill Corp.
Pyosa S.A. De C.V.

The Q-Panel Co.
Quantachrome Corp.

Raabe Corp.
Red Devil, Inc.
Reichhold Chemicals, Inc.
Rheox, Inc.
Rhone-Poulenc Inc.
Rohm and Haas Co.
Rosedale Products, Inc.
Roto-King, Inc., Unit of Idex Corp.

Sandoz Chemicals Corp.
Sanncor Industries, Inc.
SCM Chemicals
Semi-Bulk Systems, Inc.
Shamrock Technologies, Inc.
Shell Chemical Co.
Sherwin-Williams Chemicals Co.
Shimadzu Scientific Instrument
Silberline Manufacturing Co.
Sino-American Metals & Minerals
South Florida Test Service/ Atlas Electric Devices
University of Southern Mississippi
Sub-Tropical Testing Service
Sun Chemical Corp.

Thiele Engineering Co.
Tioxide America, Inc.
Troy Chemical Corp.

U.S. Borax & Chemical Corp.
U.S. Silica Co.
Unimin Specialty Minerals Inc.
Union Carbide Chemicals & Plastics
Union Process, Inc.
United Catalysts, Inc.
United States Testing Co., Inc.
Unocal Chemicals Div., Unocal Corp.

Van Waters & Rogers
R.T. Vanderbilt Co., Inc.

Wacker Silicones Corp.
Warren-Rupp, Inc.
Wilden Pump & Engineering Co.
Witco Chemical Corp., Organics Div.

X-Rite, Incorporated

York Fluid Controls Ltd.

Zeelan Industries, Inc.

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May 13-14, 1991 • Sheraton Society Hill, Philadelphia, PA

Registration fees: $160 (FSCT members); $190 (non-members)

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

NICKNAME (For Registration Badge) ____________________

FULL NAME ____________________

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Name of Federation Society
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Please reserve: Single ______________ $118.00 (per night)

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

Note: Reservations must be made no later than April 12 to guarantee availability and rates.

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

Federation's Technical Advisory Committee And Society Technical Committee Chairmen Meet in Atlanta, GA

Fifteen Society Technical Committee representatives met with members of the Federation's Technical Advisory Committee on September 12-13, 1990, at the Hyatt Atlanta Airport Hotel, in Atlanta, GA.

Society Technical Committee representatives in attendance included: Mary Somerville (Baltimore); Roland Staples (Birmingham); Freidun Anwari (Cleveland); Rose Ann Ryntz (Detroit); David Siller (Houston); Steve Bussjaeger (Kansas City); Santos Delos Santos (Los Angeles); Linda Cox (Louisville); Alain Brisson (Montreal); Michael Oliveri (New York); Julio Aviles (Philadelphia); Frank Schaffer (Piedmont); John Baker (Rocky Mountain); Walter Naughton, Jr. (Southern); and Bob Ng (Toronto).

In addition to Chairman Noren, other Technical Advisory Committee members attending were: Robert Athey (Golden Gate); Edward Ferlauto (Northwestern); and John Flack (Toronto).

Guests attending were: Dan Dixon, Southern Society Representative; Gail Pollano (New England), member of FSCT Corrosion Committee; and Charles Leete, President of Collaborative Testing Services, Inc.

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

Activities of Joint Coatings/Forest Products Committee

Steve Bussjaeger reported on activities of the Joint Coatings/Forest Products Committee. He chairs the Committee's coatings group, which is an adjunct of the TAC.

A series of monographs on various aspects of coatings and wood substrates is being developed; the monographs discuss areas of mutual concern to both industries, identify problems, and offer possible solutions.

The initial work, "Effects of Acidic Deposition on Painting Wood," has been completed and accepted for publication in the JCT. Four others are in final stages of completion: "Painting Recommendations for Pre-Primed Medium Density Hardboard Siding"; "Finishability of CCA Pressure-Treated Wood"; "Prevention of Extractive Discoloration"; and "Application Recommendations for Smooth, Embossed and Saw-Textured Surfaces."

Final review of revised National Forest Products Association booklet, "How to Paint Your Wood House," is underway; NFPA plans to publish the new edition by year-end.

Mr. Bussjaeger noted also that the Committee serves as an advisory board for research projects undertaken by the U.S. Department of Agriculture's Forest Products Laboratory at Madison, WI.

Activities of Corrosion Committee

Corrosion Committee Chairman Gail Pollano reported on Corrosion Committee activities.

The modified report of Committee-sponsored "Survey of Accelerated Test Methods for Anti-Corrosive Coating Performance" was published in the August 1990 issue of the JCT. Complete report is in final stages of editing and will be submitted to the Federation office, to be reproduced and offered for sale.

Recipients of the 1990 Corrosion Committee Publication Award have been selected for best corrosion-related papers published in the JCT. Presentation will be made at the Federation's Annual Meeting, during the Committee-sponsored symposium on "Anti-Corrosive Coatings: The Next Generation."

Ms. Pollano stated that the committee is planning a symposium for the 1991 Annual Meeting on "Coatings for Corrosion Control of Non-Ferrous Substrates." The committee is also developing a program for the 1992 FSCT Spring Seminar; initial planning is underway for the event, which will have as its topic, "Understanding Corrosion Protection."

Presentation on "Error, Precision, Accuracy, and Bias"

Bob Athey presented an overview on the importance of proficient testing and the development and implementation of reproducible test methods.

Dr. Athey noted that the coatings industry is becoming increasingly interested in quality management. Total variance of a process is made-up of variance in the product and variance in the test. The test variance interferes with the ability to make decisions which control product variance; therefore, good control of the product depends on good control of the testing process.

A key consideration is the reliability and validity of measurement equipment and procedures, to assure uniformity in the accuracy of the instruments and in the methods used by different operators. Laboratories need to evaluate materials and products by means of standard procedures and to obtain results that are in agreement.

In his presentation, Dr. Athey discussed various aspects of testing, focusing on accuracy, precision, and bias in test procedures and their consequences.

Glidden Company Tour

Chairman Noren had arranged for a tour of the Gainesville plant of The Glidden Company located in Oakwood, GA, about 40 miles away.

Plant Manager Al Crego welcomed the attendees and gave a brief overview of the Gainesville operation, which is situated on 79 acres in rural Georgia.

The plant, which last year produced over 13 million gallons of trade sales latex paint, began operations in March 1982. It employs a total of 77 operating, supervisory, and clerical personnel.

Liaison with Collaborative Testing Services, Inc.

Since 1984, the Federation has sponsored a program designed to improve the reliability of paint and coatings laboratory testing and to develop reproducible test methods. The program is conducted on behalf of the FSCT by Collaborative Testing Services, Inc., Herndon, VA, and offers participating labs the means to periodically check the level and uniformity of their testing proficiency by comparing test results with those of other participating labs. The TAC monitors the program, and meets with CTS President Charles Leete periodically to provide technical input, including suggested test methods and paint samples.

Mr. Leete briefly reviewed the history of the program, now in its seventh year; currently between 50 and 55 laboratories are enrolled, and results to date clearly indicate the need for the program, with many labs testing the same paint product demonstrating their inability to get reproducible results.

Overall, the program results give evidence that the industry has a problem with its testing proficiency, which may soon have a major impact in view of some of the demands being generated by governmental agencies and automotive companies to impose strict criteria of lab proficiency for their suppliers. Additional impact will be felt by the growing implementation of Statistical Process Control among manufacturers, who are requiring their suppliers to demonstrate SPC capability, for which accurate, reproducible testing is a requisite.

In recognition of the problem, and to build awareness, the Professional Development Committee is sponsoring a session at the 1990 Annual Meeting on "Testing: The Key to the Quality Revolution."

The awareness effort, he said, could be aided if Society Technical Committee representatives called it to the attention of their members. He noted that the problem should be deemed an "overlay" for existing quality assurance programs that companies have in place.

He said the representatives could also help by suggesting tests to be included in the program which would be of most interest, as well as paint samples and sources for obtaining them.

This year's program covers nine different ASTM test methods. Participants select the tests they wish to conduct and are sent samples four times during the testing year. Both architectural and industrial type paint samples are used in the program, and are representative of those produced by most coatings manufacturers.

Reports on Society Activities

Attendees were asked to present brief summaries of their Society's Technical Committee activity. The following capsules the reports submitted and discussed.

Baltimore

Presenting paper on "The Effects of Degree of Dispersion on the Properties of Architectural Coatings" at Federation's 1990 Annual Meeting; study includes investigation of use of the Guggenheim Equation in developing an optimum grind paste . . . Work begun on study of Effects of Proper Priming and Surface Preparation on the Durability of Exterior Architectural Coatings; hope to subsequently produce a point-of-sale videotape for demonstration use by paint store personnel.

Birmingham

Completion of the Solids/Density project is anticipated by year-end; this is a quick method giving fairly accurate results . . . The "History of the Midlands Paint Industry" has been published and received good reviews. Continued information will be collected for eventual updating . . . The "museum" project (gathering paint industry artifacts and locating suitable site for preserving them) continues on hold, due to lack of required resources to fund and support the effort . . . Newsletter continues, with three issues during the meeting season, and is a valuable source of income . . . New projects being discussed, and members being surveyed for input . . . Symposium will be held prior to monthly meeting in February 1992; programming will focus on toxic waste problems.

CDIC

Planning to undertake compilation of Raw Materials Index. Initially gathering information on pigments only; thus far, data accumulated on titanium dioxide, barium sulfate, calcium carbonate, silica and silicates; seeking to interest other Societies in participating to gather information on resins, solvents, etc.

Cleveland

Presenting two papers at 1990 Annual Meeting: "Changes in Hiding During Latex Film Formation. Part II. Pigment Packing Effects"; and "Changes in Hiding During Latex Film Formation. Part III. Effect of Coalescent Level and Emulsion Properties." Presentations are follow-up to work reported on at the 1989 Annual Meeting . . . Topics under consideration include: effect of film thickness; toning; substrate porosity; temperature and humidity; and opaque polymer.

Dallas

Corrosion project initiated which will examine an unusual corrosion test method on aluminum substrates, with aim to better quantifying the standard Salt-Spray Test (ASTM B 117). An accelerated test will be compared with an actual exposure test to see how well it predicts long-term coating performance; will also look at the lab-to-lab reproducibility. Panels are currently being sprayed, and testing will begin shortly . . . Other projects being considered include: Accelerated vs Actual Storage Stability; Survey of Non-Chromate Corrosion Inhibitive Pigments.

Detroit

Currently sponsoring a study with the University of Detroit on siloxane modified epoxy urethane acrylic interpenetrating polymer networks (IPNs). The IPNs will consist of a urethane acrylic copolymer with unsaturation in the side chains (Part A); Part B consists of a siloxane modified epoxy. Crosslinkers for the respective components will consist of peroxides (for Part A) and amines (for Part B). Variations in Part B will consist of varying molecular weight amines, both siloxane and non-siloxane modified, to determine their effect on network formation. The epoxy utilized in Part B will also be varied to include siloxane and non-siloxane modified moeities. Phase Two of the study will compare effects of other crosslinker types on epoxy curing and their ultimate effect on network formation. Crosslinkers such as anhydrides (pyromellitic anhydride) or other functional amines (DMP-30) will be studied. IPNs formed will be characterized chemically and physically by DSC and electron microscopy. Clear films will be tested for flexibility, adhesion to several substrates, impact resistance, chemical resistance, thermal stability, hardness, and permeability characteristics. Anticipate work will be completed for presentation of results at 1991 Annual Meeting . . . Initiating discussions with Eastern Michigan University with aim of developing cooperative technical programs.

Golden Gate

Drying Rate study continues. Paper presented at the 1989 Annual Meeting reported on three different substrates (aluminum, sealed Leneta charts, and unsealed Leneta charts), with three different coating formulations (solvent borne without pigment, waterborne with and without pigment) based on same polymer. Three different temperatures, and three film thicknesses were used as additional variables. Initial report recorded actual data plots (weight loss versus time), finding two linear segments in the drying curves. Linearity of initial and final drying curve segments was confirmed by least squares calculation of slope (=drying rate). Pigmentation appeared to slow the process, as well. It was concluded there are probably two different processes occurring in the two segments of the curve . . . In continuing the project, the data work-up by computer modeling was quite arduous. Data set used most of the actual time/temperature/weight records, to make a data set matrix 8 x 472. Linear models with regression for all variables were not satisfactory, as all had the same slope (actual data curves show different slopes at different temperatures) and all were straight lines.

Conversion of the time data to the inverse gave a more hyperbolic plot, and slopes did differ with temperature for the initial linear segment. However, the final dry weight was never attained in any model. After examining many such curves, the statistical modeling was abandoned as an unsatisfactory match for the real data plots. These will be reported in the paper, "Statistical Modeling Drying of Coatings," to be presented at the 1990 Annual Meeting . . . Considering collaborative study of the Pencil Hardness Test for next project, and inviting interested Societies to participate.

Houston

Initiated program to investigate morphology of commercially available titanium dioxide pigments in coatings for purpose of defining performance variables for seemingly equivalent pigments. Now comparing published titanium dioxide data from commercial sources. Also, one set of SEM micrographs has been obtained and evaluated. Obvious from these micrographs is that sample preparation technique is crucial; review of technique is underway and new micrographs are being obtained for further study.

Kansas City

Four projects currently underway. Compliant Coatings: Artificial vs Natural Weathering—This project includes VOC compliant air dry and bake industrial finishes that fall in the high solids, waterborne, and powder coatings area. Artificial exposures include QUV, carbon and xenon arc, salt spray, etc. Natural exposure sites are Kansas City, Florida, Arizona, and Houston; panels have been on exposure since January 1989 . . . Effect of High Surfactant Levels on Performance of Exterior Finishes on Hardboard—This work was initiated based on reports that surfactants induce hardboard substrate failure. Latex and oil-based coatings were used with low surfactant and high surfactant (nonionic) levels. Substrates include smooth and textured hardboard, T-111, OSB, and natural wood; exposures have been on fence in Kansas City since February 1989 . . . Extender Pigments in Exterior Finishes—This is an exposure study of 18 various extenders in flat exterior finishes. Extenders included are carbonates, silicas, and silicates; PVC has been adjusted to compensate for oil absorption. Southern and Northern exposures will be conducted to observe effects on fade/chalking, mildew growth, dirt pick-up, frosting, grain crack resistance, etc.; this series is prepared and currently being placed on exposure . . . Performance Comparison of Exterior Finishes on Hardboard Siding—Results of this 40-month exposure study were presented at the 1989 Annual Meeting; exposure is continuing and will be re-evaluated for submission as an "Open Forum" article in the JCT.

Los Angeles

Currently working on two projects. Color Standards—What is the Best System?—Working with five manufacturers of architectural paints using different systems in checking their batch versus standard; more data necessary to complete the project . . . Evaluation of Nontoxic Anticorrosive Pigments—Samples and recommended formulas of different suppliers of nontoxic and anticorrosive pigments are being gathered and evaluated. Four different laboratories will monitor performance of each pigment.

Louisville

Planning project to standardize the Brookfield Viscosity method so as to control results between plants. Brookfield and thix index data are to be used in any or all of the following studies: effect of optimized rheology of VOC control; organic yellow pigments and their effects on viscosity and thixotropy; viscosity and "hang up" control in high solids coatings via rheological additives; "thix index versus no-sag film build versus evaporation rate of solvent mix" chart; effect of various thickeners on water-based emulsion systems; and what affects Brookfield results?

Montreal

Currently involved in two projects. Acid Rain—This work was initiated in 1989 in conjunction with the Northwestern Society, to study effect of acid rain on coatings. Outdoor exposure of a series of panels at selected sites in U.S. and Canada will, hopefully, enable quantifying how air pollutants such as sulfur dioxide and ozone affect the physical and chemical characteristics of a coating. Because other weather variables are likely to affect coatings performances, there is need to study the effect of a rather large number of variables . . . Coatings for Plastics—Aim is to present a literature review of this very active field. Material is being collected in conjunction with the Toronto Society and Vancouver Section of the Pacific Northwest Society, to be part of an all-Canadian presentation at the Federation's 1991 Annual Meeting in Toronto.

New England

Working currently on two projects. Reproducibility of Artificial Weathering—Literature search has been concluded and panels of the white paint that will be used for round-robin testing of various accelerated weathering units have been prepared. Initial gloss and color readings and exposures remain to be run on these, and the preparation of the alizirine paint with subsequent readings and exposures are planned for later this year . . . Biocide Containing Polymers—Panels of the polymer paints have been exposed now for one year. Pictures are being taken on a semi-annual basis. Some showing evidence of mildew formation, while others remain clear . . . Still hopeful of renewing work on Correlation of Weathering Units.

New York

Sub-committees active on following projects: Color Computer Survey; Rheological Modifiers for High Solids Coatings; Silicone Additives for High Solids Polyester Melamine Coatings; and Defoamers for High Solids Coatings . . . An evaluation has been completed on "treated" zinc oxide, but is not scheduled to be reported. . . Other projects being developed are: Statistical Process Control Computer Program; Paint Odors; Room Temperature Crosslinking Systems; and Diluents for High Solids.

Northwestern

Continuing two projects. First is a study of water vapor transmission of a variety of coating types and comparison of various accelerated corrosion tests and outdoor exposure results. Work is focused on determining whether correlations exist among the tests that can be useful to the industry. A series of six types of coating materials applied to metal substrates have been evaluated with salt fog and humidity exposures as well as impedance measurements. Outdoor exposures are being conducted at three locations that include Florida, marine, and inland environments. The outdoor exposure results (one year) will be examined and results summarized. Planning to present results in paper at 1991 Annual Meeting . . . Second project is investigation of effect of acid rain on three coatings materials, being conducted jointly with Montreal Society. Work has progressed to a point where panels will have been exposed at two monitored locations in Canada and three in U.S. Some have been exposed for almost a year. Study includes pigmented and unpigmented films applied to metal substrates. An accelerated test chamber has been tested and procedures established to monitor the simulated acid rain composition. Formal panel exposure work is scheduled to begin this fall. Outdoor exposed and simulated acid rain exposed panels as well as Kesternich Cabinet sulfate exposed panels will be evaluated to determine whether chemical and/or physical changes can be detected. Investigations will include reflectance measurements, Fourier transform infrared attenuated total reflectance comparisons of the exposed surfaces, scanning electron microscope evaluations of the morphology and x-ray fluorescence analysis for sulfur with Kesternich Cabinet sulfate exposed panels.

Philadelphia

Committee under new Chairman. Two projects being developed. One is Knowledge-Based System for Coatings; second is Computer Formulation for Various Paint Systems . . . Third project is being initiated on Validity of ASTM D 2369-87 for Volatile Content Determination Used in Calculation of VOC of Certain High Solids Coatings; will involve round-robin testing by various labs.

Piedmont

In an attempt to revitalize interest and support, membership was surveyed for project suggestions. Survey yielded 21 proposed topics for study, mostly on wood finishing technology; these will be evaluated, and the top three selections submitted to the membership for final selection . . . Considering joint effort with Educational Committee to organize a technical conference.

Rocky Mountain

Study of Effects of Color on Surface Temperature is continuing. Test coatings have been prepared by local coatings manufacturer and delivered to Denver lab of a national company which has agreed to prepare, expose, and monitor the test panels. Panel preparation is scheduled to begin shortly. Substrates of particle board, steel, or aluminum, traditional pine, and possibly, masonry, will be used. One set of test panels will be with, and one without, insulation on the rear sides of the panels. Test colors include white, black, iron oxide yellow, and organic yellow. A minimum exposure period of one year is planned, which will be extended if the data acquired indicate that a longer exposure period is warranted. The temperatures of the fronts and backs of the panels will be checked at regular intervals. Color and gloss are scheduled to be checked before exposure, approximately half-way through the exposure period, and at the end of the exposure period. Photographs of the panels will be taken at the completion of the project.

St. Louis

Current study involving development and appraisal of a new method for the quantitative evaluation of flash rusting has made excellent progress. First phase is now complete. The new method utilizes the color computer to integrate color change of the panel, much like the human eye counts spots. This method is both user-independent and quantitative. First phase covered the method, reproducibility, and evaluation of several commercial additives which can be post-added to a formulation to reduce flash rusting. Second phase will upgrade the flash rusting procedure to improve the reproducibility of the degree of corrosion, and also evaluate anticorrosive pigments which must be ground into formulation. Second phase will also compare results obtained at different locations with various brands of color computers.

Southern

Attempting to revitalize project work. Geographical size of Society is an inhibiting factor . . . Surveying membership for project suggestions.

Toronto

Presenting a paper at the 1990 Annual Meeting on "Correlation of Hardness in Coating Films Using Koenig and Sward Pendulum Hardness Testers." This is an overview involving evaluation of five types of paint films applied to glass and cold rolled steel substrates. Coatings were tested at different thicknesses and under two drying conditions—bake and air-dry . . . Study of Mildewcides in Emulsion Paints and Their Effect on Paint Films on Exterior Exposures is still being monitored at various exposure sites . . . Planning paper for 1991 Annual Meeting on study of the heat aging and weathering behavior of basic coil coating polymers . . . Participation with the Montreal Society and the Vancouver Section of Pacific Northwest Society in literature search on coatings for plastics, with paper presentation scheduled for 1991 Annual Meeting . . . Recently formed sub-committee to develop a program for educating general public with regard to various aspects of paint application.

Open Forum

Various topics were suggested for project work, including: Development of a Lab Manual (which would include experiments, etc.); Production of videotape depicting Experiments, Applications, and Paint Manufacture, in conjunction with Educational Committee; Publishing of article/tract on "Why I'm a Paint Chemist," to promote image of industry.

Fred Anwari reported on a new OSHA rule covering laboratory safety that might have an impact on availability of company labs for project work.

On January 31, 1990 (55 FR 3300-3335) OSHA published final rule on Occupational Exposures to Hazardous Chemicals in Laboratories, which in essence requires covered laboratories to develop a chemical Hygiene Plan aimed at informing lab workers on workplace hazards, as well as medical and exposure monitoring.

OSHA intends that final rule apply to lab use of hazardous chemicals which meet following conditions: small quantities of chemicals are used on non-production basis; multiple chemical procedures or chemicals are used; procedures are not part of production process or do not simulate production process; protective lab practices and equipment are available and in use to minimize potential employee exposure.

There may be some paint laboratories which could be subject to the rule. National Paint and Coatings Association is preparing a Safety and Health Bulletin which addresses the ramifications of the OSHA rule.

Regulatory UPDATE

MARCH 1991

This digest of current regulatory activity pertinent to the coatings industry is published to inform readers of actions which could affect them and their firms, and is designed to provide sufficient data to enable those interested to seek additional information. Material is supplied by National Paint and Coatings Association, Washington, D.C.

Lead—Lead legislation has been introduced in both Houses of Congress. Sen. Harry Reid's (D-NV) Lead Exposure Reduction Act, S.391 has 11 co-sponsors and is expected to invite a lot of activity during the next few months. The legislation would restrict lead in paint (with an exemption for artists' paint), pesticides, plumbing (fitting and fixtures), toys, gasoline, food cans, and packagings. The U.S. Environmental Protection Agency (EPA), would be required to inventory all lead-containing products and devise recommendations for preventing future human exposure.

As an amendment to the Toxic Substances and Control Act (TSCA), the legislation would limit all paint and coatings products to no more than 0.06% lead by dry weight. The EPA may raise the proposed statutory threshold if "the higher level promotes the protection of human health and the environment, or if no comparable substitute is available at the time the regulations are promulgated." Further provisions include a labeling requirement for all lead-containing products indicating the presence and percentage of lead, and a research program to identify and develop more cost-effective lead-based paint abatement methods and strategies. The legislation also imposes strict penalties for companies or individuals found in violation—$25,000 fines for each day of violation and up to a year in federal prison.

In the House, Rep. James Scheuer (D-NY), has introduced H.R. 527, a lead research bill. The legislation allocates $13 million over a three-year period for research on laboratory analysis standardization, abatement and in-place management techniques, new abatement technologies, and abatement products. Additionally, there is a provision for a long-term study to establish the sources of lead exposure in children—be it paint chips, dust, food, drinking water, or soil. The research is to be conducted as a joint effort by the EPA, the Department of Housing and Urban Development, the Department of Defense, and the National Institute of Standards and Technology.

Solid Waste—Several solid waste bills have been introduced, many of which are product-specific, but no definitive action has been scheduled. Rep. Olympia Snowe (D-ME) has introduced H.R. 231, which sets national goals for the reduction and recycling of municipal solid waste. If the legislation becomes law, the U.S. would be recycling 25% of its waste by 1994.

A bill that may see some action, especially if it is debated separately from an RCRA package, is H.R. 173, sponsored by Rep. Jim Olin (D-VA). The legislation gives states authority to restrict the amount of out-of-state garbage that they receive, and to require states to develop a 20-year solid waste management plan. The issue was introduced last year in both Houses, and was fiercely opposed by Senators representing states (including New York, New Jersey, and North Carolina) that urgently need to export waste because of land fills that are already at maximum capacity.

Lender Liability—Several pieces of legislation are expected on lender liability under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

The late Rep. Silvio Conte (R-MA) introduced H.R. 293 early in January. The bill would protect federal agencies from liability when they foreclose on contaminated property. However, under another bill, H.R. 139, sponsored by Rep. Bob McEwen (R-OH), the federal government cannot force private parties to pay for part of the cleanup at a foreclosed contaminated property unless the government itself contributes to the cleanup.

Rep. McEwen also has another bill (H.R. 370) that requires the EPA to document each of its regulations as to the potential effect on small business.

Senate Committee Releases Priority Issues—In a letter to Senate Majority Leader George Mitchell (D-ME), the Chairman of the Environment and Public Works Committee, Quentin Burdick (D-ND), outlined the committee's priority issues for the 102nd Congress.

Although it is unlikely that any of these issues would reach the Senate floor until late in the first session, Mr. Burdick stated that the committee would focus on the reauthorization of the Federal-Aid Highway Program, the RCRA, and the Clean Water Act. Mr. Burdick said the highway bill could be reported sometime in the spring of 1991, while RCRA and the water bills will not be acted on until 1992. One issue that may be considered by the full Senate as early as March, is the Indoor Air Quality Act, authored by Sen. Mitchell.

Environmental Protection Agency
February 1, 1991—56 FR 4128
Registration and Agreement for TSCA Section 8(e) Compliance Audit Program
Action: Notice

The U.S. EPA has announced the opportunity to participate in its TSCA Section 8(e) Compliance Audit Program.

The Compliance Audit Program is voluntary and its purpose is to encourage companies to report outstanding "significant risk" information, as required under Section 8(e) of TSCA. In an effort to encourage voluntary compliance, EPA warned that companies that do not participate in the program, and have reportable information, will be actively pursued.

The registration period extends from February 1, 1991 to May 2, 1991. Interested parties must request a Compliance Audit Program (CAP) agreement and submit the signed CAP agreement to EPA before May 2. Copies of the CAP agreement can be obtained from the TSCA Assistance Information Service, Environmental Assistance Division (TS-799), Office of Toxic Substances, U.S. EPA, 401 M St., S.W., Washington, D.C. 20460, (202) 554-1404.

For further information, contact Michael M. Stahl, Director, Environmental Assistance Division at the above address and telephone number.

Notice: Superfund Report Released

The third of five reports to Congress on the progress of Superfund Implementation in FY89 has been released by EPA. The report is a documentation of EPA's activities regarding the cleanup of the country's worst hazardous waste sites. For further information, contact EPA's Doug Cameron (202) 382-4454.

Environmental Protection Agency
January 31, 1991—56 FR 3864
Land Disposal Restrictions for Third Scheduled Wastes
Action: Final Rule; technical amendment

The U.S. EPA has announced a technical amendment to correct errors and clarify the language of the regulations promulgating the congressionally-mandated prohibitions on land disposal of certain hazardous wastes. The final regulations were published in the Federal Register on July 1, 1990.

For further information, contact the RCRA Hotline at (800) 424-9346 or contact Rhonda Craig, Office of Solid Waste (05-320W), U.S. EPA, 401 M St., S.W., Washington, D.C. 20460, (703) 308-8462.

Environmental Protection Agency
January 11, 1991—55 FR 1154
Toxic Chemical Release Reporting; Community Right-to-Know; Sunset Provisions
Action: Proposed Rule

The U.S. EPA has announced an extended sunset provision to the rule that implements Section 313 of the Emergency Planning and Community Right-to-Know Act [40 CFR 372.30(e)]. A sunset provision typically lapses after a period of time unless specifically extended.

On the Section 313 reporting form, a range reporting option allows release of less than 1,000 lbs of chemicals to be reported within a specified range, as opposed to a specific number. This option will desist after the 1989 reporting year if no action is taken. The proposed rule leaves the option "as is," with only minor changes.

For further information, contact Anning Smith, Jr., Sunset Project Manager, Office of Toxic Substances (TS-779), U.S. EPA, 401 M St., S.W., Washington, D.C. 20460, (202) 382-3576 or the Emergency Planning and Community Right-to-Know Hotline, (800) 535-0202.

Environmental Protection Agency
January 22, 1991—56 FR 2420
Protection of Stratospheric Ozone
Action: Notice Listing Ozone-Depleting Chemicals

The U.S. EPA has published initial lists of ozone-depleting chemicals as designated under Section 602 of the Clean Air Act and as amended by the Clean Air Act Amendments of 1990.

Complying with requirements of Section 602, two lists of chemicals have been created. One list contains fully halogenated chlorofluorocarbons (CFC's), halons, carbon tetrachloride, and methylchloroform. Collectively, these chemicals are referred to as Class I substances. Class II substances, consisting of hydrochlorofluorocarbons (HCFC's), comprise the second list.

Each listed substance has an assigned numerical value that represents the substance's ozone-depletion potential (ODP), chlorine and bromine loading potentials, and atmospheric lifetime.

For further information, contact Daniel Blank, Program Analyst, Global Change Division, Office of Atmospheric and Indoor Air Programs, Office of Air and Radiation (ANR-445), U.S. EPA, 401 M St., S.W., Washington, D.C. 20460, (202) 475-8894.

States Proposed Legislation and Regulations

Alaska

Toxic Substances—H. 49 (Ulmer) amends the definition of slow-leaching TBT-based marine antifouling paint.

California

Air Quality—A. 157 (Roybal-Allard) and A. 264 (Roybal-Allard) authorizes an air pollution control officer to require specified information from a supplier of volatile organic compounds or chemical substances, and requires the supplier to disclose that information. It makes failure to comply a misdemeanor.

A. 187 (Tanner) provides that substances listed in recently enacted amendments to the Clean Air Act are toxic air contaminants. It requires the State Air Resources Board to compile and maintain a list of those substances.

A. 212 (Tanner) makes various findings and declarations relative to developing a plan for state action to determine risks posed by exposure to indoor air pollution.

A. 405 (Eaves) authorizes air pollution control districts and air quality management districts, with respect to mobile and stationary sources, to establish and implement a system to use emission reductions to offset future increases. It establishes a State Panel to develop guidelines for mobile source offset programs, which the State Air Resources Board will be required to adopt.

S. 84 (Torres) defines the term volatile organic compounds and requires a generator of these compounds to pay a surcharge to the Board of Equalization, at a rate set by the board to generate $20,000,000 per year. The money will be used to clean up or abate groundwater.

S. 124 (McCorquodale) creates the San Joaquin Valley Air Quality Management District to assume the functions of the county air pollution control districts in those counties on July 1, 1992.

CA. S. 251 (Roberti) enacts the Toxic Air Pollution Prevention Act of 1991. It requires specified facilities to prepare a pollution prevention audit and plan which would be submitted to the appropriate air pollution control district or air quality management district initially, and to conduct an audit and establish a plan every four years thereafter.

A CARB proposal revises three existing methods (421, 422, and 430) for determining air emissions from nonvehicular sources, to include new procedures for the determination of gaseous fluorides, 1,3-butadine, and acetaldehyde. For more information, contact George Lew, Monitoring and Laboratory Division, (916) 445-0657 or Public Information Office, (916) 322-2990, Air Resources Board, 1102 Q St., P.O. Box 2815, Sacramento, CA 95812.

Hazardous Waste—S. 194 (Torres) includes the collection of fees and taxes related to the handling of hazardous waste and substances within the Hazardous Substances Tax Law.

Household Hazardous Waste—A. 304 (Wright) imposes eligibility requirements on small quantity waste generators participating in a household hazardous waste program. It requires compliance with specified federal regulations and revises the definition of small quantity commercial sources.

Toxic Substances—S. 240 (Torres) requires the State Department of Health Services to establish and maintain an occupational lead poisoning prevention program. It further requires a fee to be assessed on those employers involved in industries which present a potential source of occupational lead poisoning.

Colorado

Criminal Law—H. 1057 (Prinster) establishes the abuse of toxic vapors as a crime and provides a penalty therefor. Defines "toxic vapors" and lists the substances which are toxic vapors.

Toxic Substances—H. 1205 (Jones) establishes a statewide goal to reduce use or generation of toxic or hazardous chemicals in Colorado. It requires large-quantity toxic or hazardous chemical users to prepare and file a toxic or hazardous chemical reduction plan which sets forth user's goals for reduction of use or generation of toxic or hazardous chemicals, and provides for the said plan to be updated biennially.

Connecticut

Household Hazardous Waste—H. 5427 (Farr) identifies permanent sites for the collection of household hazardous waste.

H. 6412 (Knopp) provides for the planning, siting, licensing, and operation of a regional household hazardous waste collection facility within the southwest regional planning agency's area.

H. 6420 (Knopp) provides for the creation of a system of regional collection facilities for household hazardous waste removal and for planning grants for the regional facilities.

H. 6455 (O'Rourke/Mushinsky) provides for a household hazardous materials shelf-labeling program at retail outlets which sell or offer for sale certain household products which may be hazardous when disposed of or used improperly.

Air Quality—H. 6451 (Langlois) authorizes the Environmental Protection Commissioner, through the air pollution control law, to regulate acid and toxic aerosols.

Toxic Substances—H. 5982 (Knowles/Schiessl) requires toxic household products to include a nontoxic bittering agent and to be packaged in child resistant safety closures.

H. 6022 (Smith) promotes a better environment through a coordinated approach to toxics use reduction.

H. 6629 (Smith) reduces the use of toxic substances in the state.

SARA—CT S. 150 (Spellman) imposes a per-ton tax on toxic chemical generators or treatment facility operators for toxic chemicals reportable under the federal Superfund Amendments and Reauthorization Act of 1986.

Georgia

Occupational Safety and Health—H. 217 (Brown) deletes provisions of the Public Employees Hazardous Chemical Protection and Right-to-Know Act of 1988 which requires the promulgation and review of the Georgia Hazardous Chemical List.

Hawaii

Household Hazardous Waste—H. 270 (Hiraki) makes an appropriation for the collection and disposal of household hazardous wastes.

H. 1080 (Bainum) relates to household hazardous substance recycling.

H. 1549 (Hiraki) relates to the development of coordinated county and state management of household hazardous waste; makes an appropriation for statewide collections of household hazardous waste.

Air Quality—S. 344 (McMurdo) relates to air pollution emission standards.

Illinois

Household Hazardous Waste—H. 114 (Novak) creates the Local Hazardous Waste Collection Program Act. Requires the EPA to formulate a pilot plan for the collection of small quantities of hazardous waste from households, farmers, and businesses in the state by March 1, 1992; requires the establishment of a statewide plan by March 1994.

Indiana

Household Hazardous Waste—H. 1311 (Lutz/Bosma) allows the Department of Environmental Management to provide matching grants to solid waste management districts and local units of government for projects involving the collection and disposal of household hazardous waste.

Iowa

Toxic Substances—H. 34 (Hanson) extends the duration of the lead abatement grant program.

H. 169 (Hatch) relates to the establishment of a toxics reduction program. It provides for the imposition of toxics user and source permit fees.

Air Quality—A proposed regulation by the Environmental Protection Commission adopts, by reference, recently promulgated federal regulations pertaining to new source performance standards and emission standards for hazardous air pollutants and includes, as facilities affected by these standards, additional source or pollutant categories. For more information, contact Supervisor, Air Quality Section, Department of Natural Resources, 900 East Grand Ave., Des Moines, IA 50319-0034.

Maryland

Toxic Substances—S. 444 (Miedusiewski) establishes that the mere presence of lead-based paint on interior, exterior, or other surfaces of residential premises is not deemed to be a violation of any warranties of habitability if such premises otherwise conform to the housing code standards of the applicable jurisdiction.

Massachusetts

Toxic Substances—H. 750 (Serra) establishes a fund to assist local housing authorities and owners of private property receiving federal or state rental subsidies to remove lead-based paint.

Household Hazardous Waste—S. 874 (Keating/Kafka) relates to household hazardous waste.

Michigan

Occupational Safety and Health—The Department of Public Health/Occupational Health Standards Commission has proposed a regulation concerning occupational health rules for hazardous work in laboratories. For more information, contact the Division of Occupational Health, Bureau of Environmental and Occupational Health, Department of Public Health, 3423 North Logan St., P.O. Box 30195, Lansing, MI 48909, (517) 335-8238.

Minnesota

Air Quality—H. 160 (Munger) appropriates funds to the Pollution Control Agency to establish a statewide monitoring system for toxic air pollutants and an inventory of emission sources or probable sources of listed toxic air pollutants and, by January 1, 1993, a list of toxic air pollutants.

Mississippi

Household Hazardous Waste—H. 908 (Hanson) provides for the proper collection and disposal of household hazardous waste; authorizes the Department of Environmental Quality to administer the program.

Right-To-Know—S. 2856 (Hall) creates the Mississippi Emergency Planning and Community Right-To-Know Act, creates the Mississippi Emergency Response Commission, provides for local emergency planning committees, prescribes the powers and duties of the Commission on Environmental Quality and the Director of the Emergency Management Agency.

Missouri

Right-To-Know—S. 345 (Quick) relates to emergency planning and community right to know.

Montana

Hazardous Waste—The Department of Health and Environmental Sciences has proposed a regulation defining the terms large generator, small generator, and conditionally exempt small generator of hazardous waste. For more information, contact Roger Thorvilson, Department of Health and Environmental Sciences, Cogswell Building, Capitol Station, Helena, MT 59620.

New Hampshire

Household Hazardous Waste—S. 186 (Hollingworth/Cohen) establishes the Rockingham County Household Hazardous Waste Cleanup Day and requires the Rockingham County commissions to convene a meeting of municipal officials to prepare a plan for the cleanup day.

New Jersey

Toxic Substances—NJ S. 2220 (Dalton) establishes a regulatory program in the Department of Environmental Protection designed to prevent pollution through the reduction in the use and discharge of hazardous substances. It establishes a statewide goal of 50% reduction over five years in the use of hazardous substances, in the discharge of hazardous substances into the air and water, and in the generation of hazardous waste.

New Mexico

Air Quality—The Department of Health and Environment has proposed a regulation incorporating by reference the Federal Standards of Performance for New Stationary Sources and National Emissions Standards for Hazardous Air Pollutants. The comment deadline is March 29, 1991. For more information, contact Albion Carlson, Air Quality Bureau Environmental Scientist, 1190 St. Francis Dr., Rm. S-2100, Santa Fe, NM, (505) 827-0046.

New York

Toxic Substances—A. 1615 (Parola) enacts the Children's Poison Protection Act which requires toxic household products to contain a concentration of a bittering agent sufficient to render the product adversely bitter.

A. 1766 (Catapano) directs the Commission of Health to establish a statewide program for the prevention and early diagnosis of lead poisoning in children under six years of age. It requires physicians to report positive diagnosis on such children to the Commissioner. It requires public education programs on lead poisoning.

A. 2548 (Lentol/Eve) Same as S.1582. It requires testing, by the Department of Health, of every playground and school for the presence of lead.

S. 1256 (Quattrociocchi) provides that school districts shall purchase for use in grades kindergarten through six only those art supplies certified by the Commissioner of the Department of Health as being nontoxic. School districts may purchase art supplies certified by the Commissioner of the Department of Health as being nontoxic. School districts may purchase art supplies containing chronically toxic substances or ingredients which are human carcinogens or potential human carcinogens only if such art supplies are suitably labeled and contain warnings such as: WARNING; CANCER HAZARD! Overexposure may create cancer risk.

S. 1582 (Smith) requires testing, by the Department of Health, of every playground and school for the presence of lead.

Hazardous Waste—A. 1794 (Hinchey) provides the State Department of Environmental Conservation with additional authority and means to undertake background reviews of those engaged, or about to be engaged, in the management, generation, collection, storage, transportation, or disposal of solid, industrial-commercial, regulated, or hazardous wastes.

S. 1463 (Daly) Same as A. 2860 and S. 1812. The Department of Environmental Conservation is directed to establish an education and compliance program to provide information and assistance to generators of small quantities of hazardous waste to assist them in complying with governmental regulations.

Occupational Safety and Health—NY A. 1984 (Barbaro/Mayersohn) mandates the contents of signs to be posted in each workplace where toxic materials are found and directs the Department of Health to develop posters and information sheets for this purpose.

Criminal Law—A. 2206 (Parola) provides that a person is guilty of possession of graffiti implements when he possesses any tool, instrument, article, substance, solution, or other compound designed or commonly used to etch, paint, cover, draw upon, or otherwise mark, without permission or authority.

NY S. 1592 (Padavan) imposes criminal sanctions upon persons who deface public or private property by means of aerosol paint cans.

North Dakota

Criminal Law—A. 1133 (Committee on Judiciary) prohibits the inhalation of vapors of certain volatile chemicals.

Oregon

Right-To-Know—This rule, simultaneously proposed for permanent adoption, supports the Federal and state mandated Community Right-to-Know Program and the state mandated Toxic Use Reduction and Orphan Site Clean-Up Programs. For more information, contact Ralph M. Rodia, Office of State Fire Marshal, 3000 Market St., N.E., Ste. 534, Salem, OR 97310, (503) 378-2885.

Hazardous Waste—S. 241 (Office of Budget) increases fee for disposal of hazardous waste; distributes two-thirds of fees collected to hazardous waste cleanup activities and one-third to Department of Environmental Quality for hazardous waste reduction and management activities.

A proposed rule concerns land disposal restrictions, hazardous waste manifests, toxicity characteristic evaluation, closure of hazardous waste management facilities, and hazardous waste listings. For more information, contact Gary Calaba, Department of Environmental Quality, Hazardous and Solid Waste Division, 811 S.W. 6th Ave., Portland, OR 97204, (503) 229-5913.

Pennsylvania

Toxic Substances—H. 81 (Laughlin) provides for the establishment of a Lead Poisoning Program in the Department of Health. It imposes a tax on the sale or use of paint.

PA S. 55 (Holl) establishes a lead poisoning control program, provides for the powers and duties of the Department of Health with respect to lead poisoning control, and requires reports of cases of lead poisoning.

Rhode Island

Toxic Substances—H. 5318 (Marrapese) this Joint Resolution creates a special legislative committee to study the health hazards posed by the dispersal of lead particles by commercial removal of the lead-based paints from buildings and the feasibility of regulation of commercial paint removal activities.

South Carolina

Right-To-Know—H. 3089 (Rogers) enacts the Hazardous Chemicals Right-to-Know Act.

Utah

Household Hazardous Waste—S. 86 (Steele) establishes a task force to study ways to encourage proper disposal of household hazardous waste; directs the efforts of the task force.

Vermont

Hazardous Waste—H. 39 (O'Brien) proposes to provide that waste oil and discarded paint, paint thinner, and paint remover, and their respective containers, shall not be considered hazardous waste for purposes of their being transported. Prohibits landfilling of paint, paint thinners, paint remover, and their respective containers.

Washington

Occupational Safety and Health—S. 5244 (Talmadge/Conner) provides workers with notice of hazardous substances found on the job. Requires current and prospective employees to be informed of any chemicals, toxic substances, radioactive materials, or other substances which the employer has reasonable cause to believe will cause birth defects or constitute a hazard to an individual's reproductive system.

West Virginia

Air Quality—S. 273 (Wooton) authorizes the Air Pollution Control Commission to promulgate legislative rules relating to control of air pollution from volatile organic compounds.

MODERN ANALYTICAL RESOURCES: THE PAINT CHEMIST'S ALLY

A Condensed Summary of the Presentations at a Seminar Presented by the Professional Development Committee, Federation of Societies for Coatings Technology Los Angeles, May 16-17, 1989

INTRODUCTION by the Editor of the Summary

During the past couple of decades, the problem-solving power of modern analytical theory, instrumentation and techniques has increased enormously to an extent measurable in some fields by orders of magnitude. But how much of this analytical power is available to the chemists in the laboratories of small and medium sized coatings manufacturers? Indeed, how much do many of these chemists, skilled as they are in the science and art of formulation, know about these instruments and techniques, and their power to help in the solution of problems?

These questions inspired the Professional Development Committee to organize a seminar that was presented during the Federation's Spring Week in Los Angeles in 1989. Six lecturers of exceptional professional competence and breadth of experience were selected for their ability to review this field from the viewpoint of working chemists in the coatings industry, rather than the interests of specialists in analytical chemistry. The key points in their presentations are summarized here from the tapes of the proceedings. The Professional Development Committee was gratified to see that written comments on the proceedings, submitted anonymously by those who attended the sessions, were overwhelmingly favorable.

The presentations by the speakers were given in the conversational style that can be managed only by true experts, not as set pieces. With the constraints imposed by space limitations in this JOURNAL, the task of the editor in choosing what to omit in a summary was formidable, because everything in each presentation was so interesting.

In addition to imparting the information that was given, the objective of the seminar was to make it clear that it is not necessary to own all the costly equipment that was discussed, nor to employ the specialists who know how to use that equipment and interpret the results; analytical services are available from highly reputable and experienced laboratories. The money that they can save in comparison with the use of hit-or-miss attempts to solve problems can return the cost of their services many times over in coping with potentially costly complaints that defy solution by rule of thumb.

The Committee acknowledges the contributions of the lecturers with sincere gratitude on behalf of the Federation.

Sid Lauren, *Editor*
For the Professional Development Committee

PLENARY SPEAKER: **Dr. Clifford K. Schoff, Scientist**
PPG Industries, Inc.
Allison Park, PA

The Philosophy of Problem-Solving In Coatings Science and Technology

The keys to successful problem-solving are to observe carefully; define the problem; attempt to determine causes; make some selected experiments to test hypotheses, *then* strive for a solution. Don't start out by first trying to solve the problem.

Looking and thinking are the paths to successful problem-solving. Despite the proliferation of modern analytical instruments, the eyes and the mind still remain the best instruments we'll ever have—if we use them right. When confronted with a situation in which an instrument tells them one thing, and their eyes clearly tell them something different, too many people follow the instrument. Don't neglect your senses, and your own ability to think things out. Don't put total faith in "black boxes"—they have their limitations. The optical microscope remains one of the most trustworthy and versatile of all instruments, and they are too inexpensive for anyone to be without one.

Characterize the problem; identify it; determine its cause. Use the library and coatings literature (don't overlook the public library). Consult past issues of the JOURNAL OF COATINGS TECHNOLOGY, the JOURNAL OF PAINT TECHNOLOGY, and the old *Official* DIGEST. They are a mine of information. While some academics tend to discount developments less recent than 10 years, in the field of coatings technology, literature in the cited journals dating back as far as 25 years can yield useful clues to the solution of modern problems. Don't try to reinvent the wheel if there is anything in the literature that can help you solve the problem.

Discuss the problem with others. You may discover that an associate has encountered and solved a similar problem; at least, interchange of ideas can be helpful in suggesting new approaches.

Think of solutions and test them. Keep careful records of trials and results. If company policy permits, write for publication, not only for personal satisfaction and prestige, but for the company's own benefit. People, including one's own associates, tend to put more credence in information that has been published. By all means, try to avoid having to re-solve old problems that have been solved before.

Most frequently encountered problems include the following: Flow problems, problems associated with atomization, misting, leveling, and dry spray. Craters, pinholes, crawling, dewetting, and popping. Color problems. Dry and cure. Adhesion. Blistering. Water spotting. Sensitivity to scratches. Bloom and haze.

Identification of defects. Keep a 7-10 power hand lens handy (or a 30-power pocket microscope with a self-contained light). Document the problem by photographing it, if possible, and keep easily retrievable records. Retain samples of paint chips, etc.

Light microscopy is the "most important analytical technique of all—bar none." It is unbeatable for helping to define a problem involving paints and substrates. Many defects cannot be identified by the naked eye. (For example, pinholes, craters, and pops often look the same until they are observed under the microscope.) Of course, use a scanning electron microscope (SEM) if one is available.

Determining possible causes of coating defects. Consider the paint and the painting process. Photograph the process (if possible and if permitted). Check ovens, cleaning, pre-treatment, and rinsing. Examine the substrates. Check your own plant for clues to possible defects in the paint. Use these techniques and facilities:

Chemical identification of contaminants.

Examine the paint itself—resins, pigments, solvents, additives.

Use SEM with X-ray attachment, if available.

Use FTIR, GC/LC, GPC, X-ray diffraction.

Use wet chemical methods (still useful).

Try to re-create the defects (on customer's substrate).

A few of the most useful, less expensive instruments:

- For rheological measurements, the Brookfield cone & plate viscometer. It has a relatively small shear rate range, which can be extended by relaxation techniques. The ICI cone & plate viscometer is useful for high shear rate, is unbeatably easy to clean up, and has self-contained temperature control.
- Zahn cups and Ford cups are crude instruments, but they have to be used because that's what many customers use.
- The light microscope (with polarized light capability, if possible). *The* indispensable instrument. Its usefulness in rheology comes from what it can show of the state of dispersion of pigments.

"Be a detective—use your eyes." Examples of helpful information obtained by careful observation: (1) dripping of contaminants from an overhead pipe onto a wet car after a power wash; (2) dropping of corrosion particles onto wet paint from corroded parts in an oven; and (3) drops of polymerized particles of low molecular weight resin distillates from overhead parts in an oven.

Obtain samples of the customer's substrate and work with them, instead of only with ideal panels. If you are involved with EDP coatings, obtain or put together a small scale test apparatus—about one liter. It is easier to use than a much larger apparatus, and is cheaper and easier to run. Use an oven with a window, so you can see what's happening to a film during a bake. If at all possible, make a videotape of what's happening, so you can see it again and again without having to repeat the test. Use hot plate bakes.

The speaker gave this list of things to use and things to keep:

The "Use"s

Use your eyes—look!

Use the library, literature.

Use your experience (keep a file of problems and solutions).

Use your colleagues' experience and knowledge. Don't be afraid to ask questions!

Use your hunches and intuition.

Use your head—think.

The "Keep"s

Keep at it.

Keep communicating (with tech service, sales people).

Keep thinking.

Keep your sense of humor and proportion.

The speaker had these remarks to make on the "triage" system:

There are three basic types of problems:

(1) Problems that *you* can solve.

(2) Problems that will be solved by others, whether you work on them or not.

(3) Problems that are unsolvable by you or anyone else at this time. Try to avoid working on problems in categories (2) and (3), if you can; concentrate your effort and skills on problems in category (1).

CONCLUSIONS

(1) If there can be any doubt, make sure that the paint which is the subject of a complaint is indeed your company's paint.

(2) Identify the problem, determine its cause, then attack it and solve it.

(3) Many tools are useful in characterizing problems, but light microscopy is the most valuable one of all. Learn to use it.

(4) Make use of the coatings literature. Avoid trying to solve a problem that has already been solved.

(5) Above all—*OBSERVE* and *THINK*.

"Common sense is one of the most uncommon things around these days."

Analysis of Small Samples and Particulates

Dr. Robert Z. Muggli, Senior Research Associate*
McCrone Associates, Westmont, IL

Dr. Muggli agreed completely on the importance of the light microscope as a basic tool for problem-solving, and on the usefulness of a pocket magnifier of some type. If a sample is brought from 10 to 15 inches, the normal viewing distance, to within a few inches of the eye (assuming that you have proper eye correction for near vision, if correction is necessary), you have magnified the object two or three times, so you have used a "microscope." A lab stereo microscope is particularly useful in particle handling and for identification of some materials.

At McCrone Associates, the philosophy is that most samples are "large" samples and usually one can work with just a small part of them—as long as one can be sure that the small sample is truly representative of the whole material. A stereo microscope can help to confirm this by showing whether the material is homogeneous or heterogeneous. If it is heterogeneous, one can carefully select a small sample of each phase for separate identification, a more useful procedure than the examination of the entire heterogeneous sample at one time. To supplement the

* Dr. Muggli is now retired.

stereo microscope, a polarized light microscope and a photomicrographic setup are used.

[*Editor's note: Photomacrography* provides photographs at magnifications of about 5X to 50X. The image on film is larger than the original sample. *Photomicrography* is photography through the microscope. *Macrophotography* is the making of large photographs (such as wall murals); enlargement results from the projection of the image that is on the film. *Microphotography* is the making of photographs in which the image is *very* much smaller than the original object, as in the production of microfilms.]

Dr. Muggli displayed slides showing how a bit of a single synthetic fiber could be distinguished from a similar tiny sample of a natural fiber by the use of a polarized light microscope. Another slide showed how the refractive index of a single particle of a solid, suspended in a series of nonsolvent liquids of different refractive indices, could be determined—an important distinguishing difference among substances.

Morphological analysis is another useful technique for identifying materials. The combination of color, shape, crystal faces, habit, birefrigence, structure, etc., are all unique properties of any solid. The properties of birefrigence and shape, visible through a polarized light microscope, was shown to be useful in distinguishing among particles of three forms of silicon oxide: quartz, opal (glass) and fumed silica, and diatomaceous earth. Although these forms are chemically identical, they are much different physically. Only the quartz is birefringent (showing varying brightness at different angles between crossed polars on a polarized light microscope). Diatomaceous silica, another form of silicon oxide, has a unique, identifiable structure.

In mixtures of particles, such as paint pigments, particles may be separated by particle manipulation. A useful tool for particle manipulation is a bit of tungsten wire sharpened to an ultra-fine point. An ultra-sharp tip can be produced by heating the tungsten wire to red heat and dragging it through sodium nitrite (not nitrate) melted on a Meker burner grid; alternatively, the wire may be etched electrolytically in a solution of 10% KOH. The sharpened tungsten wire is mounted in an aluminum holder for use. It was noted that a micromanipulator is "too crude and too coarse" to obtain good particle separations, in comparison with the skilled human hand. Other useful tools for particle separation are tweezers, razor blades, pieces of polyethylene tubing heated and drawn out to very fine points, rubber cement, collodion (which can be dissolved for removal), amyl acetate, and particle-free water—all the separation procedures being done, of course, under a microscope. A series of slides showed how particles as small as a couple of micrometers in diameter could be separated with appropriate procedures.

For examination by a transmission electron microscope (TEM), it is possible to image particles one has never seen by embedding the particles in collodion, transferring them to a TEM grid, and then washing away the collodion with a solvent. The appropriate area of the grid is examined with the TEM.

Fine separation of particles in a paint—whether the particles are part of the paint or foreign particles—can often be accomplished by dilution of the paint and placing a drop or two on a filter. Reflected illumination from the front lens of a stereo microscope focuses the light precisely on the sample.

One interesting example of the use of techniques of particle identification by morphology involved the examination of a statue of Zeus for authenticity. The patina on the copper statue looked authentic. Tiny bits of the patina, picked off and examined with a polarized light microscope, showed crystals of malachite (copper hydroxy carbonate) which forms naturally on copper exposed to the weather. However, the crystals were seen to be mixed with a glue, and the crystals were fractured by grinding, rather than the way they would be if they were formed naturally. The conclusion was that the crystals had been ground into the glue (hence the fractured edges), and the composition applied as a coating to the surface.

Another paint-related detective assignment involved a high-speed turbine that disintegrated the first time it was started. Since some tiny black paint chips were found among the shattered parts, it was assumed that the installers had left a file, with a black-painted handle, in the turbine. Analysis of one of the tiny chips and comparison with the composition of the black paint on a file in possession of the installers showed that the paints were not identical. The black paint chips were matched to black paint on a component of the turbine. Ultimately, it was determined that the turbine was out of balance when it was started. The installers were thus exonerated.

If a sample has not been identified by the morphological analysis, additional information is then needed. When combined with the morphological data, elemental analysis will often allow identification of the sample. Techniques for elemental analysis illustrate the "principle" that the smaller the sample, the more expensive the instrument.

The electron microprobe is basically an SEM optimized for response to X-rays. In addition to an energy dispersive detector, there are a series of spectrometers, each of which can be tuned to specific X-ray wavelengths relating to specific elements that are present in the sample. This instrument is much more efficient than the "old" type of SEM. At this point, the SEM and the electron microprobe are merging into a single instrument. The sample holder is a beryllium block, because the instrument does not detect the first four elements in the periodic table. Beryllium is one of those elements, hence it does not contribute any "background."

When morphological and elemental data are not sufficient to yield an identification, additional information, such as vibrational spectra, often yield an identity. This is especially true if the material is organic. In that case, elemental information is usually of little value. It was shown to be easy to distinguish among a group of yellow pigments by the use of Raman spectroscopy, applicable to very small samples. Infrared spectroscopy is also a very important tool for obtaining molecular information. Another instrument used for analysis of very small samples is the powder diffraction camera.

In the use of all of these techniques for small sample identification, it is important for the analyst to be able to "think small."

Use of Modern Analytical Techniques in the Paint Laboratory

James M. Julian, Jr., Senior Research Associate
DSM Desotech Inc., Des Plaines, IL

Nearly all modern analytical instruments are coupled to computers which control the instruments, collect, store and retrieve the data, perform calculations and data-smoothing, retrieve data upon command, and do reference searching (if appropriate data bases are included). Microprocessor controls have enhanced the precision of replicated tests and increased the rate of sample throughput—both of the latter contributing to the efficiency of quality control programs.

Wet chemistry analytical procedures are still useful for many problems, despite the proliferation of all-instrumental methods. Spot tests are essentially obsolete, although they remain useful for some special tasks, such as the detection of cellulosics.

VOC, solids and ash determinations, and Karl Fischer moisture determinations are among the modern wet chemical methods. The Karl Fischer test for moisture in solvents used in reactive urethanes is especially important.

Functional group determinations such as those for acid, OH and amine value, and epoxy and isocyanate groups are tests that are performed with great frequency. Microprocessor-controlled potentiometric titrations have replaced the classical burettes. Such titrations are used for quality control, raw material evaluations, in-process checks on polymerizations (such as urethane reactions), and for problem-solving. Nitrogen determinations by Kjeldahl are now performed with more standardized equipment and techniques, replacing methods that used to require a high level of personal skill.

Specific ion electrode analysis is used for determination of chloride, bromide, cyanide, sulfate, nitrate, and some metals like lead and iron. The method is sensitive to parts per million; it is especially useful for checking chloride ion concentration, which is deleterious to electrocoat systems.

Colorimetry involves the addition of a specific reagent to a sample, to form a color complex with a specific ion or functionality, or occasionally with a specific chemical. The measured intensity of the color reveals the concentration. Sensitivity is in low parts per million—in some cases, as with formaldehyde, in parts per billion. The tests can be run with speed and high precision.

Atomic absorption spectroscopy (AA) is used for determination of metals. The sample has to be put into an aqueous solution, by digestion if necessary. Where high percentages of metals are present such as in pigments, in comparison with driers, a high degree of dilution is necessary, because AA is a very sensitive method. It is useful for detecting metals in waste waters, and is the method preferred by EPA. Extra sensitivity for extremely low concentrations is added by use of a graphite furnace or a hydride generator; the extra sensitivity can be vital if the need arises to detect minute amounts of lead or mercury in paint chips. There are times when tests of this kind have legal implications. AA will detect about 68 different elements; of course, not all of them are relevant to coatings technology.

An alternative to AA is inductively coupled argon plasma spectroscopy (ICAP). The advantage over AA is that one can look at all elements simultaneously, but it has not yet been adopted by EPA for determination of toxic metals.

Chromatography, a separation technique, is used in the form of gas, liquid (HPLC), and gel permeation chromatography (GPC). In gas chromatography, the sample is introduced into a column which separates the components and identifies them as they exit the column after varying times. The retention time, which is plotted by a recorder, identifies the material, while the area under the curve is a quantitative measure of its concentration. For materials with molecular weights below 400-500, gas chromatography is used; for higher molecular weights, the HPLC method is preferred. At even higher molecular weights, such as those typical of some binder components, a size exclusion column is used in the GPC technique, making it suitable for molecular weights as high as 10 million.

In addition to its capability in identifying solvents in mixtures, gas chromatography is useful for determining the amounts of residual monomers, such as vinyl acetate and acrylates, in latex polymers, and glycols and coalescents in latex paints. The identity of gases in the head spaces of bulging cans can be determined with appropriate sampling techniques; so can the amount of retained solvent in coated panels subjected to normal drying schedules. This latter test can be extremely important for interior coatings in food cans, where it is vital to recommend, and achieve, full cure and complete elimination of solvents.

Gas chromatography can identify the monomers in acrylic polymers after pyrolysis of the polymer. By hydrolysis of ester-type condensation polymers, the polyols and polybasic acids in polyesters can be identified; the fatty acids in alkyds can also be identified. The solvents trapped in activated charcoal-filled air sampling tubes can be desorbed and analyzed by gas chromatography.

GPC is useful for determining average molecular weights and molecular weight distributions of polymers. It can also check on the uniformity of polymers from batch to batch, and can distinguish between copolymers and blends of polymers.

Infrared spectroscopy is used mostly for qualitative analysis, or identification—the so-called "chemical fingerprint." It identifies the presence of functional groups, and is sensitive enough to show the difference between, for example, orthophthalic and isophthalic polyesters. Pigments, as well as polymers, can be identified. The abundant availability of reference spectra of a broad range of materials adds to the power of this analytical method.

Attenuated total reflectance (ATR) IR spectroscopy is particularly effective for analysis for coatings on metals and some other surfaces, and for free films of polymers. For example, with paint chips consisting of a primer and topcoat, the ATR technique can identify both coatings by analysis of the top and bottom surfaces.

The diffuse reflectance technique copes effectively with problems of strong interference with polymer identification, as in the case of magnetic tape coatings containing high concentrations of iron oxide.

The speaker was asked this question: Have you ever seen identical or nearly identical IR results for different coatings? The answer was, Yes. With an isopolyester/melamine, and an epoxy, nearly identical results were obtained because of the near-similarity of the polymers.

Analysis by X-Ray Methods

James F. Ficca, Jr., President
Micron, Inc., Wilmington, DE

Mr. Ficca reviewed the capabilities of the various types of analytical instruments for characterizing the morphology, chemistry, and structure of materials. The light microscope can resolve objects down to about 2000 A in size; the scanning electron microscope (SEM) down to about 50 A, and the transmission electron microscope (TEM) down to about 4 A.

To characterize the chemistry of materials, Mr. Ficca's laboratory uses X-ray fluorescence and optical emission spectroscopy on bulk samples; for microanalysis, the SEM with energy dispersive X-ray, or the electron microprobe, with wavelength dispersive X-ray capability. For very thin films, electron spectroscopy for chemical analysis (ESCA) is used. X-ray diffraction is used for bulk analysis of crystalline materials, and selected area electron diffraction is used for characterizing the crystal structure of micron-sized materials.

Mr. Ficca concentrated on the methods that use electrons and/or X-rays for characterizing the structure of materials: principally the SEM with energy dispersive capability; the electron microprobe with wavelength dispersive capability; X-ray diffraction; and ESCA.

Electron Excitation of X-Rays

When a high energy electron beam strikes a solid sample, it knocks an electron out of one of the inner shells of an atom; then, in accordance with the principle of the conservation of energy, one of the electrons from an adjacent atom will drop into the vacancy, and will give up energy in the form of an X-ray photon. This photon has two characteristics that permit identification of the atom which is the source of the photon: a specific energy equal to the difference of energy between the two shells, and a specific wavelength. Thus, there are two means to identify the source atom: by detection and measurement of either the energy or the wavelength. Examples were shown of how these phenomena could be used to distinguish between titanium and calcium.

In both energy dispersive and wavelength dispersive X-ray analysis, there are several different modes for acquisition of data. The spectral scan yields a general qualitative elements identification, with a rough indication of concentration. The area scan involves scanning the electron beam in a raster pattern, with selective analysis of the specific element of interest. The line scan mode traverses the electron beam along a given line on the sample, to yield information on the specific element that is of interest. This technique is more sensitive to small variations in concentration. With use of appropriate standards, quantitative analysis accurate to within 2-3% absolute can be achieved. The use of these methods for the analysis of the individual layers in a five-layer paint film was shown.

X-ray diffraction is used for identification of crystalline compounds. X-ray diffractometer or the powder camera methods are employed. The distances between the diffraction lines are measured and compared with data in published tables to obtain an identification of the crystalline components.

ESCA provides a means for doing chemical analysis on very thin films, in the range of 25-50 Angstroms, with the capability of detecting all elements in the periodic table except hydrogen and helium. Valence and oxidation states are also revealed. A coatings-related application of ESCA that was cited as an example involved determination of the thickness of a wax film on an automotive enamel.

The size of latex polymer particles can be determined with an image analysis system using either a scanning electron microscope or a transmission electron microscope, depending upon the particle size. For topographical information, the SEM is the preferred instrument because the electrons are reflected off the surface of the objects being examined. In films where the presence of two polymer phases is suspected, the TEM, with which electrons pass through the material, is the instrument of choice, since it would reveal the presence of the two phases.

Solving Practical Coatings Problems—I.

Richard M. Holsworth, Senior Scientist
The Glidden Co./ICI, Strongsville, OH

Mr. Holsworth reviewed the approaches taken in the investigation and solution of a number of typical coatings performance problems, and the instruments, methods, and techniques that were used to solve them.

The experiences of many coatings chemists were expressed in these simple equations:

Polymers + Pigment = Paint
Paint + People = Problems

Almost every problem involving paint film defects is attacked first with the light microscope; many problems related to film thickness are solved this way at the outset. Film thickness is measured; pigment dispersion can be observed, and these observations compared to results obtained by rheology studies. Identification of suspected contaminants is done with IR.

The first example cited was a field problem involving loss of adhesion of paint on hardboard. The failure was suspected to be the result of wax bleed from the board; wax was known to be used as a water repellent in the composition of this construction material. When the expected wax failed to melt on a hot stage under a microscope at the upper temperature limit of the stage, which was above the melting point of any commercial wax, it seemed more likely that the culprit was a release agent transferred from the press plates. The release agent was found by IR to be a fluorine terpolymer, and when its use was abandoned, the problem went away.

In the case of a coating that was failing on aluminum siding, analysis showed conclusively that the paint was someone else's product, so the "problem" was found to be someone else's problem. This showed the wisdom of the first question to be asked in many situations: Is this our paint? Although the equipment that can answer this question is expensive, payment for unfounded complaints is also expensive, as well as unjustifiably damaging to reputation.

Another example cited the use of an X-ray dispersive unit for an SEM to solve another aluminum siding complaint. The SEM/X-ray test showed inadequate and nonuniform metal pretreatment, a finding that was then confirmed by the customer's own laboratory, but only after it had been pointed out by the manufacturer of the coating. In this case, the cost of the X-ray dispersive unit was recovered in one stroke.

A manufacturer of household appliances complained that a coating being supplied had inadequate corrosion resistance. The steel had a calcium zinc phosphate pretreatment. Examination of a well pretreated steel coupon showed tightly packed, uniform phosphate crystals, but the pretreatment on a sample of the steel being used in the process was found by SEM to exhibit much larger phosphate crystals, with many voids. The voids were the points at which attack began when the panels were scribed and exposed to the corrosion test.

It is being observed that the continuing growth of the metal recycling movement is often yielding can stock of lesser quality, so more attention is being given to the substrate in instances of complaints.

A source of pinpoint corrosion in steel cans is foam in the applied interior coating. If the coating doesn't level over a broken foam bubble, the contained product, especially if it is a carbonated beverage, will cause corrosion puncture of the can.

When seamless aluminum beverage cans are deep drawn, the die lubricant that has to be used is removed by a vigorous washing process to avoid dewetting of the applied coating by traces of the lubricant. Nevertheless, occasional failures do occur as a result of imperfections in the washing process. In these cases, traces of residual die lubricants can be detected by FTIR.

A tank car shipment of a can coating brought a complaint of extreme dewetting when the application of the coating was begun. Tests on the retain and on the contents of the shipment were negative. When the cleanliness of the procedure for transfer of the contents of the tank car was questioned, assurance was given that a brand new flexible hose was used. This response flashed a red light in the mind of the questioner, so a sample of new hose of the same type was obtained. When a sample of the coating which had passed all tests was sloshed through a section of the new hose, the same dewetting phenomenon showed up. The cause was found to be residual silicone release agent used in the manufacture of the hose.

In another instance, cans returned for test by the analytical laboratory showed puzzling traces of sodium and some other elements that were not supposed to be there. This phenomenon was traced to poor handling of the cans, which someone had picked up and held by fingers inserted into the can bodies. The moral is: Use care in handling complaint samples, lest you leave your own tracks—modern analytical techniques are that sensitive.

An interesting problem in the trade sales paint area involved the appearance of seeds in an alkyd-containing water dilutible paint. By AA analysis, the seeds were found to contain calcium and zirconium, along with phosphorous from a phosphate dispersant. Calcium and zirconium were, in fact, used as driers in this formulation. The problem was solved not by a change in the various ingredients, but by a change in the order in which they were added to the batch.

The speaker showed a brief time lapse motion picture film showing the start and progress of filiform corrosion under a clear film on an untreated steel surface. The clear coating had some intentionally introduced film imperfections (salt crystal inclusions), and the panel was exposed to high (75%) relative humidity. The film showed the progress of filiform corrosion under these conditions. When the RH was reduced to 30%, the corrosion stopped. A process like this, occurring in a very humid atmosphere, has been seen to start at film imperfections such as gel particles, which present points for entry of moisture.

In summary, Mr. Holsworth counseled patience in approaches to problems. As he put it, "Don't worry and don't hurry, because it's better to be late at the Golden Gate than to get into Hell on time."

Solving Practical Coatings Problems—II.

Dr. A. Monroe Snider, Senior Research Associate
PPG Industries, Inc., Harmarville, PA

Dr. Snider presented a series of cases describing how analytical techniques were used as tools for solving some coatings problems, with the assistance of reasoning and intuition.

The first task is to define the problem. Preliminary discussion with those who present a problem to the analytical lab often shows that the problem is not really what those who present it think it is. The more complex the problem, the more diligent should be the search for background information. Samples of presumed defective materials—whether of coatings, coatings raw materials, substrates, or all of these—should be supplemented with samples of known good materials in these categories, for A-B comparisons.

One should try to formulate a working hypothesis as early as possible on what factors could possibly have caused the problem performance. This is helpful in focusing one's effort. The real skill in problem-solving is in use of the minimum number of factors that can either verify or invalidate the working hypothesis. This procedure is very much to be preferred to the "shotgun" approach. When the problem seems too complex to yield a working hypothesis, a stronger effort should be made to clarify the differences between the good and bad samples. Modern analytical methods are bound to show significant differences between good and bad samples, but it is important to be discriminating in recognizing differences that are irrelevant to the problem. Complaint samples returned from the field and a retain of the same batch should be supplemented with a freshly prepared batch of good material.

If the starting hypothesis is seen to be compatible with the facts that are gathered from this analysis, the solution to the problem may be at hand, but if the validity of the hypothesis is not confirmed, one has to back up and start again.

If it is suspected that a failure was caused, for example, by a certain contaminant, a sample of good material should be deliberately contaminated with the same suspect contaminant to see if the failure can be duplicated; if it cannot be duplicated, then this is obviously the wrong track. No suggestion for corrective action by others should be made before one has tried the suggested procedure oneself, to see if it works. These principles were all adhered to in the work that was done to solve the following series of problems.

The first example cited was the cause of the gummy tank lining. A huge storage tank ("about half the size of a football field") was being coated with a 3-pack system. A coatings inspector who was employed to check on the job found that the coating on portions of the tank wall were still gummy well after the normal cure time.

Of course, the painting contractor was convinced that the material was defective, while the coatings manufacturer, who was thoroughly familiar with how the properly mixed and applied material should perform, concluded that the job was not being done right.

The working hypothesis was that there was insufficient curing catalyst used, and it was decided to apply IR spectroscopy to the problem. Samples of gummy, and other, apparently fully cured hard coating, were scraped from various parts of the tank and compared with samples of the same coating prepared in the lab with and without catalyst. The IR spectra for the gummy coating and the hard coating were distinctly different. The gummy coating showed the absence of a peak that reveals presence of the catalyst, so one step was taken for verification of the hypothesis. The same difference was seen in the spectra of the lab-prepared samples with and without catalyst. The validity of the hypothesis was thus confirmed both by the IR spectra and the fact that the catalyst-free lab coating was just as gummy as the defective coated areas on the tank, but the investigation didn't stop there.

Further confirmatory information was obtained from the field during the progress of the lab study when it was found that there was an excess number of packages of catalyst at the job site. The coatings manufacturer was thus absolved from any responsibility for this failure, while the painting contractor was clearly seen to be at fault. The recommended remedy was to remove the coating by sandblast and start over, which was done at the painting contractor's expense.

This successful solution was selected to illustrate two points: First, it shows what can be accomplished with a minimum number of experiments, backed up by alert and careful observation in the field. Second, it illustrates the problem-solving power of IR spectroscopy, probably the most general-purpose technique for looking at the composition of coating materials. This work was done about a dozen years ago, with a small, bench-top IR unit, not a research-grade spectrometer. It proves that even modest IR equipment that can be bought today for about $7000 has great problem-solving power.

Another case involved a new office building in which paint applied to the interior plaster walls came off easily when papers taped to the wall were removed—a kind of unintended tape-off test. The job involved a primer-topcoat system. Naturally, the painting contractor attributed the failure to defective paint. Despite the report of a rumor from one of the maintenance people that the primer had not been applied, the working hypothesis in this case was that there was something on the substrate that impaired the adhesion of the paint system.

Light microscopy was used to examine the paint chips. It showed that the primer was present, but that the back surface of the paint chips was covered with a whitish material. The whitish material was removable with a light acid wash. Chips of known good paint were prepared by casting a film on a Teflon surface, followed by removal of the dry paint. IR spectra of the back sides of the control paint chips, and of acid-washed and non-acid-washed chips of paint from the field were obtained. The IR spectra showed that the whitish material on the paint chips that came off the wall was a carbonate, which matched the IR spectrum of a scraping from the plaster wall. The conclusion was that there was cohesive failure of the surface of the plaster which had not cured properly before the primer was applied. Again, through the effective use of relatively simple equipment, responsibility for a failure passed from the paint manufacturer to the plastering contractor.

The next case was one of an easily peeled aluminum extrusion coating. A standard QC test involving immersion of a coated sample in boiling water showed extremely poor adhesion of the coating on an extruded aluminum channel. Experience had shown that poor surface cleaning prior to the pretreatment step or surface contamination after that step were frequent causes of adhesion failure on aluminum. The question was, which one of these conditions applied in this case? Since a choice had to be made for an initial working hypothesis, the decision was guided by the historically most frequent experience: poor surface cleaning prior to pretreatment. The equipment chosen for this work was the SEM with associated elemental analysis capability. The test showed that there was nothing wrong with the substrate in this respect; everything was normal with the chromephosphate pretreatment, so the initial hypothesis was wrong.

The next possibility was post-pretreatment surface contamination. The metal surface from which the paint came off was washed down with high grade hexane and the residue, after evaporation of the solvent, was applied to a KBr crystal. The method used was FTIR, and the resulting spectrum showed clear evidence of the presence of a silicone, with probable presence also of some hydrocarbon oil. The FTIR results were then confirmed by wavelength dispersive X-ray fluorescence analysis, which indicated a hexane-removable silicon species on the substrate. The culprit in this case was clearly silicone contamination.

Another case involved a poorly adhering appliance coating. The first suspect was inadequate metal pretreatment, or incorrect composition of the pretreatment. Initial tests on both factors, including X-ray diffraction analysis of the pretreatment mixture showed that these factors were apparently satisfactory. (X-ray diffraction is particularly suitable for checking crystalline pretreatments on metals.) A new working hypothesis thus had to be developed and pursued with tests that would probe deeper.

It was decided to use SEM and elemental analysis of the metal surface. An SEM photomicrograph at 2000X on properly treated metal showed tightly packed disk or coin-like crystals randomly oriented. A similar SEM scan of the problem pretreated metal surface showed an entirely different crystal morphology, with the crystals appearing as flat sheets arrayed in a leaf-type pattern. The bottom side of the paint chips that came off this surface showed an exact replica of the pretreated surface. The conclusion was that there was cohesive failure in the pretreatment. Failures of this type are not uncommon. When they occur, people are sometimes tempted to increase the pretreatment on the assumption that this will improve the situation; actually, the reverse occurs, as the thicker pretreatment is more prone to delaminate internally.

Further examination of the pretreatment composition by EDX revealed the presence of some "foreign" elements that should not have been present—elements such as calcium and magnesium from hard water, indicating that the bath was probably not made up with deionized water, as it should have been. This conclusion was further confirmed by atomic absorption (AA) analysis of a sample of the pretreatment bath. This test showed the presence of calcium, magnesium, and iron. Careless or intentional use of tap water (possibly by an operator who didn't think it would matter), instead of DI water, was the probable cause of this problem.

Another case involved a poorly cured industrial coating. The complaint was that workpieces coated with a 2-pack system showed poor resistance to abrasion and solvent. To see if inadequate bake caused the problem, coated samples were subjected to an additional bake, but there was no improvement. Attention was then directed to the concentration of catalyst. The catalyst in this instance contained an element that was not present in any other part of the composition. When a sample of the mixed paint, taken from the line, was compared by X-ray fluorescence spectroscopy with a mixture prepared from lab samples, the peak intensity for the telltale element in the catalyst was much lower in the paint taken from the line than it was in the lab paint. When the problem batch of paint was "spiked" with additional catalyst to compensate for the deficiency indicated by XRFS analysis, the paint cured properly.

An especially interesting case involved the occurrence of a persistent defect that looked like bubbles in an auto finish. Certain formulas showed a tendency to collect and retain the observed bubbles. Production personnel thought that the bubbles were getting in late in the process, and extreme efforts were exerted to try to avoid them. When these efforts were fruitless, an analysis of the solvents by GC was requested. The results were negative. Similar requests were then made for analysis of the resins by all the standard methods; again, the results were negative.

The aid of the engineering department was then enlisted, and much effort was expended on re-design of the mixing equipment. The problem remained unsolved: the bubbles were still there. Finally, the analytical department stepped in to analyze the bubbles, beginning with examination by light microscopy. This examination led to the suspicion that the bubbles were not bubbles at all, but minute specks of resin. Further work with an IR microscope showed that material within the specks matched the spectrum of one of the resin components. When another batch of resin that was pre-tested for complete absence of particles was used, the problem disappeared. It became apparent that the origin of the difficulty was small gel particles, that the bubbles were not bubbles at all, and that an incorrect initial assumption became amplified as it was passed along from one department to another.

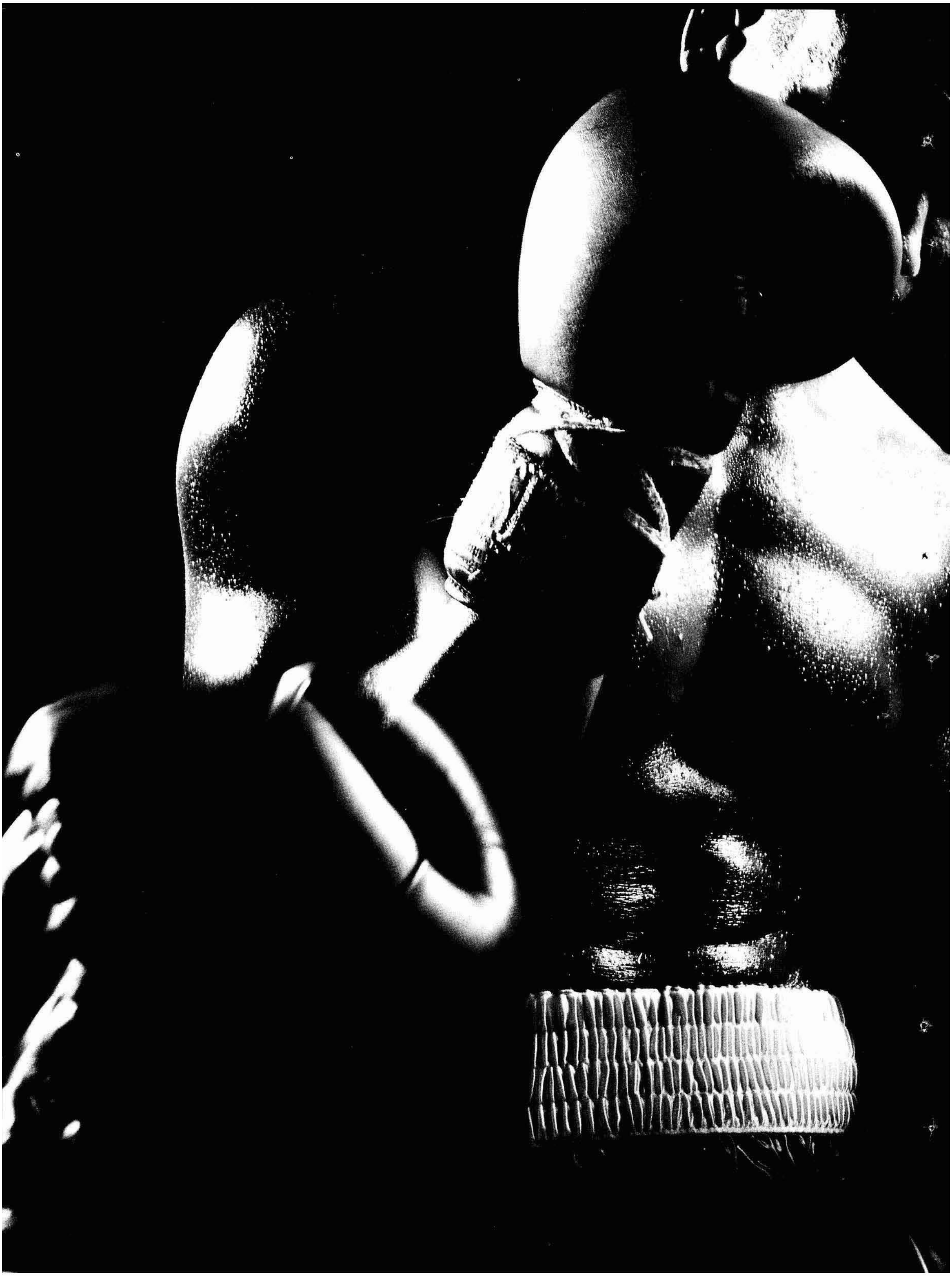
This was cited as an example of how people can lead themselves down a blind alley by pursuing an incorrect initial assumption—a good example of "group think."

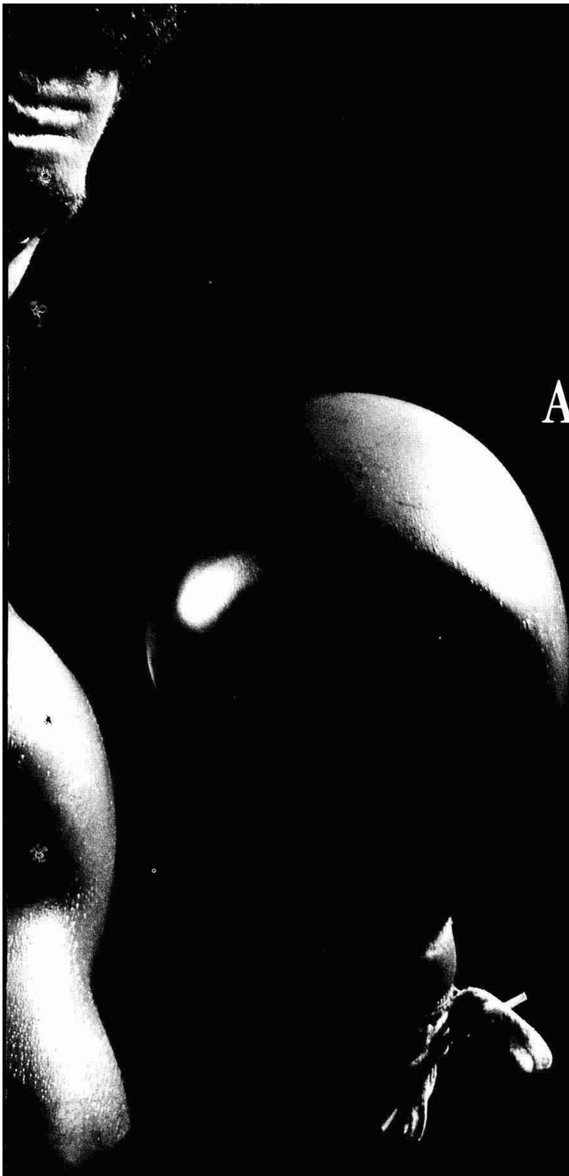
An interesting case of mistaken, or misrepresented, identity involved two samples of supposedly the same paint that didn't match at all in color and gloss. One sample represented a purchase made from a distributor, and other direct from the manufacturer. Lab examination showed that samples were indeed a mismatch. With the color and gloss varying so widely, the first suspects were the pigments and extenders, for which X-ray diffraction is a good analytical method. This test showed that the pigments in the samples did not match either qualitatively or quantitatively. The analyst noticed that the odors of the paints were different, so the volatile portions were analyzed by GC. Again, a mismatch. Finally the binder components were analyzed by IR and nuclear magnetic resonance, and the binder components in the paints were found to be totally different—one of the resins in the suspect sample was not even in use in any of the manufacturer's formulations. The obvious conclusion was that the mismatched sample was a counterfeit that someone was trying to palm off on a customer. Once these facts were in, it was seen that the batch number and other identifying marks were also counterfeit. This experience confirms the wisdom of the advice given by an earlier speaker: Before investing a great deal of time and effort in the investigation of a complaint, try to be as sure as you can be that the paint is yours.

A case of peeling window frames involved a high rise office building in which extruded aluminum frames were supposed to be coated with a primer, a color coat, and a clear coat over that. The complaint was that the clear coat was delaminating from the color coat. The peeling phenomenon was occurring on portions of the building exposed to high humidity generated by air conditioning equipment.

The use of X-ray photoelectron spectroscopy (XPS) was cited as a method for surface analysis that is powerful enough to detect surface contamination which results in intercoat delamination in multicoat systems, when other methods of analysis are not perceptive enough to pinpoint the trouble, as happened in this case.

The speaker concluded with the statement that modern analytical instruments and techniques are now more powerful, faster, and easier to use than they have ever been in the past, and that they are being constantly improved. Computers and automation have added their own contribution to analytical "firepower." His earlier remarks indicate that all these powerful tools still have to be guided by thoughtful analysis of problems and formulation of working hypotheses before work is begun, to avoid "shotgun" approaches that can yield as much confusion as information.





Battelle Forecasts $155 Billion for R&D Expenditures

Research and development (R&D) expenditures in the U.S. in 1991 are expected to reach $155.2 billion, an increase of $5.2 billion (3.5%) over what the National Science Foundation estimates was spent for research and development in 1990. The figures are part of the annual forecast produced by Battelle, Columbus, OH.

Battelle predicts a real increase in research and development spending of approximately one percent, while 2.4% of the increase will be attributed to continued inflation as it affects the R&D industry. The increase for this year is considerably smaller than the 10-year average of four percent in real R&D effort experienced since 1980.

An official at Battelle stated that the slowdown in the rate of growth of R&D expenditures is not expected to be a long-term trend.

According to the report, industrial funding for R&D will account for 48.9% of the total. Industrial support is forecast to be $75.9 billion, up 2.2% from last year.

Battelle foresees an increase of 4.3% in federal support for R&D, with funding expected to be $72.2 billion. This is 46.5% of total expenditures for 1991.

Funding by academic institutions is expected to be $4.7 billion (three percent of the total), and other nonprofit organizations will provide nearly $2.5 billion (1.6%).

Battelle reports that industry and government have switched roles as the primary source of R&D support. Prior to 1980, government was the principal funder; since then, industrial support has been dominant, and the trend is expected to continue this year.

Industry will remain the primary performer of R&D, according to the forecast. This year, performance by industry is expected to rise to $111 billion, or 71.5% of all research performed. This compares with $17.5 billion (11.3%) by federal government laboratories, nearly $22.4 billion (14.4%) by academic institutions, and $4.3 billion (2.8%) by other nonprofit organizations.

According to Battelle, federal funding supports research performance in all four sectors. Currently, almost one-fourth goes to support R&D conducted by the government itself; slightly more than one-half goes to industry; one-fifth to colleges and universities; and the rest, about one twenty-fifth, to other nonprofits.

Industry, however, absorbs almost all of its own funds, either performing the R&D itself or contracting with other industrial performers. Contracts and grants to nonprofit organizations are a little more than one-half as large as those to colleges and universities. The nonprofit organizations finance both themselves and the academic institutions about equally, and colleges and universities consume all of the funds they originate.

The study reports that four government agencies dominate the federal R&D scene and account for 91% of total federal R&D funding authority this year, only slightly lower than the percent of funding in 1990.

	1991 Estimated Percent of Federal Funds	1990 Estimated Percent of Federal Funds
Department of Defense	56.8	58.4
Health and Human Services	13.1	13.3
National Aeronautics and Space Administration	12.1	10.0
Department of Energy	8.8	9.4

Defense spending increases, as noted by the forecast, primarily are directed toward tactical programs and advanced technology development, manufacturing technology, and basic research. The R&D budget for strategic programs and the expansion of the technology base show small decreases.

Energy funds are expected to continue to decline for research on basic energy supply and conservation, but not for programs in direct support of national defense, waste treatment, and general science. The report points out that energy projects involving short-term or low-risk R&D largely have been financed by industry.

Almost all federal agencies are expected to increase their efforts in the general area of technology transfer, or alternate use for industrial applications.

Industrial support of research is growing in fields related to electronics, communications, sensors, and advanced machinery, according the Battelle study. Increases also are seen in those fields most directly influenced by the need for more energy efficient products and processes.

The forecast states that R&D will continue to be heavily self-funded in manufacturing industries, where, on the average, approximately 34% of the total will be supported by the federal government. Nonmanufacturing industries, which do relatively little R&D, will receive much of their support by the federal government.

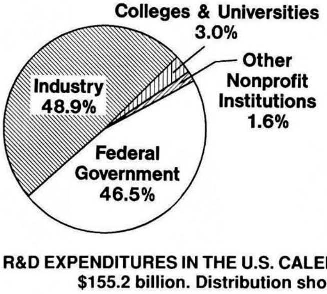
Industry will continue to support short-term R&D projects and is reacting to the pressure from foreign technological competition. The study reports that a shift in patterns has been developing in the industrial support for R&D. Industrial expansion has been—and will continue to be—affected by "mergermania" and a concentration on investments and actions that lead more toward short-term payoff rather than long-term survival.

While there is no data available for analyses, the forecast notes that there is and predicts that there will continue to be an increasing emphasis on the interactions between industry and other facilities, especially those associated with the federal laboratories.

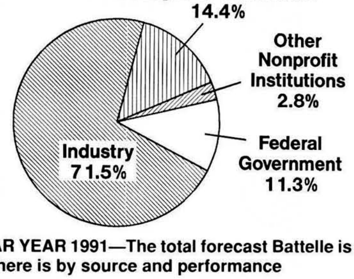
In conclusion, as has been noted in previous Battelle studies, the rate of growth of R&D has been slowing and is expected to continue in a period of uncertainty. Among the factors affecting government priorities and postures are: the combined influences

(Continued on page 32.)

Sources of Funds



Performers of R&D



R&D EXPENDITURES IN THE U.S. CALENDAR YEAR 1991—The total forecast Battelle is $155.2 billion. Distribution shown here is by source and performance

New Construction Contracting Down 11% in December 1990; Year-End Totals for Contracting Show Sharp Decline from 1989

Contracting for new construction dropped in December 1990, according to a report compiled by the F.W. Dodge Division of McGraw-Hill, New York, NY. The value of newly started projects was reduced 11% for the final month of 1990.

The decline in construction contracting left 1990's year end total at $240 billion, down 11% from 1989's record $270.7 billion. The 1990 setback was shared equally by housing and nonresidential building (down 14% and 13%, respectively). By contrast, nonbuilding construction—public works and utility projects—held virtually even with 1989's value.

According to officials at F.W. Dodge, the volume of construction being started in the early part of this year barely matches the level that prevailed during the industry's deep recession of 1980-82.

The contracting data for December 1990 reveals declines in all three major categories of construction. Nonresidential building was down five percent from November 1990 and showed typical weakness in commercial/industrial building, which was tempered by stability of institutional building. At the same time, a deep decline of multifamily housing starts pulled the residential category down another six percent in December 1990. A much steeper decline of nonbuilding construction was experienced, further aggravating these two moderate setbacks.

For 1990 as a whole, contracting was down in all five major regions. The Northeast (-21%) and the South Atlantic (-17%) reported above-average declines from 1989, followed by the South Central (-9%), the West (-7%), and the North Central (-4%). Toward the year-end, the West was showing the deepest decline, while the North Central still remained relatively strong.

ASTM Seeks Participants for Inspection Task Group

ASTM, Philadelphia, PA, Subcommittee D.33.04 on Inspection needs participants for a new task group for developing a standard training guide for coatings inspectors in the power generation field. D33.04 is a subcommittee of standards-writing Committee D-33 on Protective Coating and Lining Work for Power Generation Facilities.

According to ASTM, such a guide is needed as coatings projects become more complex in light of their potential environmental impact.

All interested individuals are welcome to participate. The next meeting of Committee D-33 is in Denver, CO, on April 15-17.

For more information, contact Barry Barman, KTA-Tator, Inc., 6430 Variel Ave., Ste. 101, Woodland Hills, CA 91367, or Anne McKlindon, ASTM, 1916 Race St., Philadelphia, PA 19103.

Reinforced Plastics Industry Is Focus of Skeist Techno-Economic Study

A multi-client study on "Reinforced Plastics, II" will be conducted by Skeist Inc., Whippany, NJ. The techno-economic study, the fifth in a series begun in 1971, will detail the profit opportunities in the reinforced plastics industry.

According to Skeist, in 1990, reinforced plastics are expected to exceed a volume of 2.6 billion pounds. Of that, 60-65% was based on styrenated unsaturated polyester matrix, and another 8-10% were epoxy composites. Reinforced plastics account for 27% of the market. The remaining three percent were based on various thermosetting resins, including vinyl esters, phenolics, polyimides, and allyl compounds.

Reinforced thermoplastics are increasing at an average rate of 8-10%, and have more than doubled their share of the reinforced plastics market, from 12% in 1980 to 27% in 1990, according to the report.

"Reinforced Plastics, II" will provide detailed information on markets, materials, technology, performance requirements, producers, fabricators, and processes. Markets such as motor vehicles, aircraft, electrical, corrosion-resistant equipment, construction, and others will be analyzed. Materials will include thermosetting and thermoplastic compositions, resins, glass and advanced fibers, and other components. The industry analysis will include information on market structure, producers, their product mix and market position, competitive analyses, and acquisition opportunities.

The final report will be approximately 700 pages. Following a review of product literature and published data, information will be obtained from interviews with end users, formulators, resins and fiber manufacturers, other materials suppliers, trade associations, and government agencies.

The subscription fee for early subscribers (before April 1) is $8500. A brochure, with a tentative Table of Contents, is obtainable from Skeist Inc., 375 Rte. 10, Whippany, NJ 07981.

Akzo Coatings Rexdale Plant Faces Mid-Year Closing

Akzo Coatings has announced that it is closing its Rexdale, Ont., Canada facility by the end of June.

Officials at Akzo said the operation will be phased out and products currently produced there will be made in other Quebec and U.S. facilities.

The Akzo Rexdale plant employs approximately 29 people and produces paints and stains for the industrial and decorative markets.

Battelle Forecasts . . .

(Continued from page 30.)

of federal budget-cutting and negotiations on defense; and the major political changes occurring in Eastern Europe.

Industrial support will continue to be affected by conflicting and complex factors. Decreases in defense procurement and the resulting profits are certain to affect the availability of funds for R&D support in selected industries. The trade imbalance and efforts to correct it, as well as efforts to expand markets in response to shifts in government priorities, could spur expanded R&D. However, according to the forecast, the environment that permits greater rewards for short-term financial results, rather than technical innovation, will continue to have an adverse effect on R&D investment.

Production of Plastics Resins Statistics Released for November 1990

The final statistics on the production of plastics resins have been released by the Committee on Resin Statistics of The Society of the Plastics Industry, Washington, D.C.

According to the final numbers, the production of plastics resins totaled almost 4.5 billion pounds in November 1990, up 8.9% over the same month in 1989. November 1990 production figures were down 4.2% from the October 1990 total. Production for 1990 up through November totaled just over 49 billion pounds, up 6.5% over the same period in 1989.

Sales and captive (internal) use of plastics resins in November 1990 exceeded 4.3 billion pounds, a decrease of 2.1% from the same month in 1989. November 1990 sales were down 12% from October 1990. Sales and captive use for 1990 up through November were 6.3% ahead of 1989.

For more information, write The Society of the Plastics Industry, Inc., 1275 K St., N.W., Ste. 400, Washington, D.C. 20005.

New Kaolin Company Formed in Dry Branch, GA

Asea Brown Boveri Inc. has announced the formation of a new kaolin company, Dry Branch Kaolin Company, Dry Branch, GA. The new company was formed as a result of the acquisition of Georgia Kaolin Company by ECC Group plc, Cornwall, England.

Under the agreement with ECC, Asea Brown Boveri will retain the Dry Branch plant of Georgia Kaolin and its associated clay reserves.

Dry Branch Kaolin is expected to undergo capacity expansion and continue to offer a line of clay products.

Officials at Asea Brown Boveri have announced their intentions of selling the Dry Branch Kaolin Company to keep in line with its strategy of concentrating on its core businesses.

CMA Seeks Views on Developing MSDS

Organizations interested in developing the standard for the Preparation of Material Safety Data Sheets (MSDS) should contact the Chemical Manufacturers Association (CMA), Washington, D.C.

CMA is the sponsor of a new American National Standard for the Preparation of MSDS (ANSI Z400.1), and is canvassing other interested organizations for their views on the standard.

ANSI Z400.1 is a proposed standard that provides a guideline for preparing MSDS for materials used and handled in the U.S. In developing the standard, CMA is soliciting the views of other trade associations, consumer groups, labor unions, small business, professional societies, and any other organizations with direct and material interest in MSDS.

Anyone interested in participating in the canvass process should contact Diane Layne, CMA, 2501 M. St., N.W., Washington, D.C. 20037.

JOURNAL OF COATINGS TECHNOLOGY

GUIDE FOR AUTHORS

GENERAL

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

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

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

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

SUBMISSION OF MANUSCRIPTS...

...for the Journal

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

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

. . . by Constituent Societies For Annual Meeting Presentation

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

. . . for Roon Foundation Award Competition

Ten complete copies of the manuscript are required, and should be submitted to the Chairman of the 1991 Roon Awards Committee, George R. Pilcher, Akzo Coatings, Inc., P.O. Box 147, Columbus, OH 43216. (For complete details, see "Roon Awards" section of the JOURNAL in January 1991 issue.)

MANUSCRIPT PREPARATION

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

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

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

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

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

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

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

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

Title

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

Authors' Biographies and Photographs

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

Abstracts

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

Text

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

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

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

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

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

Metric System

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

Tables, Graphs, and Drawings

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

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

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Equations must be typed, or written clearly, with equations numbered sequentially in parentheses to the right. If Greek letters are used, write out their names in the manuscript margin at the first point of use. Place superscripts^{a} and subscripts$_{b}$ accurately. Avoid the use of superscripts in a manner that can lead to their interpretation as exponents.

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The paper should be concluded with a summary which is intelligible without reference to the main text. The summary may be more complete than the abstract, listing conclusions drawn from the text. A well written summary can serve to inspire the busy reader to turn back to the paper, to read it thoroughly.

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(1) Pascal, R.H. and Reig, F.L., "Pigment Colors and Surfactant Selection," *Official* DIGEST, *36*, No. 475 (Part 1), 839 (1964).

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* * * *

A Mathematical Model for the Cathodic Blistering of Organic Coatings On Steel Immersed in Electrolytes

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A physical/mathematical model which describes blistering resulting from the corrosion of coated metals containing defects exposed to electrolytes has been developed. The model is based on the two-dimensional diffusion of cations through some arbitrary medium. Cations migrating along the coating/metal interface from the defect to the cathodic sites are assumed to be responsible for the formation of highly water-soluble corrosion products, leading to blistering. Solutions of the model were expressed in terms of dimensionless parameters. Concentration profiles between the blister and defect and cation flux into the blister as functions of time, blister size, distance between the blister and defect, ion diffusivity, and potential gradient were calculated. The predictions were related to available experimental data in the literature on cation uptakes and blistering rates for coated steel panels exposed to metal chloride solutions.

INTRODUCTION

Corrosion of metals costs the United States about 4.2% of the gross national product[1] yearly, or over $200 billion in 1990. Although many techniques have been developed to reduce corrosion, the use of organic coatings is still the most effective, economical, and widely-used means to prolong the service life of a metal. One important function of a protective coating is to act as a barrier between the environment and the substrate. For thick maintenance coatings, the coating may act as a true barrier, but many coatings are too thin to be true barriers—screen or filter would be a more accurate term. However, barrier is the usual term. Despite the great progress of coating technologies in recent years, problems continue to exist in providing protection to metals from exposure to the environment.

There has been considerable research on the degradation and adhesion failure of coated metals in the past decade and significant advances have been made in understanding the mechanisms and degradation factors.[2,3] However, very few theories quantitatively, or even qualitatively, describe the degradation and predict the performance of a coating system during service.[4,5] This is primarily due to the complexity of the metal/coating system and the many variables that affect the performance and life of a coating system as depicted in *Figure* 1.[6]

In addition to the physical and chemical properties of the coating and the substrate surface, a coating system may contain inhomogeneities such as air bubbles, microvoids, contaminants, trapped solvent, nonbonded areas, and pigment/resin and coating/substrate interfacial layers, as illustrated in the conceptual model shown in *Figure* 2. These factors influence the transport of environmental elements through the coating and along the coating/metal interface, and the degradation processes at the coating/metal interface.

Another reason for the lack of a comprehensive theoretical framework for understanding and predicting corrosion protection by a coating is that there are so many different coating chemistries and formulations on the market. Together with the long duration necessary for weathering tests and the many factors involved in corrosion, this has resulted in poor correlation between lab and field studies.

If the effectiveness of coatings is to be increased through development of improved selection and evaluation criteria, it is essential to develop improved methods

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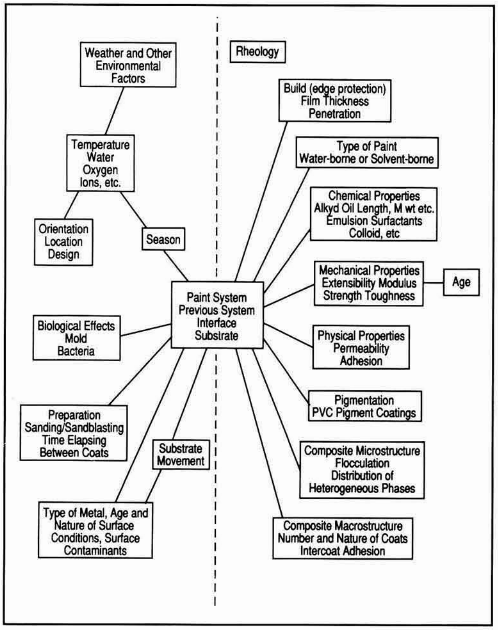

Figure 1—Factors influencing the durability of a coating system (after Blakey[6])

for predicting the service life of a coated metal. The purpose of this work is to develop mathematical models for predicting the rate of the degradation as a result of exposure to an environment. The approach we have taken to tackle this problem is (1) to develop preliminary models based on the present understanding of the physical phenomena associated with a specific mode of failure, (2) to carry out experiments to validate the models, and (3) to produce a final mathematical model for a specific mode of failure which adequately predicts the service life of a coating exposed to a particular environment. This paper presents a preliminary model for cathodic blistering, one of the most common degradation modes of coated metals containing defects exposed to electrolytic environments.

STATEMENT OF THE PROBLEM

Blistering of organic coatings on metallic substrates is a commonly observed phenomenon and a large amount of literature exists on this subject.[7-9] One of the most severe cases of blistering is the so-called "cathodic blistering" or "alkaline blistering" which occurs when a coated metal with a defect in the coating is exposed to salt spray, constant immersion, or cyclic wet-dry immersion in salt solutions.[9-12] The defects in the coating may be a mechanical damage, a pinhole, an incomplete or very thin coating coverage section,[9,13,14] or an area of low ionic resistance, such as a region of low crosslink density.[15] Cathodic blistering occurs in the neighborhood of the defects (*Figure* 3a). Continued exposure will lead to enlargement and coalescence of the blisters, and eventual total delamination of a coating (*Figure* 3b). The delamination resulting from the cathodic blistering does not start at the defect but at blister sites near the defect.[11] The growing anodic character at the defect area stimulates the cathodic reactions adjacent to it. Cathodic blistering also occurs when the metal is made cathodic with respect to its rest potential by means of an applied potential.[16] Many coated metals can be intentionally or unintentionally subjected to an electrical potential.[17]

Cathodic blistering occurs when a scribed, coated steel panel is immersed in a NaCl solution without an applied potential (*Figure* 4). The defect serves as the anode where the iron is oxidized

$$Fe \rightarrow Fe^{2+} + 2e^- \qquad [1]$$

The other half cell corrosion reaction, where the oxygen is reduced (the cathodic reaction), occurs under the coating a short distance away from the scribe[17]

$$H_2O + 1/2O_2 + 2e^- \rightarrow 2OH^- \qquad [2]$$

The cathodic and anodic sites are connected by an electrolyte layer. Initially, the cathodic and anodic reactions can start at adjacent atom sites.[18] However, as corrosion products form and concentration gradients of corrosive species are established, the reaction sites separate and localize. An increase of this separation leads to failure of a coating system.

The principal difference between neutral blisters and cathodic blisters is that the liquid in the neutral blisters observed with defect-free organic coatings exposed to dilute NaCl solution is weakly acid to neutral,[11] while the liquid in the cathodic blisters is highly alkaline as observed both in the lab and the field.[10,11,16] Indeed, pH values close to 14 have been measured in liquid underneath a coating on steel near a defect using a pH-sensitive electrode inserted through the substrate.[19] This alkalinity can be explained only by the migration of cations from the surrounding environment to the cathodic sites at the coating/metal interface; this cation flux neutralizes the electric charge of the hydroxide ions produced by the cathodic reactions according to the following reactions[10]:

$$1/2O_2 + H_2O + 2e^- + 2Na^+ = 2(Na^+OH^-) \qquad [3]$$

$$H_2O + e^- + Na^+ = Na^+OH^- + 1/2H_2 \qquad [4]$$

Metal cations instead of hydrogen ions are involved since the pH in the blister is very high.[13] The reaction products from reactions *[3]* and *[4]*, which have a very high solubility in water, cause a difference in the thermodynamic activities of water between the exposure environment and the coating/metal interface. The osmotic pressure gradient, which results from the water activity difference between the two sides of the coating, is the principal mechanism responsible for blister formation.[10,11,20,21]

RATE CONTROLLING FACTOR

Following the previously mentioned argument and according to reaction *[2]*, for cathodic blistering to occur, oxygen, water, and cations must reach the reaction site by either permeating through the coating or migrating along the coating/metal interface via a defect. Although there are many factors that affect the concentration of $[OH^-]$ in the blister and the rate of the cathodic reactions,[13,22] two main assumptions are made for the development of the model. The first is that cation presence at the cathodic sites is the main factor controlling the thermodynamic activity difference of water across the coating. The resulting osmotic migration of water leads to the formation of a cathodic blister. The second assumption is that in the absence of an applied potential, the migration of cations to the cathodic sites is along the coating/metal interface via the defects. Thus the cations that are responsible for neutralizing the hydroxide ions are those migrating from the electrolytic exposure environment and not from other sources, for example, from the pigments or extenders in the coating, contaminants on the substrate surface, or ions permeating through the bulk of the coating. These assumptions are based on current understanding of the "cathodic delamination" phenomenon, a subject that has received extensive study in the last few years and which has been briefly reviewed and summarized.[12]

The difference between cathodic blistering and cathodic delamination is due to the events that occur after the hydroxide ion interacts with the metal ion. Blister growth away from the defect is the result of osmotic pressure developed due to high water solubility of the cathodic reaction products in the blister as indicated earlier, while delamination progression from the defect is due to the bond breaking at the coating/metal interface resulting from the alkalinity of the cathodic reaction products reaching the delamination front as shown in *Figure* 4. Thus, cathodic blistering generally occurs after cathodic delamination.[13,23] Since the developed model will predict the degradation as a function of the transport of the controlling species reaching the cathodic sites, the model should be applicable to the cathodic delamination phenomenon as well.

MATHEMATICAL MODEL

Our preliminary mathematical model of cathodic blistering of a coated metal system is based on two-dimensional, radially-symmetric diffusion in an annular domain, $a < r < R$ (*Figure* 5), where a is the radius of the "blister," R is the distance between the center of the blister and the scribe, and r is the distance between the center of the blister and any location on the coated panel between the blister and the scribe. In this configuration, we represent the blister as a water-filled tube in the center of the coated panel while the defect (scribe) surrounds the annulus (area between the blister and the scribe). The

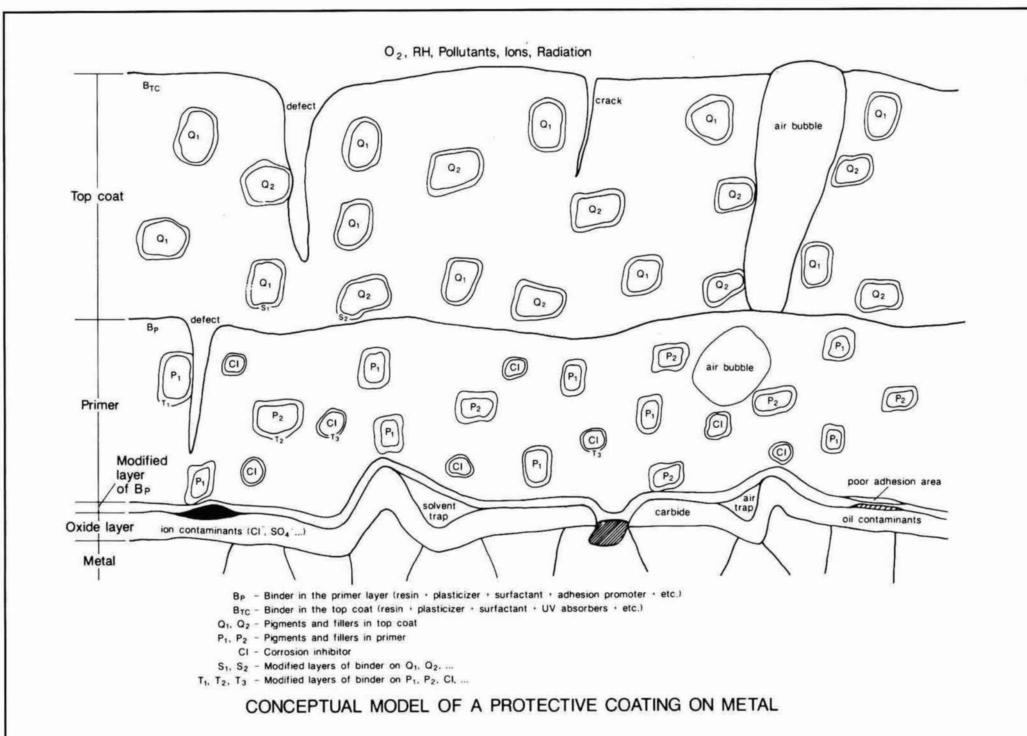

Figure 2—Conceptual model of a primer-top coat coating system

area inside the cylinder is the bare metal, which is based on the assumption that the disbonding resulting from the cathodic blistering occurs adhesively at the coating/metal interface. This assumption is consistent with one of the proposed mechanisms for bond rupture, whether resulting from the products of the corrosion reactions of a coated steel system with a defect in the coating, or under an applied potential exposed to an electrolytic environment.[22,24] This configuration provides a conceptual and experimental model that has several attributes: reproducibility (scribe imperfections are averaged out because of the annular shape), the model is experimentally verifiable, and lastly, the associated reaction-diffusion analysis is mathematically tractable.

Initially, the cation concentration c′ in the annulus is zero, and at time $t' = 0$ the concentration at $r' = R$ is raised to c_0 (the concentration of the exposure environment), and maintained at that level henceforth. At $r' = a$, the concentration vanishes; thus, in this model the annulus is bounded by infinite "reservoirs" which can maintain the concentration at fixed levels. This preliminary model does not take into account cations that are not "associated" with hydroxide ions (formed from the cathodic reactions); that is, the blister serves as a sink consuming every cation entering it. This assumption is reasonable, particularly in the early stage of the blister formation, since the main driving force of the cation migration into the blister is the electrical neutralization of the OH^- ions generated by the cathodic reaction.

The cation is assumed to diffuse from the scribe to the blister along the coating/metal interface. For two-dimensional diffusion of an ionic species in some medium,[25] the relationship is

$$\frac{\delta c'}{\delta t'} = D\frac{1}{r'}\frac{\delta}{\delta r'}\left(r'\frac{\delta c'}{\delta r'}\right) + \mu E\frac{\delta c'}{\delta r'} \qquad (1)$$

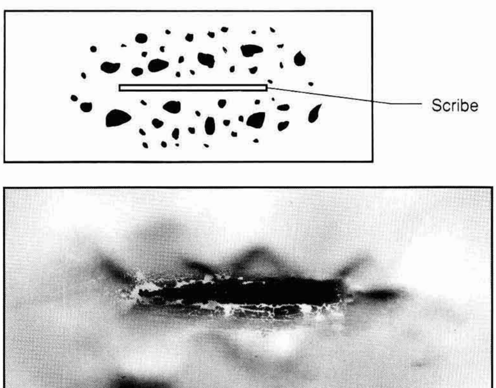

Figure 3—Blisters developed around a defect (after Funke[11]) (a), total delamination resulting from cathodic blistering of a scribed, alkyd-coated steel immersed in 0.86 M NaCl solution (b)

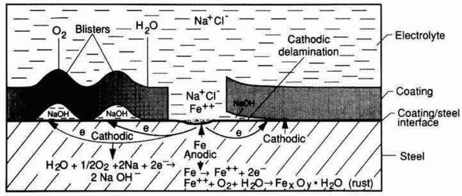

Figure 4—Cathodic blistering and delamination of a scribed, coated steel panel exposed to a NaCl solution

where D is some average ion diffusion coefficient, μ is an average mobility coefficient, and E is an electric field, which is assumed to satisfy $E = -\delta\phi(r)/\delta r$, where the potential ϕ is given by the unscreened electrostatic form

$$\phi(r) = (\Delta\phi)\frac{\log r'/a}{\log R/a} \qquad (2)$$

and where Δϕ is the potential difference between a and R.

The diffusion coefficient D in equation (1) is assumed to be independent of time and constant through the space between scribe and blister. In general, D along the coating/metal interface will be less than the molecular diffusion coefficient of molecules moving unimpeded through the solution. D is thus regarded as an effective diffusion coefficient rather than a bulk medium diffusion coefficient.

Equation (1) deserves a few comments. It is well known in electrochemistry that, as far as diffusion is concerned, the constraint of local charge neutrality leads to the exact cancellation of an arbitrary external field in the equations for mass balance.[26] This implies that the concentration profile of any electrolyte should be independent of the potential difference between the electrodes, except for the influence of the external potential on boundary conditions at the electrodes. However, electrolytes confined to two spatial dimensions (as assumed in this study) behave very differently from their three-dimensional counterparts. For example, it has been shown that the mean-field assumption inherent in the Poisson-Boltzman equation breaks down for a two-dimensional electrolyte and that a Mayer-style resummation of the virial series is necessary to extract the correct limiting law thermodynamic properties.[27] This anomaly reflects the fact that ionic screening in two-dimension is much less efficient than in three-dimension. Furthermore, when the effects of heterogeneity in the coating/metal interfacial region are also considered, it becomes clear that the assumption of local charge neutrality is tenuous.

Another point that is worthy of comment is that the "perfect sink" boundary condition at the "blister radius" automatically eliminates the field-induced current flux into the blister. While we intend to generalize this condition in a future analysis, it should be noted that a perfect sink boundary condition with an unscreened external field imposes an upper limit to the two-dimensional cation flux into the blister. This may prove to be a useful idealization in situations where the cation flux directly through the coating is also considered.

We rewrite equation (1) in dimensionless units, in terms of length scale L (= R − a), the time scale t, and the concentration scale c. It is advantageous to express the model in terms of dimensionless groups since, in effect, all possible cases can be condensed into a single mathematical form. The dimensionless governing equation takes the form

$$\frac{\delta c}{\delta t} = \frac{\delta^2 c}{\delta r^2} + \frac{1}{r}\frac{\delta c}{\delta r} + \frac{p}{r}\frac{\delta c}{\delta r} \qquad (3)$$

and the corresponding flux is given by

$$F = -\frac{2\Pi\kappa}{(1-\kappa)}\left(\frac{\delta c}{\delta r}\right) \qquad (4)$$

for $\kappa/[1-\kappa] < r < 1/[1-\kappa]$ and $t > 0$, where $\kappa = a/R$, $c = c'/c_0$, $t = Dt'/L^2$, $r = r'/L$, and $p = \{-\mu(\Delta\phi)\}/\{D\log R/a\}$. The boundary conditions are

$$c(\kappa/[1-\kappa],t) = 0$$
$$c(1/[1-\kappa],t) = 1$$

with

$$c(r, 0) = 0$$

Equation (3) expresses the cation concentration at any location between the scribe and the blister as a function of time. The rate of concentration change is governed by the values of the model parameters. There are two dimensionless parameters in the problem, the geometric aspect ratio κ and the mobility factor p.

NUMERICAL RESULTS AND THEORETICAL PREDICTIONS

We solved equation (3) numerically using the so-called "method of lines" approach.[28] The equation is discretized spatially using a pseudo-spectral Chebyshev approximation to the r-derivatives[29] which gives "infinite-order accuracy" to the spatial approximation. This results in a set of ordinary differential equations for the time-evolution of the concentration at the spatial grid points, which we solved using the Ordinary Differential Equation package DDRIV1.[30] The solutions were obtained for a number of cases where the geometric aspect ratio κ and the mobility factor p were varied.

WITHOUT A POTENTIAL GRADIENT:

$\kappa = 0.1$ and $p = 0$

Figures 6 and 7 display a representative family of curves illustrating the concentration profile (*Figures* 6a and 7a) and the corresponding flux (*Figures* 6b and 7b) of cations migrating into a blister over short ($t = 0.0$ to 0.1) and long ($t = 0.0$ to 1.0) time intervals, respectively, for the case where the potential difference between the blister and the scribe is ignored ($p = 0$) and the radius of the blister is one tenth of the distance between the center of the blister and the scribe ($\kappa = a/R = 0.1$). The flux was derived from the slope of the concentration profile curves given in *Figures* 6a and 7a at $r = \kappa/1\text{-}\kappa$. By hypothesis, the total flux (diffusive in this case) of cations into the blister determines the rate of hydroxide ion production, and the OH^- concentration should be closely correlated with the rate of blistering. The negative values on the vertical axis of the flux-time curves indicate a diffusion inward from the scribe. In the absence of a potential gradient between the defect and the blister, the model predicts a gradual concentration build-up between the scribe and the blister as exposure time in increased. The flux does not change (delayed) at the beginning of the exposure ($t < 0.05$) (*Figure* 6a) but increases rapidly with exposure time reaching a "steady state" value at $t > 0.5$ (*Figure* 7b).

It is important to emphasize that it is t ($= Dt'/L^2$, the dimensionless time) that affects the rate at which a steady state is attained, rather than the absolute time t'. Thus, to prevent or minimize cathodic blistering, D should be small and L (the distance between scribe and blister) should be large; both of these parameters depend on the interfacial properties and their behaviors during exposure of a coating system. Thus, the model predicts that as long as the adhesion around a defect is maintained so as to minimize cation migration from the defect area to a potentially blistering area (thereby deterring the initiation of a cathodic blistering site close to the defect), the cathodic blistering around a defect will be minimal. This prediction is consistent with the suggestion that "wet adhesion" (adhesion of an organic coating to a substrate on exposure to liquid water or high relative humidity) is the "most important and decisive property" that affects corrosion protection by an organic coating.[23] It is always observed that adhesion of a wet coating is substantially diminished before any blistering is visible.[11,23]

Except for a few special coatings containing carboxylic acid groups, either present initially[31] or formed during oxidative curing[17,32] the majority of coatings interact with the hydroxylated oxide on a metal surface by means of secondary forces (dispersion and polar forces). (The

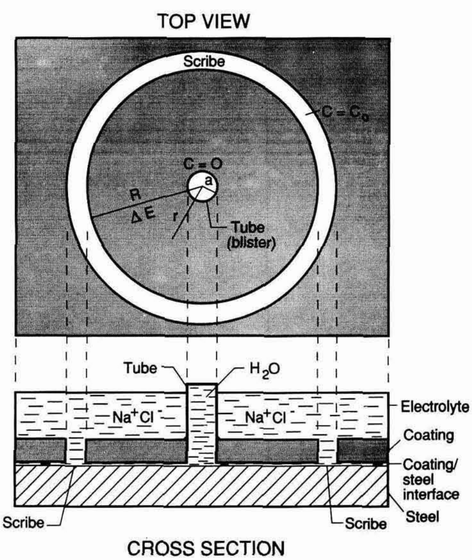

Figure 5—Conceptual basis for the mathematical model of cation transport from the defect to the blister

oxide on a metal surface is always covered with at least a monolayer of water under normal room conditions.[33]) Numerous examples included in the two reviews on adhesion and interfacial parameters of "low-energy surface" materials[34,35] show a direct relation between substrate surface free energies and bond strength. This strongly suggests that the secondary force interaction is the predominant mechanism responsible for the adhesion between an organic coating and a metal substrate. These bonds are not thermodynamically stable in the presence of very polar liquids such as water and aqueous solutions of corrosion products,[36,37]; that is, when the coated metal is exposed to these liquids, the water will readily displace the organic coating from the metal. This will enhance cation migration along the coating/metal interface and will also provide more available sites close to the defect for cathodic blistering to occur.

With a Potential Gradient:

$\kappa = 0.1$ and $p = 1$

We now allow for a potential gradient, either externally applied or resulting from the corrosion processes, between the cathodic sites at the blister and anodic sites at the scribe. The concentration profile curves are different from those derived without a potential gradient (compare *Figure* 7a with *Figure* 8a). The slopes near the blister are steeper, while those near the scribe are lower for the case with a potential gradient; this suggests that, in the presence of a potential gradient, the concentration build-up in the vicinity of the blister is faster than without a potential gradient. This is better seen from the flux-time curves for different p values presented in *Figure* 9a; this shows an increase in flux at steady state ($t > 0.5$) to the blister by a factor of about three as the mobility factor p increases from 0 to 1. In this range, the flux increases almost linearly with p as shown in *Figure* 9b; the flux values in this figure were derived from *Figure* 9a for $t = 1$. As mentioned earlier, an increase of cation flux into the blister increases the rate of reaction *[2]*, which will result in an increase in the rate of blister formation and growth. The driving force for corrosion at the scribe (the anode) and cathodic blistering away from the scribe (the cathode) is the potential difference between these two regions. The existence of the potential difference causes electon flow and allows corrosion and cathodic blistering to proceed. Increased cathodic blistering as a result of increased corrosion activity at the defect is commonly observed in practice.[10]

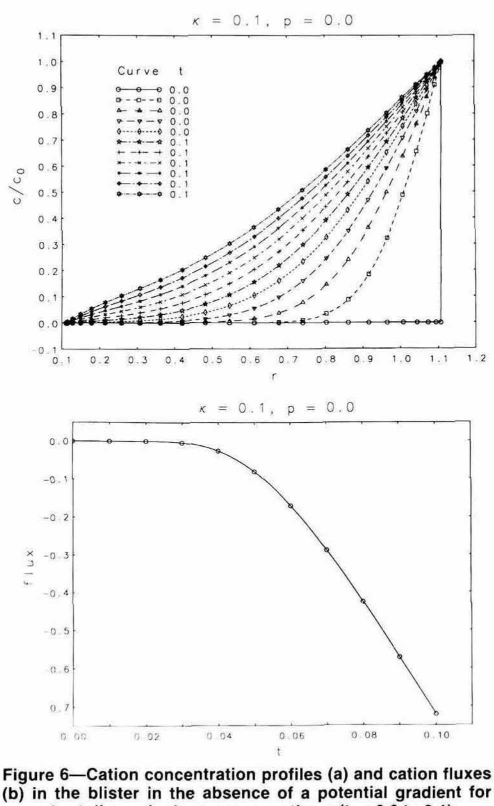

Figure 6—Cation concentration profiles (a) and cation fluxes (b) in the blister in the absence of a potential gradient for short dimensionless exposure times (t = 0.0 to 0.1)

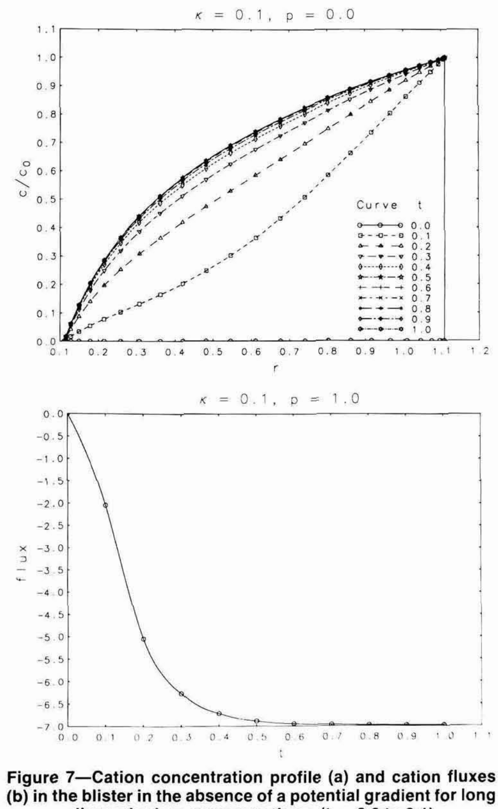

Figure 7—Cation concentration profile (a) and cation fluxes (b) in the blister in the absence of a potential gradient for long dimensionless exposure times (t = 0.0 to 0.1)

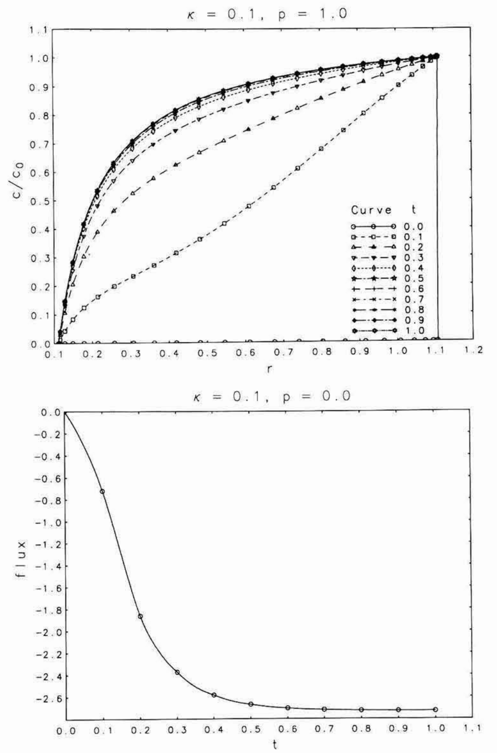

Figure 8—Cation concentration profile (a) and cation flux (b) in the blister in the presence of a potential gradient at long dimensionless exposure times (t = 0.0 - 1)

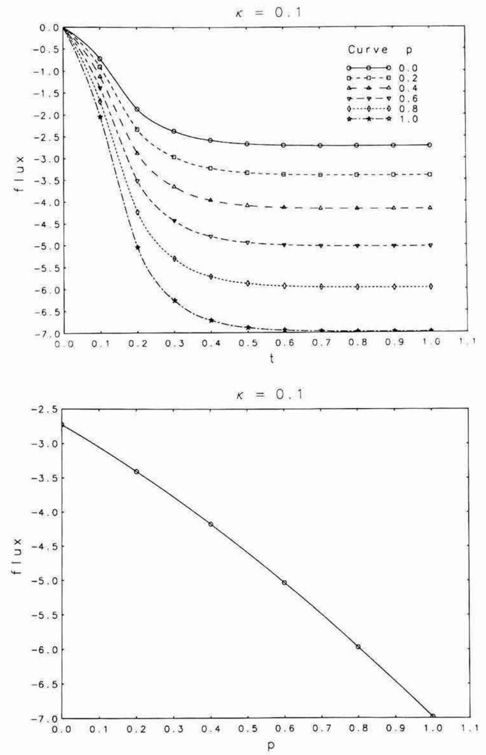

Figure 9—Cation fluxes in the blister: (a) as a function of time for different p values, and (b) as a function of p; both at κ = 0.1

As in the case of no potential gradient, the flux increases rapidly with time for short exposure times, $t < 0.3$ (*Figures* 8a and 9a). This prediction is in general agreement with experimental results for Na^+ and Cs^+ ion uptake in alkyd and polybutadiene coated steel with a defect in the coating and/or under an applied cathodic potential.[38] Cation uptake and cathodic delamination increased very rapidly at first then leveled off as exposure continued (*Figures* 10a and 10b); an induction time was noted for the delamination. The study also found that the area of cathodic delamination was a function of the cation uptake, with or without an applied potential.

These predictions are also in general agreement with recent quantitative experimental data on cathodic blistering of scribed, with no applied potential,[12] and unscribed, with an applied potential,[16] alkyd-coated steel panels exposed to alkali metal chloride solutions. In the presence of an applied cathodic potential, the blistered areas of a 2.5 μm-thick coating on steel containing no intentional defect (but possibly with small unintentional defects) immersed in 0.1 M K, Li, and Na chloride solutions increased rapidly and reached their asymptotic values within 2 to 10 days, depending on pigment type, type of electrolyte, exposure temperature, and metal surface conditions (*Figure* 11a).[16] In the absence of an applied potential but with an intentional defect (scribe), the cathodic blistering of most of the 140-μm thick coatings on steel panels immersed in 0.86 M NaCl solutions was observed to increase rapidly with exposure time up to 1500 hr, after an induction time that varied greatly among the panels (*Figure* 11b).[12]

The effect of the mobility factor p on cation flux into the blister obtained from the model is also consistent with the experimental results; thus, it was observed for alkyd coatings on steel under an applied cathodic potential across the coated panel that the rate of blister formation increased with an increase in applied potential.[16] The study also showed that the rate of blistering of a zinc chromate alkyd coating depends on the type of alkali metal ions in the solution (greatest for K^+ and smallest for Li^+) and attributed the differences to the size of the ions in the hydrated state. The applied negative potential across the coated metal makes the metal cathodic. This accelerates reaction *[2]* with the formation of hydroxide ions, and accelerates the diffusion of alkali metal ions.[22,38] Indeed, in the presence of an applied cathodic potential, the major route for the counterions (for the OH^- ions generated by the cathodic reaction) to reach the cathodic sites is believed to be through the coating, with or without defects in the coating. On the other hand, in the absence of an applied cathodic potential, the migration of the counterions is along the coating/metal interface. Regardless of the route the counterions must take to reach the cathodic sites, the delamintion (i.e., cathodic) mechanism is the same whether there is an applied potential or not.[38] Thus, an increase in the mobility factor p, which corresponds to an increase in the potential difference between the bare metal at the defect and the cathodic regions, appears to have an effect similar to an increase in the applied cathodic potential across the coated metal. Cathodic potential application is commonly used to reduce the corrosion of bare metals, but it is known to increase the cathodic delamination and blistering of coated metal.[10,13] A decrease in p has the same effect as making the coated metal more anodic; it tends to reduce the cathodic blistering but facilitates the anodic blistering of the coated metal.

Figure 12 depicts the change in cation flux into the blister as a function of κ, the ratio between the blister

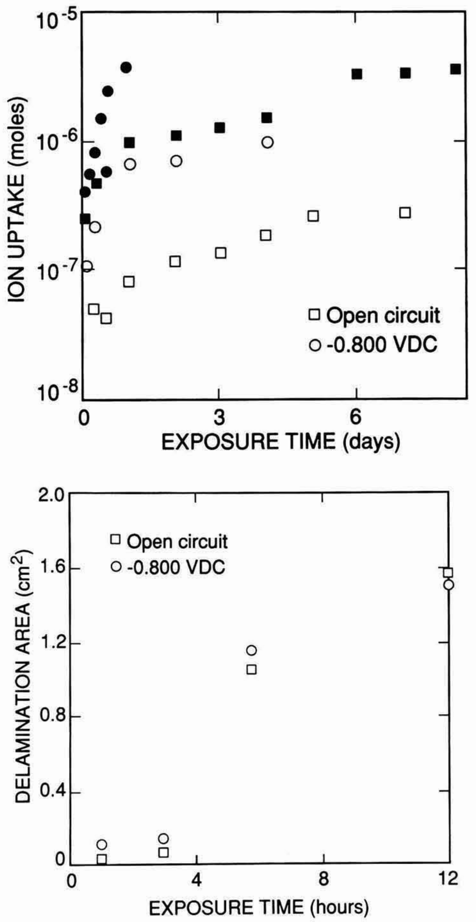

Figure 10—(a) Representative measurements of $^{137}Cs^+$ uptake by an alkyd top coat, 58-66 μm in thickness, during exposure to 0.5 M CsCl solution; open symbols: defect-free coatings, solid symbols: 3-mm-defect coatings; b) delamination of the alkyd top coat, 38-48 μm thick immersed in 0.5 M CsCl solution (after Parks and Leidheiser[38])

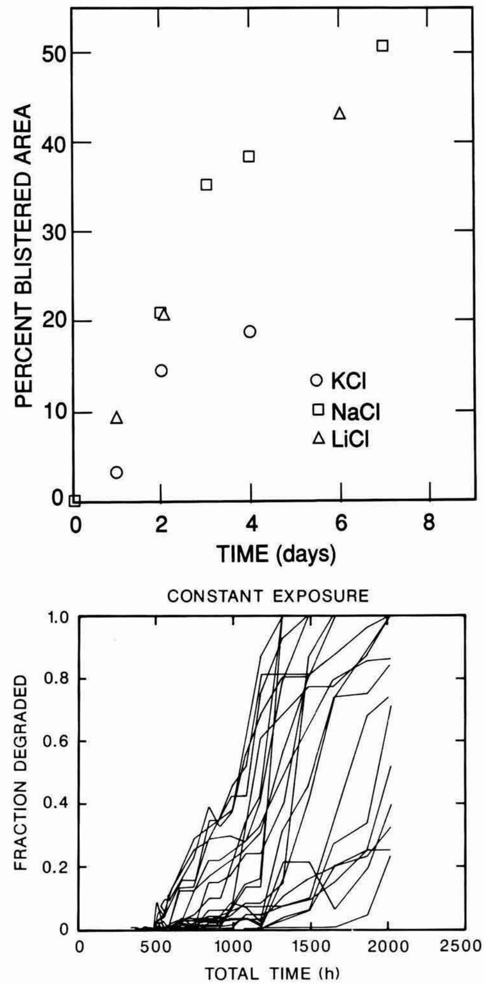

Figure 11—(a) Percent of area blistered as a function of time for a 2.5 μm-thick lead oxide alkyd coating at room temperature and with an applied potential of −1100 mV (vs SCE) (after Rodriguez and Leidheiser[16]); (b) plot of the delaminated (blistered) fraction of the sampling area vs time for 23 continuously immersed panels; each line represents the blistering of a single panel (after Martin et al.[12])

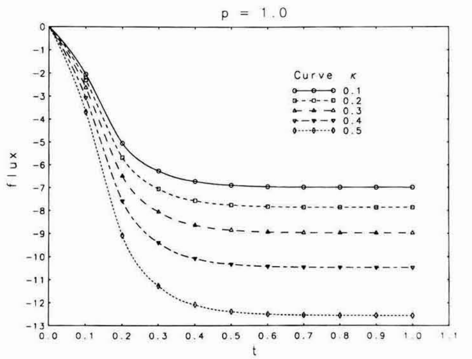

Figure 12—Cation flux into the blister as a function of time for different κ values at constant p

radius and the distance between the center of the blister and the scribe, at a constant potential gradient (p = 1). The flux increases as the blister size increases or the distance between the blister and the scribe is reduced. For two blisters of the same size and under the same potential gradient between defect and blister, the model predicts that a blister that is one-fifth of the distance from the scribe will have almost twice the amount of cation flowing into it. Similarly, if the distance and potential difference between the blister and the scribe are the same, a blister having a radius larger by a factor of five will receive twice as much cation as the smaller blister. No experimental data ia available to test this prediction.

SUMMARY AND CONCLUSIONS

A physical/mathematical model which describes blistering resulting from the corrosion of coated metals with defects in the coating exposed to electrolytes was developed and analyzed. The model is based on the two-dimensional diffusion of cations through some arbitrary medium. Cations migrating along the coating/metal interface from the defect to cathodic sites are assumed to be responsible for the formation of highly water-soluble corrosion products; the resulting water activity differences between the two sides of a coating lead to blistering. Solutions to the model were expressed in terms of two dimensionless variables. Concentration profiles between blister and defect and cation flux into the blister were calculated as functions of time, blister size, distance between blister and defect, ion diffusivity, and potential gradient. The model predicts that cation flux into the blister increases rapidly with time at early ages (before reaching steady state) and almost linearly with potential.

The predictions of the model were related to the available experimental data on cation uptakes and blistering rates for coated steel panels exposed to metal chloride solutions. The predictions of the relationships between flux and time and flux and potential were consistent with general trends in experimental results obtained on (1) blistering rate and area in cathodic blistering, and (2) ion uptake and delaminated area in cathodic delamination of alkyd coatings on steel substrate. No experimental data is available for comparing with the other predictions of the model but experiments using ion-sensitive microelectrodes are being carried out at the National Institute of Standards and Technology to verify the predictions of the model.

Undoubtedly, there will be modifications and refinements of the model as more experimental data become available. However, the development of a physical/mathematical model to predict cathodic blistering and other degradation modes of coating systems should greatly enhance our ability to develop effective protective coatings for metals.

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Structural Painting in Early America

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About 50 years ago, the restoration of Williamsburg, VA, and similar colonial landmarks caught the attention of historians, architects, and the paint industry. Authentic reproduction was their utmost concern. Much emphasis has been placed on reproducing furnishings and ornaments. However, to completely obtain a realistic effect in a restoration effort, thought must be given to the reproduction of the painted surfaces.[1] For the architect to achieve a true reproduction, he must rely on the paint manufacturer to supply material which accurately represents that used during the period. The paint industry must obtain information from historians concerning raw materials in use during the period in question. This knowledge is necessary for the craftsman to successfully produce the illusion of uninterrupted existence.[2]

This paper will attempt to bridge the gap between the historian and the craftsman by studying the history of early American painting. Hopefully, the craftsman will draw beneficial conclusions from the facts obtained in this study.

INTRODUCTION

Until today, color has been the object of most paint research. Color also will be included in this study, along with the effects resulting from the different types of paint, the mode of manufacturing, the quality of raw materials, and the extent of painting which was done in early America.

With modern electronic devices, the reproduction of early American colors by matching paint remnants can be achieved with a great deal of accuracy.[3] However, there are inherent problems in color matching, specifically those associated with pigmentation.

HISTORY OF PAINT MAKING

Pigments used to make paint colors in early America were crude and unstable. Therefore, the colors found on homes built during this period are not fair representations of the original colors.[4] As a result, the modern-day chemist is prevented from accurately determining the degree of color change which has occurred over the years. Raw materials used to make the coatings varied depending on the source and year obtained.[5] Their problems are magnified when we realize that the major part of early American paint was made by the homeowner, in the home, and from raw materials taken from the woods, fields, or his own cellar.[6]

White exterior paints made with linseed oil and white lead do not present the difficulties associated with colored paints. The method used for making white lead in Europe was widely known and recorded as it required a certain degree of scientific knowledge.[7] All the white lead used by early Americans had to come from Europe, since no American manufacturer existed until Samuel Wetherill and Sons of Philadelphia in 1804.[8]

The difference in names for the same color and the difference of colors with the same name also makes the reproduction of early American colors difficult.[9] Dr. Johnson defined purple in the *New England Journal* of May 9, 1738 as "red tincture with blue." Brown was described as "the name of a colour, compounded of black and any other colour." Again, the trouble is clearly seen when one finds that some early Americans spoke of brown-ochre and brown-pink. They called yellows "English pink" and reds "purple brown."[10]

The pigment (or color) is not the only problem area. The unstable materials used for binding the ground pigment to the wall had poor durability. These diverse materials produced known but undetermined changes in the appearance of the paint. Lack of better materials forced colonial craftsmen to improvise, using milk products and egg whites as binders for interior paints.[11] Linseed oil was used as the primary binder in exterior paints, but yellowed with age.[12]

Another source of difficulty emerged in 1765. The passage of the Stamp Act imposed duties on painter's colors, as well as on glass and tea. This forced the early Americans to change the raw materials used for paint manufacture. The fairly uniform colors and oils imported from London were replaced by those manufactured at home. Societies, established in several cities, promoted the use of locally manufactured materials. In January, 1768, the Philadelphia Society reported "a clay found near Newcastle on the Delaware, when used as a paint, retains its colour for years. . . ."[13]

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The problems previously mentioned certainly make recreation of early American landmarks difficult. Therefore, one must learn from documents as well as from the paint remnants as such as possible. A good area to begin with seems to be in the study of the purposes of early American painting.

PURPOSES OF EARLY AMERICAN PAINTING

The recorded comments of observers of early American buildings probably give one the best insight into the purpose of painting. The houses in the large towns of New Netherlands impressed observers as being "very pretty." Madam Knight (teacher of Franklin and friend of the Mathers) wrote of her visit to New York in 1704, stating that the houses were generally of brick, stately and high. The bricks displayed many designs and colors as well as glazing (varnish). The framework was "white scour'd" (whitewashed). In 1656, Hammond, a foreign writer, wrote in his *Leah and Racheal*, "pleasant in their buildings, and continued delightful, the rooms large, daubed and whitelimed, glazed and flowered, and if not glazed windows, shutters made pretty and convenient."[14]

Therefore, it seems clear that the main aim in painting was decorative effect. However, there are some hints of more practical reasons. For instance, the New York Dutch Church during the 1700s was painted with white to reflect light and "reason of cleanliness."[15]

Just as the interior paint had to beautify, exterior paints had a dual role, to beautify and protect. One source states: "The earliest painting was inspired by necessity, as a protective against the weather. It was devoid of any artistic intention."[16]

With the purposes established, the specific colors used many be considered. Colors for paint generally came from two sources. First, materials found on the farm (or frontier) were used. Red, yellow, and gray clays plus various tints from bark, berries, and flower dyes were used. Black was made from charcoal, mahogany from boiling walnuts and blue from indigo plants.[17] By 1710, a second source, the local merchant, provided many materials. The paint trade had progressed somewhat and "Painters Colours" were for sale in Boston.[18] A wholesale merchant, William Allason, of Falsmouth, Virginia (1760-1790), offered fig blue, lampblack, Spanish brown, white lead, Prussian (probably blue or purple), indigo, light blue, and chalk for sale. Other business transaction documents of 1771 and 1772 show that yellow ochre, venetian red, red lead, white copperas, spruce yellow, Spanish whiting, allom, and copperas were added to the merchant's list.[19]

Various colors were offered for sale and purchased for many uses. A variety of surfaces were painted with pumpkin yellow, turkey red, wagon wheel blue, gray, black, buff, deep red, madder, green, winter-green, and indigo blue.[20] The most-used color of Colonial America was dark red (noted in that day as Spanish brown). It was often used in the finish coat, but it also served almost universally as pigment for the primer coat because of its low cost.[21]

WHITEWASH

Discussion on color naming could continue, but any more attention to this point would probably make for a common fault—excessive emphasis on color when the majority of painting was done in white. As previously mentioned, the New York Dutch Church was painted yearly in white. A church in Pennsylvania, Greenwich Hospital chapel, and "many buildings in Halifax, Virginia and vicinity, were painted white."[22] The pigments used for making white paint suffered from crude manufacturing and refining during the 17th and 18th centuries.[23] Therefore, the white of that day was no doubt far less bright than modern day white.

The discussion of whites naturally leads into whitewashing, one of the many types of painting done by the early Americans. Whitewashing came to America with the first English colonist and was without a doubt the earliest form of painting in this country. Governor John Rising of New Jersey reported to the English government in 1654, "there is a very beautiful clay of every kind to be found, white to whitewash houses with, as good as lime, yellow, blue, etc."[24] In general, whitewash can be described as a mixture of any white color in water. The better whitewashes were made by using lime. If lime was not available, local deposits of white clays were used.[25] When neither lime nor deposits of white clays were available, powdered clam shells were used.[26]

The wide use of whitewash was not only due to the good supply of materials, but it was economical and could be used for a variety of practical applications. The extreme low cost of whitewash precipitated the name "the poor man's paint" in 1810. It was applied liberally to the walls in the spring for cleaning effects, to back walls of porches for light reflection, and to fireplace walls for heat reflection.[27]

Of course, white was the most popular wash; however, this same type of painting also was used to apply numerous colors. On the islands of New York, the Dutch houses were painted with a ruddy tone by using blends of lime and old iron ore. Blue and green shades were applied in Pennsylvania.[28] This eastern American practice of washing with colors influenced the first settlers of California to wash their adobe houses with tinted pastel shades of pink, gray, and green.[29]

PAINTING IN EARLY AMERICA

The paints classified as washes had no binder or adhesive material to hold the color to the wall. Therefore, the washes had to depend on being embedded in the rough cracks and pores of the surface for adhesion. However, another group of water paints employed various materials as binders. The adhesives that were the most popular were egg whites and milk products. These two binders made only slight improvements in the quality of the water paints. Hence, like the washes, these paints were only suitable for interior painting.[30] Distemper paints, which were water paints modified with animal glue or melted parchment, must have been an improvement, as they were recommended as replacements for exterior oil paints.[31]

Nevertheless, exterior painting with oil continued to be popular. P.A. Bruce, in his *Economic History of Virginia*, notes that William Fitzhugh imported a large quantity of walnut and linseed oil from England in 1686. For exterior use, the oil was most often pigmented with white lead.[32] Oils were also used to make glazes (varnishes) which were applied to brick exteriors or entire rooms.[33] Another use of oil was noted in the trade name of "Painter-stainer" given to Thomas Childs of Boston in 1701. Oil stains, varnishes made from oils, and white lead oil paints all remained significant until well into the 20th century. However, the oil paints of early America were not like those of only a few decades ago.

The appearance of the finished paint job was affected by the crude manufacturing processes of early America.[34] Most paints were made by hand without the aid of mechanical or power equipment. Unskilled and inexperienced labor, such as Negro slaves, was most often used. Even the professional paintmaker of the early 1700s was a crude operator. This was certainly the case with Thomas Childs. In 1700, he imported from England America's first paint mill, a large stationary stone 12-15 feet square with a hollowed 75-100 gallon trough and a movable smaller stone. The mill operated as the smaller stone worked back and forth on the larger stone until the pigment was dispersed in the liquid.[35]

Just as crude processing affected the final appearance of the paint, the application methods could have had a significance. The only tool for application was the brush. These brushes were not like the present day flat ones, but were round.[36] Not all paint was brushed on in a smooth uniform coat. For special effects, it was sometimes applied by special techniques.

Floors were painted with a basecoat, then colors splattered over this solid coat.[37] In 1750, the board floors of the Linden's home in Danvers, Massachusetts, had painted borders in scroll, fruit, and leaf patterns.[38] In 1796, a French traveler to America remarked about a special paint job in Philadelphia.

> *"An attempt is made to enliven the facades by painting them brick-colour, then painting symmetrical white lines in squares, thus, seemingly outlining the divisions between the bricks. The window trim is painted white in imitation of cut stone."*[39]

John Rhilomath Smith recorded in a London publication in 1723 complete directions for imitating marble.[40]

Even though numerous techniques were used by the very early Americans, a large amount of painting was not done before the latter half of the 1700s.[41] Painting was especially rare in New England, since painters did not appear in any of the lists of workmen from 1670 into the early 1700s.[42] In Boston, the average building from 1650 was an "unpainted frame structure" with shelter as its only purpose. By 1698, a list of workmen in Philadelphia included two painters. In 1686, an individual in Virginia ordered a large quantity of paint material from England. By the latter half of the 18th century, painting had become more common. A traveler of 1784 noted that "many buildings in Halifax, Virginia and vicinity are painted." A contemporary also noted that generally the buildings along the road from Boston to New York were painted. However, even in the 18th century, the majority of painting was done on public buildings.[43]

Although the extent of painting was limited, the variety of surfaces were not. Examples have already been given of interior wall painting which was often done yearly with little or no inconvenience to the inhabitants.[44] Thomas Dobson's *Encyclopedia or Dictionary of Arts and Sciences*, published in Philadelphia in 1799, suggested a color for painting doors, window shutters, arbors, garden seats, rails, balustrades, and wainscotting, whether the surface was wood or iron.[45] Mention has already been made of floors that were painted, as well as exterior surfaces of wood and brick.

Just as the question as to what was painted is clarified from such recorded examples as those cited previously, most aspects of early American painting such as types of paint, colors, period of painting, etc., can be given by the historian to the present day paint craftsman. However, the true reproduction of the early American finishes needs more than basic historical research. There must be an in-depth knowledge of the physical appearance of the coatings as a result of the use of unrefined raw materials, unskilled labor, and crude manufacturing. Even the person with no special technical education or training can realize that paints made in such a crude way will have a rough texture.

Basically, this rough texture gives a finish without gloss or shine regardless of the type of paint. Of course, washes and other interior paints with only egg whites or skim milk as binding material would essentially be only caked powder after the water evaporated; undoubtedly, they would be finishes without gloss or shine. Without a doubt, this is the meaning of the term "dead white," which was adopted in this country in 1766 and mentioned as being the style in London.[46] The Lucas house of Williamsburg still retained its "dead black paint" in 1928.[47] Therefore, the use of bright shiny bathroom tiles, high gloss baked enamel cabinets and appliances, rubbed lacquered furniture, and high lustre exterior paints would destroy all efforts of authentic restoration.

CONCLUSION

In conclusion, many problems may be seen in the reproduction of early American finishes. There are special problems due to color changes with time, which are helped but not completely solved by the historian, architect, paint manufacturer, and craftsman working together. Also, we see that the appearance of the finish resulted from more factors than might seem apparent from a quick reading of the historian's findings. Lastly, we find that for true authenticity, the texture of the paint must be stressed, not just the color, as has been done in the past.

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Candee, R.M., "Housepaints in Colonial America," *Color Engineering*, IV, 26-34, September-October 1966.

Part I is the preparation, sales and storage of colors. This is a very thorough source with a good list of references.

Candee, R.M., "Housepaints in Colonial America," *Color Engineering*, IV, 24-26, 30, January-February 1967.

Part II is a very detailed account of the materials used, their manufacture, and application. A good listing of early American colors. Several more references are added.

Candee, R.M., "Housepaints in Colonial America," *Color Engineering*, IV, 37-43, January-February, 1967.

Part III deals with the problems of nomenclature of colors and discusses in detail each type of pigment. Especially good history of white lead. Large amount of references given.

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Factors Affecting Titanium Dioxide Dispersion in Trade Sales Paints

A. Brisson and A. Haber
Tioxide Canada Inc.*

The manufacture of alkyd and latex trade sales paints requires that their components be carefully combined so as to minimize any adverse effects. Because of the complexity of most paint systems, problems can be encountered during the manufacturing process, including rheological and colloidal problems. A variety of factors have been studied in terms of their effects on titanium dioxide dispersion in both latex and alkyd trade sales paints using the flocculation gradient technique. It will be shown that a good knowledge of the effect of these factors on pigment dispersion is essential to ensure a quality product.

INTRODUCTION

The optical, rheological, and mechanical properties of a paint are profoundly affected by the state of dispersion of the titanium dioxide (TiO_2) pigment. A great deal of effort, as a result, is made by the paint technologist to control and understand the paint manufacturing process so as to obtain a stable deflocculated dispersion of the pigment in the system.

The dispersion process[1] relates to the process of incorporating TiO_2, in the form of a powder, into a liquid medium such that the final product consists of fine particles distributed throughout the medium. Ideally, the TiO_2 particles should be dispersed in the system in the form of single crystals. However, in actual practice, the pigment particles are never completely present as single discrete crystals, but rather as groups of crystals in the form of aggregates, agglomerates, and flocculates.[2] While the presence of agglomerates and aggregates is related to the pigment manufacturing process, the presence of flocculates is directly related to the stability of the pigment dispersion.

Individual TiO_2 particles will recombine by the process of flocculation in an unstable dispersion. This recombination occurs due to the pigment particles colliding under static (Brownian motion) and dynamic (shear) conditions. The probability of flocculates being formed, given such conditions, depends on the stability of the pigment dispersion, which in turn depends on the attractive and repulsive forces which exist between the colloidal particles.[3]

Steric and charge stabilization are the two key mechanisms used to ensure pigment stability in dispersions. While both mechanisms occur simultaneously in all paint systems, steric stabilization is the principal mechanism acting in non-aqueous systems, while charge stabilization predominates in aqueous systems.

Steric stabilization is achieved by the adsorption of resin and solvent at the TiO_2 pigment surface. The degree of stability obtained is influenced by the conformation adopted by the resin and the degree of resin solvation achieved.[4] The type of surface treatment on the pigment largely determines the degree of pigment/resin interaction[5] and, hence, the stability of the dispersion. Charge stabilization is achieved by the adsorption of ionized molecules on the pigment's surface. By inducing a repulsive charge at the surface, individual pigment particles are kept apart.

The degree of pigment dispersion in a latex paint, in general, will be poorer than that in a solvent based paint, thus resulting, for example, in poorer performance in terms of hiding power. An explanation for this difference can be given in terms of the acid-base nature of the TiO_2 surface treatment. In alkyd paints, the adsorption of the resin is influenced by the alumina/silica ratio in the pigment surface treatment.[6] A more complicated situation exists in water based systems, because of the number of different paint additives which can be adsorbed onto the

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Table 1—Effect of TiO_2 Surface Treatment

Pigment	Mean Crystal Size (μm)	Inorganic Coating	Flocculation Gradient	Contrast Ratio at 1 mil	Gloss 20° (units)
A	0.23	Al_2O_3	0.29	95.7	76.1
B	0.23	Al_2O_3 and SiO_2	0.34	95.4	74.5

pigment surface and because a lower level of additives may be adsorbed. This point is illustrated by noting that the adsorption of solids in water based paints[5] (1.5-8.5 mg/g pigment) is lower than that of solvent based paints[6] (13-27 mg/g pigment).

There are many methods by which the state of pigment dispersion can be studied, in either liquid or in dried paint films, the most common being: fineness of grind gauge,[7] sedimentation analysis,[8-10] rheological behavior,[11] and color strength.[12,13] These techniques are relatively simple to use but provide only qualitative information on the state of pigment dispersion.

More sophisticated techniques include electron microscopy,[9,10] light scattering techniques,[14,15] acoustic microscopy,[16-18] free volume microprobing,[19] and proton scattering.[20,21] Such techniques are capable of providing quantitative data on the state of pigment dispersion, but often require special sample preparation techniques and are relatively expensive to use. Sample preparation techniques are always suspect in that they may change the existing degree of pigment dispersion. An alternate technique, the flocculation gradient technique, can be used to monitor pigment dispersion in both liquid and dry paint films without having to use any special sample preparation procedures. In addition, this technique provides quantitative information on the degree of pigment dispersion.

The objective of this work is to analyze the factors which affect TiO_2 dispersion in trade sales paints, using the flocculation gradient technique. Thus, we will describe how factors such as the pigment surface treatment, rheological additives, milling resin concentration, and paint manufacturing process can influence TiO_2 dispersion in alkyd paints. For water based paints, the factors studied include the effects of coalescing agents and dispersants. A comparison also was made between alkyd and latex paints where both laboratory prepared and commercial samples were analyzed for pigment dispersion.

EXPERIMENTAL

Flocculation Gradient Technique

The flocculation gradient technique (FGT) was developed by Balfour and Hird[22] to specifically study the degree of TiO_2 dispersion in simple paint systems. This technique was subsequently applied to study paints containing other white, iron oxide, and colored organic[23] pigments. The FGT is based on the measure of the amount of backscattered infrared radiation (relative to barium sulfate) at a wavelength of 2500 nm as a function of dry film thickness. Reference (24) provides a complete description of the apparatus used. The flocculation of TiO_2 crystals causes an increase in the mean particle size, which results in preferential light scattering at 2500 nm. A plot of backscatter versus dry film thickness yields a straight line whose slope increases with increasing flocculation. The slope of this line is what is called the Flocculation Gradient (FG). Paints with high FG have been shown to possess low opacity, gloss, and color in both latex and alkyd paints.[22-24]

The degree of pigment dispersion in liquid samples can also be measured using this technique. This method involves the measurement of backscattered infrared radiation of a wet film of constant thickness, 40 μm. The reflectance value at 2500 nm expressed, as R_w^{40}, has been found to be proportional to the degree of dispersion in the dry paint film.[23] This approach, as a result, can be useful as a quality control test.

Opacity (Contrast Ratio)

Three films of each paint, having different nominal wet film thickness, were applied to a polyester sheet using wire wound applicators. After a drying period of 48 hr, the reflectance over black and white standard tiles was measured using a HunterLab D25-9 colorimeter and contrast ratio was calculated as follows:

$$\%\ \text{Contrast ratio} = \frac{\text{Reflectance over black substrate}}{\text{Reflectance over white substrate}} \times 100$$

Using experimentally determined film weight and calculated dry specific gravity, the actual thickness of each film was determined. A plot of contrast ratio against reciprocal film thickness was constructed, and by graphical interpolation the contrast ratio at a film thickness of one mil determined.

Gloss

Gloss values were obtained by drawing down each paint film on glass panels using a six mil U-bar. The films were allowed to dry for seven days at room temperature and then measured for gloss using a HunterLab D48-7 glossmeter. Reported gloss values are averages obtained from five different panels.

Table 2—Effect of Rheological Additives

Additive	Sag[a] Resistance	Leveling[b]	Contrast Ratio at 1 mil	Flocculation Gradient	Gloss 20° (units)
No additive ...	5	10	95.3	0.32	77.7
A	6	10	94.5	0.59	72.7
B	5	10	94.9	0.38	74.6
C	12	6	94.0	0.61	71.2
D	12	4	93.5	0.94	54.1
E	5	10	94.7	0.57	74.0

(a) Mils of wet paint that do not produce sagging.
(b) 0 = worst; and 10 = best.

Table 3—Effect of Mill Base Resin Concentration on Pigment Dispersion

Mill Base Resin Concentration	Flocculation Gradient Increasing Anti-Settling Agent Concentration			
10%	0.35	1.08	1.88	2.30
20%	0.32	1.08	1.76	2.05
30%	0.33	1.09	1.68	2.03

Table 4—Effect of Mill Base Resin Concentration on Opacity

Mill Base Resin Concentration	Contrast Ratio at 1.0 mil Increasing Anti-Settling Agent Concentration			
10%	94.9	93.2	91.1	90.6
20%	94.9	93.3	91.4	90.6
30%	95.1	93.4	91.7	90.8

ALKYD PAINTS

Titanium Dioxide Surface Treatment

Steric stabilization induced by the adsorption of solvated resin at the pigment surface is the predominant stability mechanism in alkyd paints. Goldsbrough and Peacock[6] showed that a variety of conditions must be fulfilled for an adsorbed polymer layer to confer stability to a pigment dispersion. These conditions are directly related to the conformation adopted by the solvated resin at the pigment surface. Resin molecules that are extended from the pigment surface will increase the repulsive force between particles, and thus increase the flocculation resistance.

Modifying the surface properties of a pigment will result in changes to the chemical interactions which occur between the resin molecules and the pigment surface, and thus lead to changes in the degree of stabilization. It has been demonstrated, in adsorption studies,[25,26] that TiO_2 coated with alumina, silica, or a mixture of both will exhibit different adsorption characteristics. The pigment resin interactions, when using an alumina treated pigment, were shown to result in adsorbed polymer molecules extending in loops from the surface. This configuration is expected to increase the stability of the pigment dispersion. A pigment treated with silica, however, has been shown to result in a compact adsorbed resin layer which extends very little into the surrounding medium, thus decreasing the degree of stability. As a result, we would expect silica treated pigments to exhibit a higher degree of flocculation than alumina treated pigments.

To illustrate the effect of the pigment surface treatment upon pigment stability, the FGT was used to study the dispersion of two commercial TiO_2 pigments (*Table* 1). These pigments are identical except for the surface treatments used. The pigments were ballmilled in a long oil alkyd resin to a final pigment volume concentration (PVC) of 20% and evaluated using the FGT. The paints prepared using pigment A, treated with alumina, were found to have a lower flocculation gradient, slightly higher opacity, and higher gloss than the paints prepared using pigment B, which had a silica surface treatment (*Table* 1).

Rheological Additives

Rheological additives are widely used in the manufacture of alkyds paints to control viscosity and impart better pigment anti-settling properties. The latter is generally performed through controlled pigment flocculation. The weak forces holding the flocculates together form a pigment settlement that is soft, voluminous, and easily redispersible. However, uncontrolled flocculation can have a detrimental effect on the opacity and gloss of a paint.

To illustrate the effect of using rheological additives, five commercial rheological additives were added at a level of 2.5% (based on pigment weight) to a 20% PVC alkyd paint and evaluated using the FGT. The results, as shown in *Table* 2, indicate that when a rheological additive is used, the FG value increases when compared to the control. As a result, the gloss and opacity values were lowered. It is interesting to note that significant differences in the FG were observed depending on the type of additive used. For example, rheological additive D increased substantially the FG value, which consequently affected the opacity and gloss values. In addition, the use of additive D produced a paint with the highest sag resistance and the poorest leveling.

The use of a rheological additive can effectively improve the flow and leveling properties of a paint, but also increases the pigment flocculation, as suggested by Hall[29] and Melville.[5]

Mill Base Resin Concentration

The addition of a concentrated resin solution to a highly pigmented mill base is known to cause "pigment shock," that is, reagglomeration of the pigment particles. Daniel[27] attributed pigment shock to the gradual diffusion of solvent across the interface between the mill base and the more concentrated resin solution. The diffusion of solvent results in desolvation of the dispersion medium, which consequently becomes physically incapable of sustaining a high concentration of pigment. The resin con-

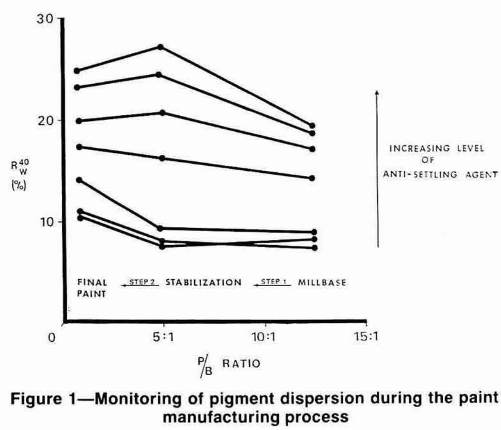

Figure 1—Monitoring of pigment dispersion during the paint manufacturing process

centration in the mill base is therefore expected to have a significant effect on the degree of pigment dispersion in the final product.

To study the effect of varying the mill base resin concentration upon pigment dispersion, a series of paints was prepared in a ballmill using a commercial grade of TiO_2 pigment and evaluated using the FGT. The pigment was ballmilled at 10, 20, and 30% long oil alkyd resin concentration. Various levels of an anti-settling agent were added to induce pigment flocculation in the mill base. The mill bases were then diluted with the required amount of resin, solvent, and additives to obtain a 20% PVC paint. *Tables* 3 and 4 illustrate the effect of increasing milling resin concentration on flocculation gradient and opacity.

The results show that as the milling resin concentration increased, the flocculation gradient decreased and the opacity increased. In addition, the use of an anti-settling agent induced pigment flocculation. It is interesting to note that varying the mill base resin concentration had very little effect on the pigment dispersion, for the paints having a low level of anti-settling agent. The FG for the poorly dispersed paints, that is, high levels of anti-settling agent, was found to decrease as the mill base resin concentration increased. This demonstrates the instability of paints milled at low resin concentrations.

Manufacturing Process

The quality of a finished paint is greatly dependent on the way in which the various components are combined. The interactions between the various components during the manufacturing process will undoubtedly affect the overall performance of the paint. Daniel[27] demonstrated that these interactions, if not carefully controlled, can cause many problems. These problems include pigment/vehicle incompatibility, co-flocculation, syneresis, microscopic phase separation, and color separation.

Careful dilution of the mill base has been known to prevent pigment shock or "seeding." The dilution is preferably performed in a stepwise process, where increments of vehicle solids are added at a concentration close to the mill base concentration. A more practical two-step process is often employed, that is, the mill base first is partially diluted (stabilization step) and then the remaining resin solution and additives are added (let down stage) to produce the final paint.

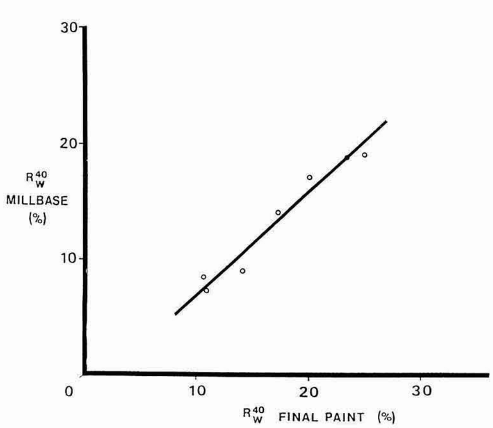

Figure 2—Relationship between pigment dispersion of a mill base and a paint

Table 5—Effect of Coalescing Solvent Type on Gloss Development and Pigment Dispersion

Coalescing Solvent	Flocculation Gradient	Contrast Ratio at 1 mil	Gloss 20° (units)
2-Butoxyethanol	0.88	95.2	70.3
Isodecyl benzoate	0.90	94.9	66.7
Butyl Carbitol Acetate ..	0.92	94.8	63.2

Table 6—Effect of the Point of Addition of Isodecyl Benzoate on Gloss Development and Pigment Dispersion

Point of Addition	Flocculation Gradient	Contrast Ratio at 1 mil	Gloss 60° (units)
Mill Base	1.14	94.7	59.1
Stabilization	1.18	94.6	56.3
Final paint	0.90	95.0	70.3

In this study, the dilution process has been investigated in terms of pigment dispersion. The variation in the reflectance of a 40 μm wet film was used to detect the presence of flocculation during the manufacturing stages. A series of 20% PVC alkyd paints was prepared by ballmilling the pigment and a long oil alkyd resin solution at a pigment binder ratio (P/B) of 12:1. The mill base was further diluted at a P/B of 5:1 and finally brought to a final P/B of 0.9:1. Various levels of an anti-settling agent were also added to induce partial flocculation during the milling process. The infrared scattering measurements obtained are shown in *Figure* 1.

The results illustrate that for the well dispersed paints (i.e., a low level of anti-settling agent) the addition of the resin solution to the mill base (step 1) did not affect pigment dispersion. Further addition of resin solution (step 2), which includes several additives, resulted in a slight increase in the infrared scattering. The increase in flocculation is attributed to the presence of the driers and the anti-skinning agent added in step 2, as suggested by Hall.[28] For flocculated mill bases (i.e., those having high levels of anti-settling agent), the stabilization stage induced pigment flocculation, which can be explained by the increased instability of the initial mill bases. Further addition of the let down resin solution and additives did not induce further pigment flocculation.

It is important to note that as the P/B ratio decreases, the pigment concentration decreases in the system. As a result, care must be taken when interpreting the R_w^{40} values. An increase in the R_w^{40} value indicates increasing pigment flocculation, however a decrease in the R_w^{40} value may be due to dilution of pigment flocculates. *Figure* 2 illustrates that the degree of dispersion in the mill base is directly related to the degree of pigment dispersion in the final paint.

Table 7—Effect of Dispersant (Methacrylate) Level on Pigment Dispersion

Dispersant Concentration	Flocculation Gradient	Contrast Ratio at 1 mil	Gloss 60° (units)
0.4%	1.15	94.3	64.2
0.8%	1.15	94.2	64.1
1.0%	1.05	94.5	65.5
2.0%	0.94	94.5	63.5
5.0%	0.92	94.5	59.8

Table 8—Comparison of Alkyd and Latex Paints

Paint	PVC (%)	Volume Solids (%)	Flocculation Gradient
Alkyd	20	33	0.32
Alkyd	20	42	0.31
Latex	20	33	1.08
Latex	20	42	1.04

LATEX PAINTS

Coalescing Aids for *High Gloss Emulsion Paints*

A coalescing aid is a solvent with a high boiling point which, when added to a coating, aids in film formation via temporary plasticization. By using a high boiling point solvent, the coalescing process is prolonged, and thus permits the formation of a glossier film. Gloss development is very dependent on pigment dispersion, especially for high gloss paints. A small increase in flocculation can cause a marked loss in gloss.

The effect of various coalescing solvents on the FG of high gloss emulsion paints was studied in detail. *Table* 5 shows how the use of different coalescing solvents results in significant differences in the measured gloss values. During the drying process, when the liquid phase has evaporated leaving the latex and pigment particles crowded together, and the latex begins to coalesce, the temporary plasticization of the latex may influence the efficiency of the coalescing process, with a corresponding decrease in gloss. The point at which the coalescing solvent is added during the manufacturing process has also been found to affect gloss development, as shown in *Table* 6.

Dispersants

Dispersants are used to provide a physical barrier around pigment particles to prevent flocculation. The amount of dispersant is usually determined by flow point methods. The concentration of dispersant that results in monolayer coverage is theoretically the point of maximum stabilization (better dispersion) and corresponds to a minimum viscosity. The use of the optimum amount of a dispersant, rather than an arbitrary amount, results in raw material cost savings.

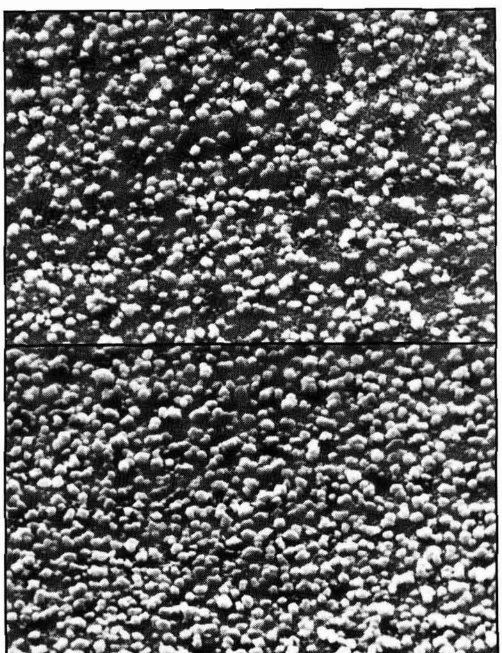

Figure 3—Level of dispersion in a 20% PVC alkyd paint

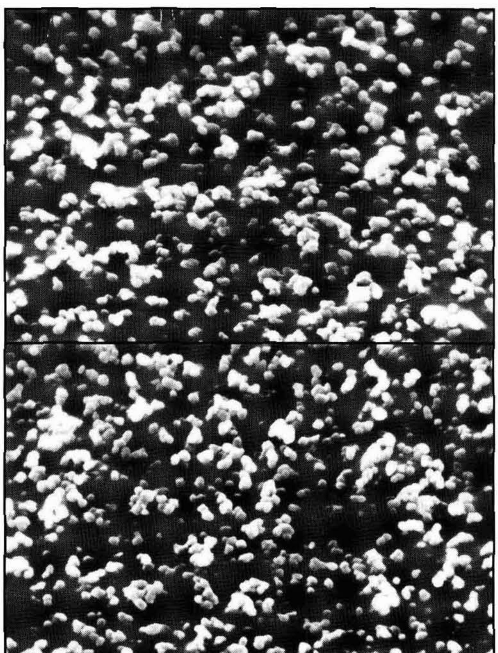

Figure 4—Level of dispersion in a 20% PVC latex paint

Table 9—Analysis of Commercial Gloss Alkyd Paints

Paint	Specific Gravity	Non-Volatile (%)	Ash (%)	P/B ratio	TiO_2 (g/L)
A1	1.12	62.2	24.1	0.63	254
A2	1.29	74.6	32.4	0.77	246
A3	1.16	69.8	25.9	0.59	267
A4	1.12	60.7	27.2	0.81	204

Table 10—Analysis of Commercial Gloss Latex Paints

Paint	Specific Gravity	Non-Volatile (%)	Ash (%)	P/B ratio	TiO_2 (g/L)
E1	1.20	48.1	19.9	0.70	222
E2	1.22	48.1	19.5	0.68	219
E3	1.25	49.1	23.7	0.93	279
E4	1.21	46.8	20.6	0.78	194

Table 11—Physical and Optical Properties of Commercial Gloss Alkyd Paints

Paint	Flocculation Gradient	R_w^{40} (%)	Contrast Ratio at 1 mil	Gloss 60° (units)	L Value
A1	0.70	16.8	94.5	93.2	89.1
A2	0.38	13.9	91.6	90.5	90.4
A3	0.61	14.0	91.2	90.6	92.6
A4	0.52	15.7	92.1	86.8	90.6

Table 12—Physical and Optical Properties of Commercial Gloss Emulsion Paints

Paint	Flocculation Gradient	R_w^{40} (%)	Contrast Ratio at 1 mil	Gloss 60° (units)	L Value
E1	1.08	8.9	94.2	68.6	91.6
E2	1.72	11.5	94.2	53.9	89.9
E3	0.72	8.80	97.4	58.4	90.1
E4	1.14	12.2	93.2	44.8	91.9

To illustrate the effect of dispersant level on pigment dispersion, the concentration of a commerical dispersant (methacrylate) in a 20% PVC latex formulation was varied from the minimum (as determined by minimum viscosity) to 5% on pigment weight. As expected, the overall performance was found to decrease as the dispersant level increased above 1% (recommended level by the manufacturer), as shown in *Table* 7. A high dispersant level resulted in a lower gloss, which surprisingly was also associated with a lower flocculation gradient. The reason for this is not clear and was observed again when 40% of the dispersant was replaced by a co-dispersant.

COMPARISON OF ALKYD AND LATEX PAINTS

The FGT was used to compare the TiO_2 dispersion of a latex and alkyd paint having the same PVC and volume solids. The results, shown in *Table* 8, indicate that latex paints exhibit higher flocculation gradients than their alkyd counterparts. The volume solids of the paints, in addition, did not affect the flocculation gradient values. Scanning electron micrographs are presented in *Figures* 3 and 4. These micrographs clearly show the TiO_2 to be more flocculated in the case of the latex paints.

To gain an appreciation of the effects of pigment dispersion on the opacity of commercial paints, an evaluation was also undertaken to measure the FG of several commercial gloss alkyd and gloss latex paints. These paints were examined for opacity, composition, and degree of pigment dispersion. To assess the pigment concentration in these paints, the ash and non-volatile (NV) contents were determined. The ash content, in this study, was assumed to be composed entirely of TiO_2, with any additive residues being ignored. Ash and NV contents were used to calculate the P/B, again assuming that these paints did not contain extenders. The specific gravity of each paint was determined using a weight per gallon cup, thus enabling the pigment concentration in terms of grams of TiO_2 pigment per liter of paint to be derived.

The results of our evaluation are presented in *Tables* 9-12. It was observed that the commercial latex and alkyd paints evaluated possessed P/B ratios ranging from 0.6 to 0.9. These variations resulted in variations in the optical and physical properties of the paint. Nevertheless, these results show that gloss latex paints possess higher flocculation gradients than their alkyd counterparts. Although the paints evaluated are marketed as being white, some of the paints tested contained a toner pigment, as is clearly illustrated by their reduced brightness. This is known to have a positive effect on opacity (e.g., paint Al in *Table* 11). This is not due to efficient utilization of TiO_2 but rather to the addition of the toner.

CONCLUSION

The effect of such factors as the pigment coating, rheological additives, mill base resin concentration, and manufacturing process on pigment dispersion was illustrated using alkyd paints, while the effect of such factors as dispersants and coalescing aids on pigment dispersion was illustrated using latex paints.

Paints are complex systems in which the interactions between the different components have to be carefully balanced to ensure a quality product. The flocculation gradient technique has proved to be a useful technique in providing a quantitative analysis of the state of titanium dioxide dispersion in both alkyd and latex paints. This technique was used to illustrate the effect of several factors on pigment dispersion of trade sales paints.

Finally, an appreciation was gained of the differences between the degree of dispersion and opacity of commercial North American paints.

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Effect of the Di-Iron Phosphide Conductive Extender on the Protective Mechanisms of Zinc-Rich Coatings

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Impedance measurements are primarily utilized in this paper to obtain information about the effect of replacement of part of the zinc by Fe_2P extender on the anti-corrosive properties of zinc-rich coatings. In particular, attention is focused on the performance of these coatings as porous electrodes (with a large anodic surface), and on the evolution of the barrier effect during coating exposure to a saline solution.

INTRODUCTION

The incorporation of the conductive extender Fe_2P in zinc-rich paints (ZRP) has been studied by a number of workers.[1-5] A combination of experimental techniques, including visual inspection, measurement of cathodic protection potential, polarization, and impedance measurements, have been used to estimate the behavior of these coatings in their exposure to corrosive solutions and atmospheres.

In this new study, impedance measurements over a wide frequency range are used in an attempt to complete the information available on the behavior of ZRPs co-pigmented with Fe_2P. This technique has proven to be particularly useful in previous research with conventional zinc-rich coatings without this conductive extender.[6,7]

Determinations of rest potential of ethyl silicate zinc-rich coatings have shown that the replacement of a part of the zinc by Fe_2P can be achieved with little decrease in the duration of the stage of cathodic protection of the steel; however, the effect of Fe_2P has been questionable in epoxy-polyamide coatings.[3] In this paper, an attempt is made to connect these results with the tendency of the coating to behave as a porous electrode, since the large surface of a porous electrode promotes the galvanic action of the ZRP coating.

Previous research by the authors demonstrated the usefulness of impedance measurements for assessing the progress of the barrier effect in ZRP coatings, through the measurement of the chord length of the high frequency arc in the Nyquist diagram and the value of the Warburg coefficient calculated from the low frequency diffusion tail.[7] In this paper, using a similar experimental technique, the effect of Fe_2P additions on the development of this ZRP protection mechanism is studied.

To this end, a series of ZRPs were used with varying proportions of zinc and Fe_2P particles and two types of vehicle, ethyl silicate and epoxy-polyamide, which have quite distinct properties.

EXPERIMENTAL PROCEDURE

The experimental technique used for impedance measurements of ZRP coatings has been described in a previous paper.[6] The electrolyte used was a sodium chloride solution of 3% (by weight).

The discussion of the electrodic behavior of the ZRP coating is based on a comparison between the corrosion values of zinc corrosion when estimated electrochemically (from the impedance diagrams) and those determined through the gas evolution method.[8] Using the Stern-Geary equation,[9] the corrosion rate of the zinc particles in the coating is related to the charge transfer resistance of the corrosion process. This electrochemical estimation only refers to the zinc particles which are interconnected electrically and are also in electric contact with the steel base. These are the only particles which respond to the electrical signal applied during the measurements. When

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the electrode acts as a flat electrode, the diameter of the arc of the higher frequencies in the impedance diagram provides the value of the charge transfer resistance. In this case, the integration with time of the Stern-Geary equation permits the calculation of the corrosion of the total of zinc particles acting as an electrode. If the zinc particles behave like a porous electrode, the false value of charge transfer resistance deduced from the impedance diagram leads to higher corrosion values than the real ones.[6]

However, the real value of the corroded zinc is obtained via the so-called gas evolution method,[8] in which the metallic zinc remaining in the coating is proportional to the volume of hydrogen gas evolved in the reaction between the ZRP coating and the HCl. It should be noted that in contrast to the electrochemical measurement, the corrosion data in this test refer to all the zinc particles whether they are interconnected or not.

RESULTS AND DISCUSSION

As stated in a previous paper,[6] the Nyquist diagrams obtained from ZRP coated steel samples often show one or two arcs. The arc drawn at higher frequencies is related to the charge transfer reaction or to the parallel combined effect of ionic resistance and capacitance of the insulating layer. The low frequency arc is either related to a charge transfer reaction or a diffusion process in a layer of finite thickness. Often, the diffusion tail with a curved appearance masks the semicircle belonging to the charge transfer reaction.[6,7]

Figures 1 and 2 show a synthesis of the impedance diagrams for the ZRP coatings co-pigmented with the Fe_2P conductive extender.

Action of ZRP Coating as a Porous Electrode

As mentioned previously, it is interesting to determine whether the coating response to the application of an electrical signal is that of a porous electrode.[6] If this is so, the response will indicate the existence of a high degree of electrical interconnection among the conductive particles of zinc and Fe_2P, which would be favorable to the galvanic activity of the coating providing cathodic protection to the steel substrate. On the contrary, if the coating acts as a flat electrode, it will indicate a low number of conductive particles in electrical contact, and thus a much lower anodic surface of the zinc (greater polarization) for the cathodic protection of the steel. The

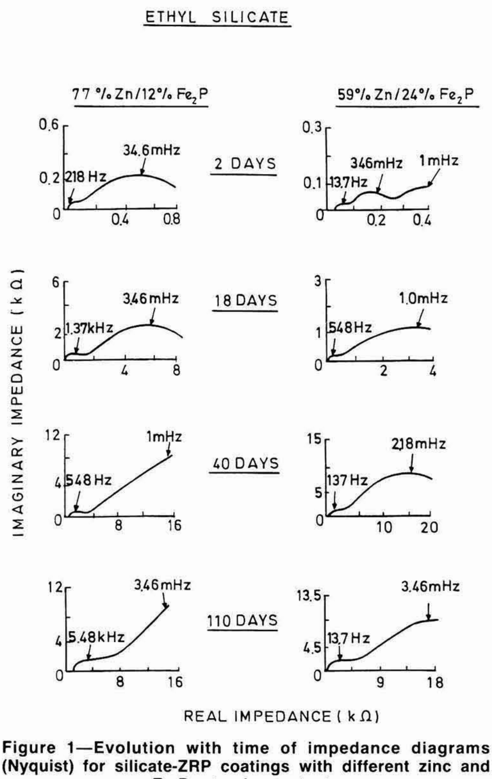

Figure 1—Evolution with time of impedance diagrams (Nyquist) for silicate-ZRP coatings with different zinc and Fe_2P extender contents

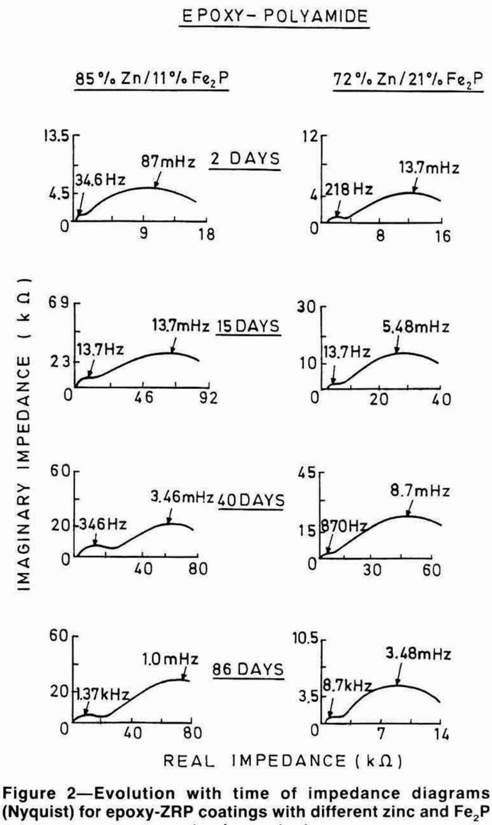

Figure 2—Evolution with time of impedance diagrams (Nyquist) for epoxy-ZRP coatings with different zinc and Fe_2P extender contents

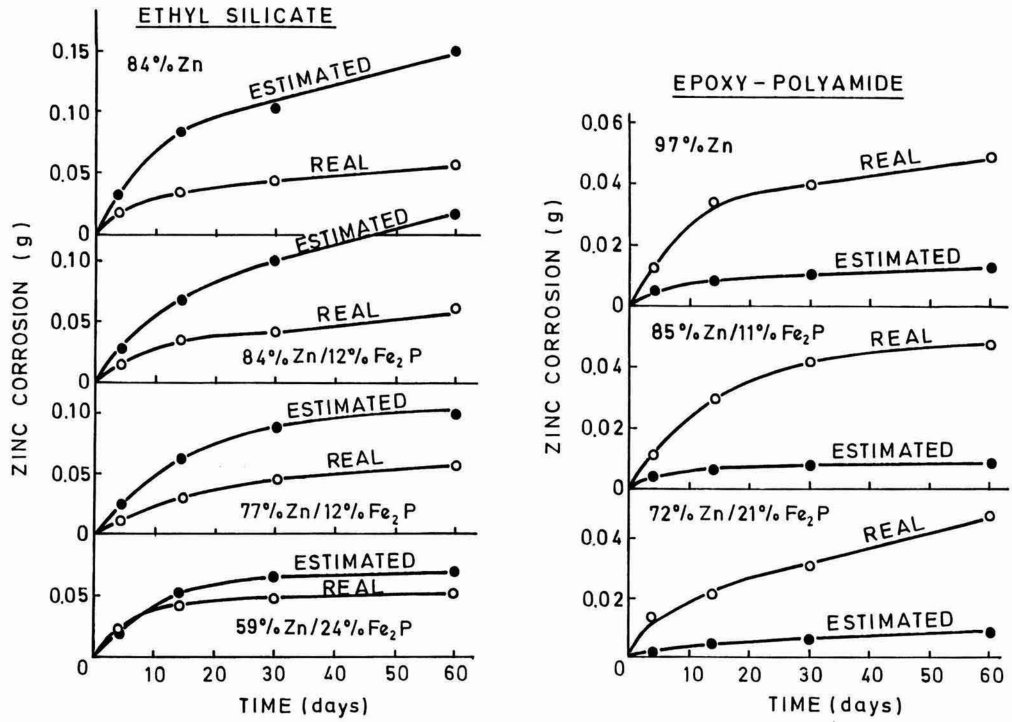

Figure 3—Comparison of the corrosion values estimated for zinc from the electrochemical measurements with the real values. Data are referred to 3.1 cm² of coating surface

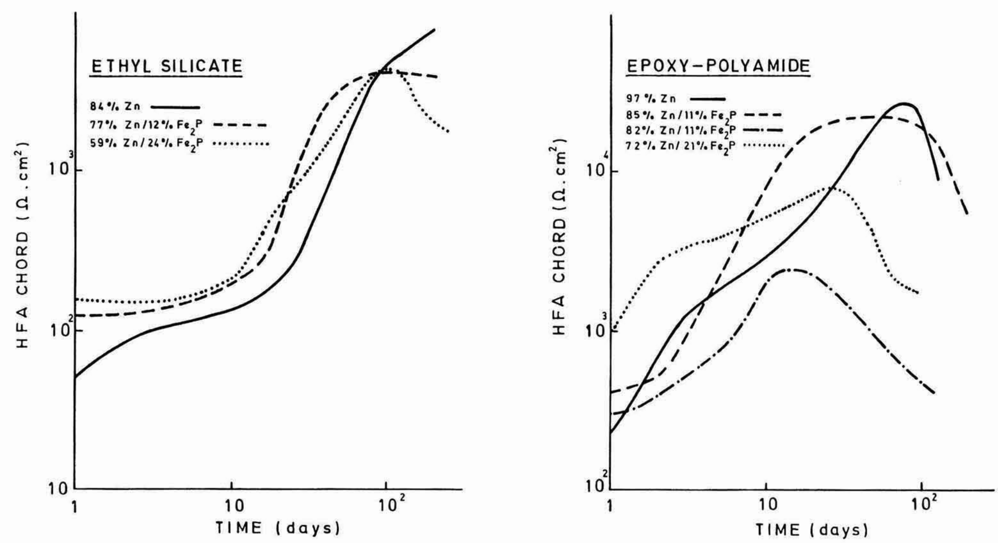

Figure 4—Evolution with time of the higher frequency arc chord length

question to ask, therefore, is: does the presence of the conductive extender substantially modify the tendency of the zinc-rich coating to act as a porous electrode?[6]

The comparison of the corrosion values estimated for zinc from the electrochemical measurements with the real values obtained using the hydrogen evolution method provides information on the matter. *Figure* 3 shows that, regardless of the percentages of zinc and Fe_2P used, the corrosion values estimated electrochemically for ethyl silicate ZRPs are always greater than the real values, while with epoxy-polyamide ZRPs, the opposite occurs. In the first case, the conclusion is that the ZRP coating behaves like a porous (or a rough) electrode,[6] in which most of the zinc and extender particles maintain electrical contact between each other and with the steel base. In the second case, the ZRP coating behaves like an electrode with a small surface, as the estimated corrosion values are always lower than the real ones. This situation tends to occur in coatings with few conductive particles in electrical contact (i.e., with relatively low percentages of zinc and Fe_2P particles, when the paint vehicle is a good insulator or after prolonged periods of attack, and when a layer of corrosion products has built up around the particles).

In general, the results of this study show that ZRPs with an ethyl silicate vehicle and additions of Fe_2P have a clear tendency to act as porous electrodes, probably because the majority of the conductive (metallic and extender) particles are in electrical contact with each other as well as with the steel base. However, epoxy-polyamide paints seem to act like a flat electrode of small surface in which only a few number of conductive particles maintain electrical contact.

These results are similar to those found in a preceding study using ZRP formulated without the conductive extender.[6,7] Hence, the addition of Fe_2P particles does not substantially modify the propensity of the silicate coatings to act as porous electrodes, nor those with an epoxy vehicle to act as small surface electrodes.

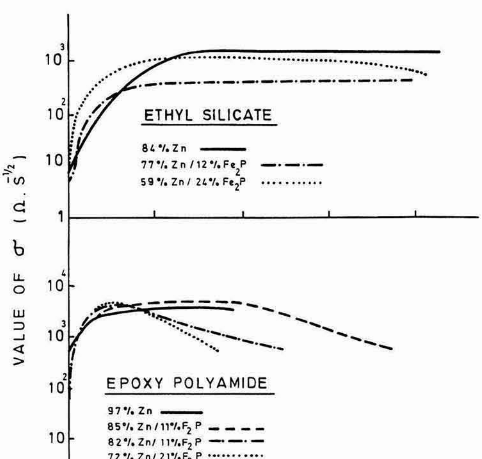

Figure 5—Evolution with time of the Warburg coefficient

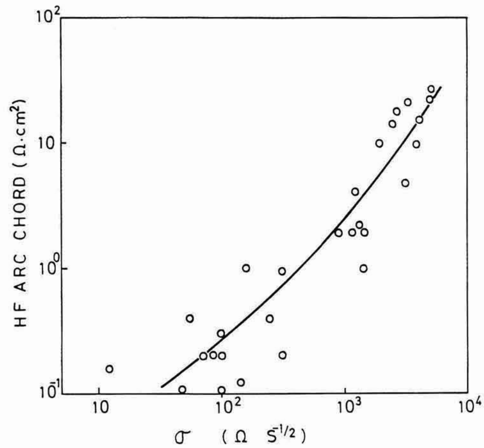

Figure 6—Relationship between the Warburg coefficient and the chord length of the high frequency (HF) arc

Barrier Effect

The length of the chord of the high frequency arc in the impedance diagram of the ZRPs formulated with Fe_2P extender tends to increase with time of exposure to the aggressive medium (*Figure* 4). This effect is relatively more pronounced with ethyl silicate ZRPs than those with an epoxy-polyamide vehicle. This effect should be associated with the formation and accumulation of insoluble corrosion products within the coating (barrier effect) and a reduction in the number of conductive particles, which maintain electrical contact between each other as well as with the steel base (less real surface area of the electrode).[7] After sufficiently long periods of exposure, this trend may be inverted due to the perforation of the coating. In this case, the deterioration of the coating prevails over the barrier effect of the zinc corrosion products. This inversion appeared sooner in the epoxy type of coatings than in the silicate type, and also in paints with a lower zinc content (*Figure* 4).

The Warburg coefficient (σ) calculated from the diffusion tail at low frequency also provides information on the barrier effect. Since this coefficient depends on the degree of impediment of the diffusion process, it provides a direct measurement of the barrier effect.[7] Using the same procedure as in reference (7), the values of σ were determined for the different coatings tested. *Figure* 5 shows the variation in σ with time of exposure to the saline solution.

The enormous increase of σ in the case of the ethyl silicate ZRP coatings co-pigmented with the Fe_2P extender must be noted. This same effect was found in a previous study on ZRP coatings without Fe_2P.[7] The inclusion of the extender therefore does not disturb the barrier effect of the coating. On the contrary, its inclusion in the paints formulated with the lower zinc contents (around 50-60% Zn) seemed to reinforce it in comparison to the behavior of similar paint formulations without the Fe_2P extender.[7]

The value of σ in the epoxy-polyamide ZRP coatings is initially very high (*Figure* 5). The evolution with time of this coefficient also shows some reinforcement of the barrier effect. Nevertheless, the increase in σ is less significant here than with ethyl silicate paints. In these coatings, the σ versus time curve passes through a maximum, and the subsequent decline in σ is due to the perforation of the coating, as proven by the appearance of rust areas.

Finally, it is worthwhile to note the close relationship between the value of σ and the length of the high frequency arc chord (*Figure* 6). This confirms the idea that both parameters depend on the same cause: the accumulation of zinc corrosion products within the coating.[7]

Information Based on Capacitance Determination

Figure 7 illustrates the evolution of the electrical capacitance values of the ZRP coatings with time. At the start of exposure to the saline solution, values of the same order or even greater than the typical values of capacitance for the double layer on a flat metallic electrode are determined. These values suggest that a large number of zinc and Fe_2P particles are in electrical contact and exposed to the corrosive medium at the same time. The lower capacitance values of the epoxy-polyamide vehicle coatings are explained by a smaller number of electrically connected conductive particles, possibly due to the better wetting properties of this vehicle.

The capacitance values of paints without the Fe_2P extender were found in general to decrease with a reduction in the zinc content of ZRPs.[6] This behavior is not found in paints in which part of the zinc has been replaced by Fe_2P. The difference is that here the addition of Fe_2P compensates for the reduction in zinc, thus the electrical contact between a large number of conductor particles is assured.

Remarkably enough, the initial capacitance of the ethyl silicate coatings are around 100× that of a typical flat metal surface. This is in good agreement with the aforementioned behavior of these coatings as porous electrodes. Later, during the prolonged exposure to the saline

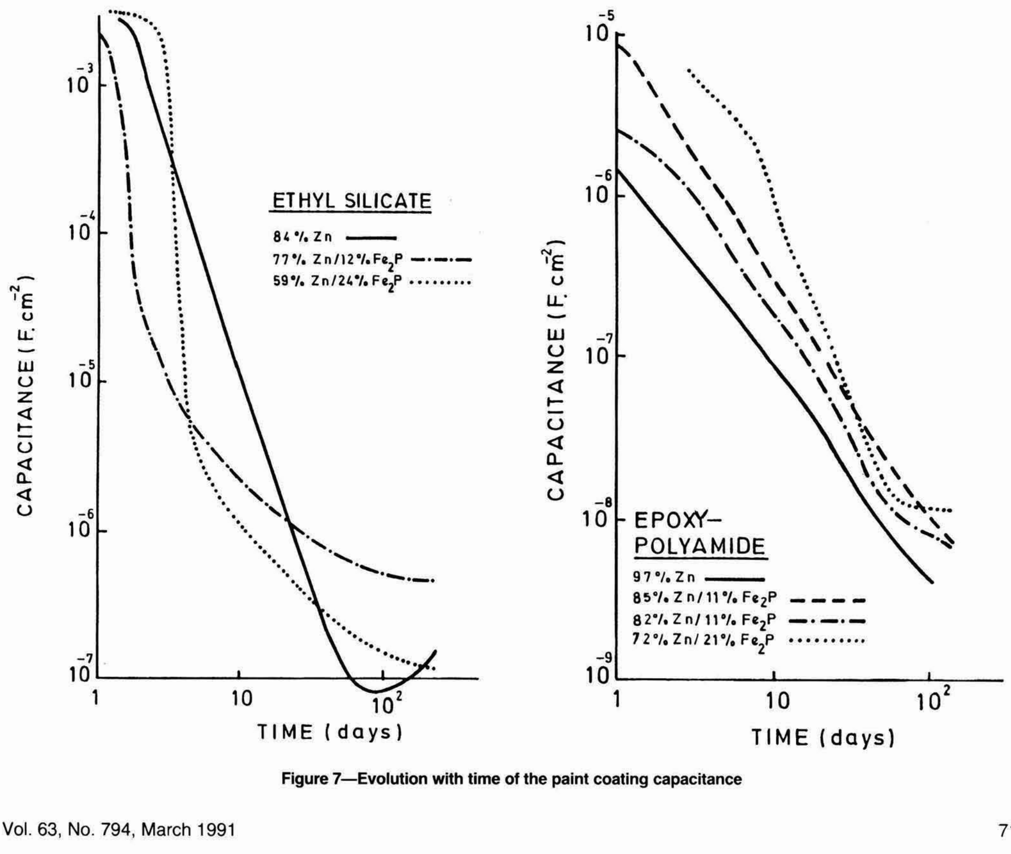

Figure 7—Evolution with time of the paint coating capacitance

solution, the progressive electrical disconnection of the particles causes a decrease in the capacitance of all coatings (*Figure* 7).

CONCLUSIONS

Ethyl silicate ZRP coatings with Fe_2P additions tend to act as porous electrodes, probably because the majority of the metal and conductive extender particles maintain electrical contact between each other and with the steel base. However, epoxy-polyamide ZRP coatings tend to act as small surface electrodes due to the lower number of conductive particles in electrical contact. This explains the greater ability of the silicate coatings to provide cathodic protection to the steel substrate.

The inclusion of the Fe_2P extender does not disturb the marked capability of ethyl silicate ZRPs to develop barrier coats. In the case of epoxy-polyamide ZRP coatings, this extender seems to reinforce their barrier effect.

The high capacitance values determined at the start of the test indicate that many of the conductive particles (of zinc and Fe_2P) are directly exposed to the corrosive medium. The larger capacitance values of ethyl silicate coatings in comparison with those with an epoxy-polyamide vehicle are explained by the lower number of conductive particles, which are connected electrically to the steel base in the case of the latter vehicle. The progressive electrical disconnection of these particles, together with the thickening of the layer of corrosion products on the zinc particles, explains the reduction in capacitance of the zinc-rich coatings during the time of exposure to the corrosive solution.

ACKNOWLEDGMENTS

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Society Meetings

BIRMINGHAM .... NOV.

"Water-Based Technologies"

The meeting's speaker was Armin Sickert, of Bayer UK Ltd., whose topic was "RECENT DEVELOPMENTS IN WATER-BASED TECHNOLOGIES."

A slide presentation showing recent developments in water-based coatings was shown. The speaker explained the advantages of water-based systems and pointed out that, as far as industrial applications are concerned, only electrodeposition has made a major breakthrough.

Mr. Sickert stated that German regulations on emissions, the T.A. Luft, will become operational in 1991. He said that he expects other EEC members to follow and also enforce emissions regulations. Slides illustrated the various emission requirements for T.A. Luft.

The speaker said that water based industrial coatings account for only 10-12% of all coatings used in Europe, and even less if electrodeposition coatings are discounted.

The effort required to develop water based systems was described. Slides depicting the influence of cosolvents, the effect of melamines, and the usefulness of additives were shown.

Mr. Sickert stated that certain German automotive companies are actively pursuing the use of water-based coatings to minimize solvent emission.

In conclusion, the speaker observed that the market share of water-based coatings will increase in Europe, and eventually will compete with powder coatings market.

Q. Can water-based coatings be used in refinishing applications?

A. There has been some development in West Germany with primers. The top coat could be a problem due to drying conditions.

D.C. MORRIS, *Secretary*

BIRMINGHAM .... DEC.

"Multicompatible Stainers"

A commemorative plaque was presented to Ray B. Tennant, of Carrs Paints Ltd., in recognition of his years of service as Society Representative.

The Norman Hill Memorial Lecture was given by Mike Husbands, of Sandoz Ltd. Dr. Husbands' presentation was on "THE ROLE OF MULTICOMPATIBLE STAINERS IN THE INDUSTRIAL PAINT MARKET."

The speaker began his talk by defining multipurpose stainers as single pigment dispersions with a high pigment loading. He said the average paint manufacturer may have as many as nine basic ranges, some based on aliphatic solvents and others using aromatics. In addition, various two-pack materials are available in other solvents.

According to Dr. Husbands, 12-15 tinters are required for each range and as many as four different resin systems are needed for compatibility over the product range.

The advantages and disadvantages of cogrinding were discussed. Co-grinding, stated the speaker, lowers the tinter stocks required, however, small batches are difficult. Dr. Husbands continued by saying that color bases plus tinters make small batches less difficult. However, the problem of incompatibility among the various resin systems still remains. In addition, lead free colors present difficulties.

Dr. Husbands pointed out that clear resin bases plus multipurpose stainers have advantages. But, there is a maximum level of stainers above which problems can occur.

The speaker discussed the concept of paint product efficiency assessment. Slides illustrated the various attributes of cogrinding, color base, and resin base. It was concluded from the demonstration that the resin base gave the best results.

In conclusion, Dr. Husbands summarized the advantages of multipurpose stainers, including giving excellent customer service, having the ability to meet "just in time demands," and requiring less skill by color matches. Also, he said that production control can be very closely monitored.

Q. Can the use of multipurpose stainers in metallic and mica finishes be used in conjunction with a color computer?

A. Probably not, the variation of aluminum flake is the problem. Regarding mica, I think it would be virtually impossible.

Q. How about wet paint color prediction?

A. This is a possibility, however, the change of color due to application and the drying process makes it virtually unlikely in industrial applications.

D.C. MORRIS, *Secretary*

CDIC .... DEC.

"Polyurethane Coatings"

This month's technical speakers were Sherri L. Bassner and Thomas M. Santosusso, of Air Products and Chemicals, Inc. The speakers discussed "EXPERIMENTAL DESIGN IN HIGH SOLIDS POLYURETHANE COATINGS."

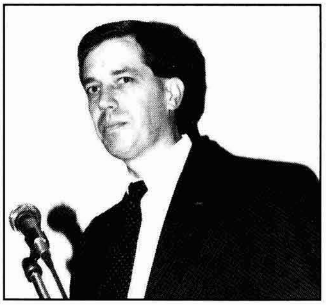
Drs. Bassner and Santosusso focused on the use of multicomponent mixture design studies in the area of high solids polyurethane coatings. They stated that their company is currently using this experimental approach to optimize the processing and performance properties of coatings prepared from a series of unique isocyanate-terminated prepolymers with low viscosity and low monomeric isocyanate content.

The speakers' presentation included a discussion on the development of this new line of prepolymers, the design methology, and the use of the method in obtaining prepolymer blends which meet specific coatings requirements.

An expert system formulating program, built from the results of the design studies, was demonstrated. According to Drs. Bassner and Santosusso, this program allows the calculation of a blend of prepolymers that will produce a coating which meets the desired performance requirements; or, conversely, the physical properties of a coating produced from a given blend.

Q. How do you predetermine compatibility of the systems, because one portion is incompatible in certain levels and will cause the data to rise?

A. Sure, in fact the 12 experiments we are running are preceded by a couple of experiments to determine the compatibility of the systems. We want to be sure we know what we are getting into and make sure we are using the perfect catalyst level.



POLYMER EMULSIONS—Steve Cooper, of Unocal Corporation, speaks at the January meeting of the Chicago Society. His topic is "What the Latex Paint Formulator Should Know About Polymer Emulsions"

Q. What happens if you add another variable, that is, make four to five blends of resins?

A. You can put as many components as you want, however, what happens is that the more blends you have, the more complex and the less reliable the experiment.

The Educational Speaker was Jeff Kirk, of the Engineering and Environmental Affairs Group, of Ashland Chemical Company. Mr. Kirk's presentation was on "REGULATIONS CONCERNING DISPOSAL OF HAZARDOUS WASTE."

ALIPIO R. RUBIN, JR., *Secretary*

CHICAGO .... JAN.

"Polymer Emulsions"

The meeting's speaker was Steve Cooper, of Unocal Corporation, who gave a talk on "WHAT THE LATEX PAINT FORMULATOR SHOULD KNOW ABOUT POLYMER EMULSIONS."

The focus of Mr. Cooper's presentation was to acquaint formulators with the basic principles of polymerization, the makeup of coatings polymers, and how latex polymers affect the performance characteristics of typical coatings application and performance properties.

An explanation of the types of polymerization and the types of polymers obtained from each was given.

The speaker then discussed latex or emulsion polymerization and how this method produces polymers used for both industrial and architectural coatings. Linear, branched, and crosslinked polymers and their mechanisms were discussed in simplified terms. Mr. Cooper also explained the advantages and disadvantages attributed to polymers by various monomers, such as vinyls, vinyl-acrylics, styrene acrylics, styrene-butadiene, and acrylic, and the advantages and disadvantages of copolymers of these materials.

CLIFFORD O. SCHWAHN, *Publicity*

KANSAS CITY .... NOV.

Retired Members Recognized

A moment of silence was observed in memory of Abner Hood Hauck who died recently.

President H. Jeff Laurent, of H.R. Hall, Inc., acknowledged the presence of all the retired Society members in attendance at the monthly meeting.

Special recognition was given to Federation Past-Presidents J.C. Leslie (1974-75), and Terryl F. Johnson (1983-84), of Cook Paint & Varnish Company.

CRAIG HUGHES, *Secretary*

MONTREAL .... NOV.

"Accelerated Weathering"

President Robert Benoit, of Kronos Canada Inc., was presented with the traditional Hüls Gavel by David Doughty, of Hüls Canada.

It was announced that the Society paint course would once again be offered at a local college. The excellent reputation of the course is expected to attract high enrollment.

The evening's speaker was Patrick J. Brennan, of the Q-Panel Company, whose talk was entitled "THE TRUTH ABOUT ACCELERATED WEATHERING: IT'S SIMPLER THAN YOU THINK." Mr. Brennan is a member of the Cleveland Society.

A brief review of the history of accelerated weathering was presented. During this review, the speaker said that fluorescent UV testers are now the standard in the coatings industry for sunlight and moisture. The fluorescent UV testers have been in use for 20 years. He stated that new UV lamps with a more realistic UV spectrum show promise for QUV testing, possessing improved correlation to outdoors. However, Mr. Brennan explained that the whole concept of correlation is much misused and must be reexamined.

Recent data, according to the speaker, demonstrates the error and futility of complex mathematical procedures for correlation, especially methods that attempt to correlate radiation dosage to real time. He added that by treating weathering data as comparative data, extremely important and reliable information can be obtained.

G. SIMPSON, *Director*

NEW ENGLAND .... NOV.

"Stable Latex Paints"

Eric A. Johnson, of Rohm and Haas Company, was the meeting's speaker. His topic was "FORMULATING STABLE LATEX PAINTS CONTAINING ZINC OXIDE."

Dr. Johnson began his presentation by reviewing the benefits, potential problems, and the proposed failure mechanisms of zinc oxide in latex paints. He summarized the benefits as mildew protection, UV absorption, hiding power, and acid reactivity. It was pointed out that mildew protection is now particularly important given the problems with mercury.

Next, the speaker discussed the major potential problem using zinc oxide in latex paint, loss of in-can stability, which can become evident as catastrophic viscosity increase, rheological variation (even a slight viscosity loss before a significant increase), or flocculation (which can turn zinc oxide's hiding power benefit into a shortcoming).

Solubilization of ionic zinc and co-flocculation of zinc oxide and titanium dioxide are the two most popular theories for proposed failure mechanisms, according to Dr. Johnson.

The remainder of the presentation was devoted to the variables affecting stability in latex paints. Factors examined by Dr. Johnson included: dispersants, adjuvants, binders, titanium dioxide, extenders, zinc oxide grade, PVC, pH, and multi-component effects.

The speaker explained that to test the different variables, extensive 28-day accelerated aging tests were conducted. Daily performance was vital since there was no advance warning or viscosity increase. Each daily viscosities check was assigned a pass/fail designation. Testing continued until the paint failed.

Dr. Johnson said that the tests were conducted on three different acrylic latex paints: one gloss and two flats with different PVC and solids levels. Results showed that all three paints proved stable, but failed anywhere from 3 to 27 days after incorporating zinc oxide.

In conclusion, Dr. Johnson stressed that pH and the multi-component effects of zinc oxide grade, titanium dioxide grade, and dispersant type selection are the main determinants of latex paint stability.

Q. What effect does temperature have on these interactions?

A. This is a debated topic in our laboratories. Usually, cooling the grind enhances stability. However, I have found that elevated (steaming) grind temperatures with various ammonia levels yielded only slightly less stable results. Stability loss was due to the combination of grind temperature and ammonia.

Q. What are you predicting in terms of shelf life from your 28-day test? How long was your shelf life test, and would you entertain determining long-term shelf stabilities?

A. We conducted one-year shelf life stability tests on all variations tested. In 12% of the cases of shelf life failure, the accelerated tests passed all 28 days. Therefore, accelerated testing is valuable as an indicator of shelf life stability, but it does not totally predict performance. Your long-term shelf test idea is a good suggestion.

JOHN LUKENS, *Secretary*

NEW YORK .... NOV.

"Carbon Black Pigments"

The Technical Committee Report was given by Larry Waelde, of Troy Chemical Corporation. Mr. Waelde reported that the four Technical Committee Subcommittees are working on the following topics: "Color Computer Usage in the Industry"; "Defoamers for Water-Reducible Low VOC Coatings"; "Rheological Modifiers for High

Solids Coatings"; and "Silicone Additives for High Solids Coatings."

The meeting's speaker was Society Member Maria Nargiello, of Degussa Corporation. Ms. Nargiello's topic was "CARBON BLACK PIGMENTS FOR COATINGS: PRODUCTION, PROPERTIES, APPLICATION, DISPERSION."

The channel, furnace, and lamp black production processes were discussed. The channel or gas blacks process produces the smallest particle size black pigments. The furnace black process is the most versatile process of the three. It can be used for large particle size blacks for the rubber industry and some blacks that approach the size of channel blacks. The lamp black is the oldest process, and it produces the largest particle size blacks.

According to Ms. Nargiello, most pigments are much larger than any type of carbon black pigment. Co-grinding carbon black with other pigments leads to flooding and floating problems.

Carbon blacks, said the speaker, are characterized by three main properties: particle size, structure, and surface chemistry. Particle size is determined for the primary particle and is measured by electron microscope. Structure is the extent of aggregate formation of carbon black pigment. Surface chemistry depends on the treatment done by the pigment manufacturer to turn the hydrophobic product more hydrophilic.

Ms. Nargiello also discussed considerations when dispersing carbon black, including: equipment, vehicle, mill base concentration, and monitoring of the process. She recommended using ball mills and pebble mills for the highest jet pigments and they should be used with beaded pigments. Also, she stated that the most polar resin should be used for the mill base with proper solvent/diluent balance. The vehicle must complete wet-out, and the carbon black and the system must have the proper viscosity for the equipment used. Gradual let down addition can prevent shocking of the mill base. Ms. Nargiello discussed methods of measuring dispersion, including microscopy, photometric and calorimetric examination, and visual examination.

In conclusion, the speaker talked about let down procedures for preventing shock.

Q. If you disperse a beaded black in a ball mill, do you have to start with a very thin mix first to allow the viscosity to come up?

A. We see more and more people, for the most part, use a high speed disperser before the mill. They set a grind value of two to three on the high speed dispersion to homogenize all components. That will cut down on the dispersion time.

Q. If you have two pigments of equal primary particle size, what would cause one of them to have a high structure and the other to have a low structure?

Constituent Society Meetings and Secretaries

BALTIMORE (Third Thursday—Snyder's Willow Grove Restaurant, Linthicum, MD). JIM SMITH, Eastech Chemicals, 5700 Tacony St., Philadelphia, PA 19135.

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

CDIC (Second Monday—Location alternates between Columbus, Cincinnati and Dayton). ALIPIO R. RUBIN, JR., Hilton-Davis Chemical Co., 2235 Langdon Farm Rd., Cincinnati, OH 45237.

CHICAGO (First Monday—alternates between Sharko's Restaurant, Villa Park, IL, and Como Inn, Chicago, IL). WILLIAM FOTIS, Valspar Corp., 1191 S. Wheeling Rd., Wheeling, IL 60090.

CLEVELAND (Third Tuesday—Brown Derby, Independence, OH in Sept., Oct., Nov., Feb., March, April; Jan. meeting, Landerhaven, Mayfield Heights). ROY GLOVER, Mahoning Paint Corp., 653 Jones St., P.O. Box 1282, Youngstown, OH 44501.

DALLAS (Thursday following second Wednesday—The Harvey Hotel, Dallas, TX). MIKE EVANS, J.M. Huber Corp., 803 Pleasant Valley, Richardson, TX 75080.

DETROIT (Second Tuesday—meeting sites vary). SCOTT WESTERBEEK, DuPont Co., 945 Stephenson Hwy., Troy, MI 48007.

GOLDEN GATE (Monday before third Wednesday—alternates between Francesco's in Oakland, CA, and Holiday Inn in S. San Franscisco). LARRY G. SAYRE, O'Brien Corp., 450 E. Grand Ave., S. San Francisco, CA 94080.

HOUSTON (Second Wednesday—Sonny Look's Sirlion Inn, Houston, TX). TERRY F. COGAN, Raw Materials Corp., P.O. Box 690285, Houston, TX 77269.

KANSAS CITY (Second Thursday—Cascone's Restaurant, Kansas City, MO). CRAIG HUGHES, Farmland Industries, Inc., P.O. Box 7305, N. Kansas City, MO 64116.

LOS ANGELES (Second Wednesday—Steven's Steakhouse, Commerce, CA). V.C. BUD JENKINS, Ellis Paint Co., 3150 E. Pico Blvd., Los Angeles, CA 90023.

LOUISVILLE (Third Wednesday—Executive West Motor Hotel, Louisville, KY). TIMOTHY FORTNEY, American Dispersion, Inc., P.O. Box 34033, Louisville, KY 40232.

MEXICO (Fourth Thursday—meeting sites vary). ANTONIO JUAREZ, Amercoat Mexicana, via Gustavo Baz 3999, 54030 Tlalnepantla, edo de Mexico.

MONTREAL (First Wednesday—Bill Wong's Restaurant, Montreal). ROBERTO CUBRAL, L.V. Lomas Chemical Co., 1660 Hynus, Dorval, Que., H9P 2N6, Canada.

NEW ENGLAND (Third Thursday—Sheraton Lexington Hotel, Lexington, MA). JOHN LUKENS, D.N. Lukens, Inc., 15 Old Flanders Rd., Westboro, MA 01581.

NEW YORK (Second Tuesday—Landmark II, East Rutherford, NJ). MICHAEL FRANTZ, Daniel Products Co., 400 Claremont Ave., Jersey City, NJ 07304.

NORTHWESTERN (First Tuesday after first Monday—Jax Cafe, Minneapolis, MN). JOSEPH WIRTH, Consolidated Container Corp., 735 N. Third St., Minneapolis, MN 55401.

PACIFIC NORTHWEST (PORTLAND SECTION—Third Tuesday; SEATTLE SECTION—Third Wednesday; BRITISH COLUMBIA SECTION— Third Thursday). JOHN BARTLETT, Pacific Bartlett Co., 11813 S.E. 257th St., Kent, WA 98031.

PHILADELPHIA (Second Thursday—Williamson's Restaurant, GSB Bldg., Bala Cynwyd, PA). WILLIAM J. FABINY, Sermaguard Coatings, 155 S. Limerick Rd., Limerick, PA 19468.

PIEDMONT (Third Wednesday—Ramada Inn Airport, Greensboro, NC). ANNETTE SAUNDERS, Akzo-Reliance, P.O. Box 2124, High Point, NC 27261.

PITTSBURGH (Second Monday—Montemurro's Restaurant, Sharpsburg, PA). JEFFREY STURM, Kop-Coat, Inc., 3020 William Pitt Way, Pittsburgh, PA 15238.

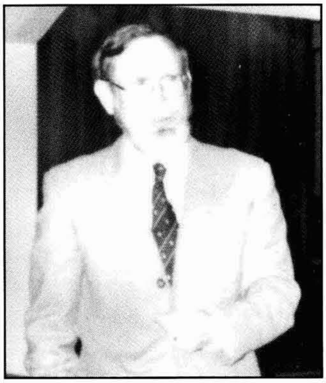
ROCKY MOUNTAIN (Monday following first Wednesday—Zangs Brewery, Denver, CO). ED MCCARTHY, Cyprus Minerals, 8995 E. Nichols, Engelwood, CO 80112.

ST. LOUIS (Third Tuesday—Salad Bowl Restaurant, St. Louis, MO). DENNIS CAHILL, Archway Sales, Inc., 4321 Chouteau Ave., St. Louis, MO 63110.

SOUTHERN (GULF COAST SECTION—third Thursday; CENTRAL FLORIDA SECTION—third Thursday after first Monday; ATLANTA SECTION—third Thursday; MEMPHIS SECTION—bi-monthly on second Tuesday; and MIAMI SECTION—Tuesday prior to Central Florida Section). BILLY M. LEE, Kemira, Inc., P.O. Box 368, Savannah, GA 31402.

TORONTO (Second Monday—Cambridge Motor Hotel, Toronto). MIKE HAZEN, L.V. Lomas Ltd., 99 Summerlea Rd., Brampton, Ont., L6T 4V2, Canada.

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



THEME NIGHT SPEAKER—Clifford Schoff, of PPG Industries, Inc., discusses "Philosophy of Problem Solving in Coatings Science and Technology" with members of the Pittsburgh Society. Dr. Schoff's presentation is part of the Society's November theme night meeting

A. The process. Characteristically, a channel black will have a higher structure than a furnace black. This does not depend on the chemistry, it is the actual manufacturing process. This depends on the surface area and oil absorption of the carbon black. You can have two pigments with the same primary particle size, but with drastically different surface area and oil absorption.

MICHAEL C. FRANTZ, *Secretary*

NORTHWESTERN .... NOV.

Foam and Air Entrapment

The first speaker of the evening, Jay Adams, of Tego Chemie Service, spoke on "COMBATTING FOAM AND AIR ENTRAPMENT IN COATINGS."

According to the speaker, the two types of foam, macrofoam and microfoam, give rise to craters and pinholes in coatings and each requires a different type of additive for elimination.

A presentation entitled "FACTORS OF INFLUENCE IN MATERIAL WEATHERABILITY" was given by Michael Crewdson, of Sub-Tropical Testing Service.

The synergistic effect of solar radiation, humidity, moisture, and high temperature can create rapid deterioration of exposed materials, stated Mr. Crewdson. He emphasized that, by better understanding the factors that affect weatherability, accelerated testing techniques can be improved to better simulate real-time testing.

JOE WIRTH, *Secretary*

NORTHWESTERN .... DEC.

"Color Perception"

A moment of silence was observed in memory of Society member John F. Regan, of Chemrex, Inc., who died recently.

The meeting's first speaker was Romesh Kumar, of Hoechst Celanese Corporation. Dr. Kumar's topic was "COLOR PERCEPTION AND MEASUREMENT."

The speaker began his presentation stating that the process of color requires light. He said to see color, light must be radiated off of an object and be received by the eye, which will then perceive only the color reflected.

Dr. Kumar explained that the cones and rods in the eye are responsible for color vision. He stated that color blindness, which occurs in 9% of the male population and .1% of the female population, results from imperfections in the rods or cones.

The next speaker was Houston Society member Daniel N. King, of Exxon Chemical Company. His talk was entitled "A SOLVENT PROPERTY AND SOLUBILITY PARAMETER CALCULATOR."

Mr. King stated that by plotting the characteristics of individual resins and solvents, the calculator computes how they will interact during mixing. He said that Exxon has 500 resins in their program now to aid in product formulation.

JOE WIRTH, *Secretary*

NORTHWESTERN .... JAN.

"Gyratory Sieving Equipment"

The initial presentation was delivered by Vic Maroscher, of MM Industries, Inc. His presentation focused on "THE HISTORY AND APPLICATIONS OF HIGH FREQUENCY GYRATORY SIEVING EQUIPMENT."

The speaker explained that sieving is the last step before the paint is placed into the container. Gyratory straining was defined as a "rapid rotary motion on a horizontal plane." Sieving began in the 1930s and was used for flower and sugar. Mr. Maroscher said the introduction of the Vorta Siev in 1957 marked the beginning of sieving to the paint industry.

The speaker stated that high frequency gyratory sieving equipment (800-3400 rpms) is required.

The meeting's second speaker was David Ulrich, of CB Mills Division/Chicago Boiler Company. His topic was "ADVANCES IN WET MILLING TECHNOLOGY/ON-SITE SOLVENT RECOVERY."

Mr. Ulrich began with a history of the mill. He said the original media mill was the ball mill, which relies on gravity. In 1950, Du Pont Company pioneered the use of the small media mill which operated vertically and 200-300 times faster than gravity mills. During the 1970s, vertical mills were prevalent throughout the market place.

The speaker stated that with increasing environmental concerns pushing paint users to low VOC/high solids coatings, smaller, more uniform particle sizes are required. He said smaller particle sizes can be accomplished with the use of smaller media.

Mr. Ulrich also discussed on-site recovery, noting that it is of growing interest to companies who want to reduce hazardous waste.

JOE WIRTH, *Secretary*

PHILADELPHIA .... NOV.

"Salt Fog"

New York Society member Alan Smith, of Rheox, Inc., presented a talk on "COMPARATIVE ANALYSIS OF SALT FOG AND EXTERIOR EXPOSURE RESULTS."

Mr. Smith reviewed general electrochemical corrosion theory as it applies to anticorrosive pigments.

Several sets of accelerated and natural exposure results were compared on a series of lead and chromate-free anticorrosive pigments. The speaker pointed out that while some pigments may perform well in salt fog, they demonstrate poor exterior durability; this non-routine action can be attributed to their excessively high solubility levels, which facilitate good short-term protection in accelerated tests. However, these pigments result in depletion of the inhibitor on long-term exposures.

In contrast, according to Mr. Smith, anticorrosive pigments which lower solubilities demonstrate relatively poorer performance in salt fog. However, they provide superior protection on exterior exposure. This is attributed to their slow controlled rate of inhibitor release which provides insufficient protection in the accelerated test, but provides good long-term protection in natural environments. Dr. Smith stated that additional evidence to support these hypotheses was found by analyzing rates of failure in salt fog and correlating these with solubility.

The speaker then pointed out that if a pigment is insoluble, it is not an inhibitive pigment. He said there needs to be enough solubility to provide inhibition, but if there is too much solubility in exterior exposure, it can lead to rapid depletion of the pigment. According to Mr. Smith, this effect leaves severe porosity in the paint film, which then compromises the paints barrier properties. The net effect is poor exterior durability.

In conclusion, the speaker advised that good formulation practice would entail complete testing of the formulas in both accelerated and outdoor environments. Mr. Smith recommended that the outdoor series of testing be carried out for as long as is practical.

Q. What was the frequency of salt spray treatment on the exterior exposures?

A. The panels were sprayed twice daily each day of a five-day work week.

Q. With what were the panels sprayed?

A. The panels were sprayed manually with natural sea water and were completely saturated each time.

WILLIAM J. FABINY, *Secretary*

PIEDMONT .... DEC.

"A Republican President And Democratic Congress"

Educational Committee Chairman James Bohannon, of Valspar Corporation, reported that the Society has awarded two more scholarships. Recipients of the two $1,000 scholarships were Paige Mahaney, of Guilford College, and Thomas Dixon, of University of North Carolina—Greensboro.

The meeting's speaker was David Olson, Professor of Political Science, of University of North Carolina—Greensboro. Dr. Olson gave a talk on the subject of "THE STRANGE CHEMISTRY OF A REPUBLICAN PRESIDENT AND A DEMOCRATIC CONGRESS."

Dr. Olson reviewed the changes in Eastern European politics.

He discussed the similarities between most European and American political systems. The speaker said most European countries are set up on the basis of a coalition of several political parties by which accomplishments are made by agreement with the coalition. According to Dr. Olson, the American people have given themselves the same type of coalition by the way they vote, collectively, for a permanent, floating coalition government. Policy decisions are not made unless both the Republican and Democratic parties agree.

Dr. Olson noted that this type of political system often leaves us with a Democratic Congress and a Republican President.

The speaker explained the conflict between the President of the U.S. and the U.S. Congress, stating that there is an endemic structuring conflict irrespective of political party.

Dr. Olson discussed the paradox of the budget deficit, and its ultimate irrelevance except as a rhetorical weapon. He also pointed out the options remaining in the face of these huge deficits: to raise taxes, to shift responsibility to the state and local levels, and to use financial gimmicks to address the deficit problem.

In conclusion, the speaker presented his assessment and hope for the future of the European community and its relationship to the U.S. Also, he commented on the Middle East crisis.

ANNETTE SAUNDERS, *Secretary*

PITTSBURGH .... NOV.

"Philosophy of Problem Solving"

Society member Clifford Schoff, of PPG Industries, Inc., was the meeting's speaker. Dr. Schoff's topic was "PHILOSOPHY OF PROBLEM SOLVING IN COATINGS SCIENCE AND TECHNOLOGY."

The speaker began his presentation with a list of the various problems a coating film can experience. All of the discussed problems have one or more causes. Dr. Schoff stated that problem solving is making careful observations and experiments to define the problem and determine the cause; then, attacking and solving it.

Steps in the problem solving process were then presented: (1) Characterize the problem by identifying it and determining the cause. (2) Use the library, and focus on coatings literature. (3) Discuss the problem with others. (4) Think of and work up possible solutions. (5) Test these possible solutions, and use the results to guide the development of other solutions. (6) Repeat the steps until the problem is solved. (7) Document the problem and solutions in the form of a retrievable report so that others can benefit from your work.

Dr. Schoff also recommended bringing physical evidence that show the problem back to the laboratory. He stated that when solving problems, be sure to look at the whole picture, including the process, the customer's equipment, the substrate being coated, and housekeeping at both plants.

The re-creation of the problem in the laboratory is very important, stated the speaker. Careful documentation of the results is also a vital step in the process. Lastly, intuition can play a major role in problem solving.

In conclusion, Dr. Schoff said to keep communicating, keep thinking, and keep your sense of humor. He stated that all problems have a cause—find it and the solution will follow.

Q. Many problems occur on the surface of a coating as its viscosity increases near its cure point. Is there any way to determine or measure viscosity of a coating at this point?

A. Inclined planes with a rolling ball have been used. A turntable with adjustable speeds has also shown some promise. Finding the proper technique to measure the viscosity is a difficult position.

JEFFREY C. STURM, *Secretary*

ST. LOUIS .... NOV.

"Polyfunctional Isocyanate"

Environmental Affairs Committee Chairman David L. Wieties, of Resourceful Env. Ideas, Inc. reported on a joint venture with the St. Louis Paint & Coatings Association concerning the Associated Industries of Missouri (A.I.M.). He stated that a $300 fee will enable the Society and St. Louis PCA to become jointly active in A.I.M. Information will be sent to one member of each company each quarter.

Bernard Taub, of Reichhold Chemicals, Inc., presented a talk on "POLYFUNCTIONAL ISOCYANATE—OXAZOLIDINE RESINS FOR AUTOMOTIVE CLEAR COAT APPLICATIONS."

The speaker said stable one-component urethane coatings are prepared by reacting aliphatic diisocyanates prepolymers with N-2 hydroxyethyl oxazolidines.

Dr. Taub stated that the most aggressive use of urethanes is the automotive based clear coats, which represent the largest growing urethane market. Clear coats are also used in automotive interiors, aircraft, plastic coatings, pleasure boats, industrial floors, trade sales, and leather-like finishes.

He said urethane advantages include: air day or force day in 30 min at 140°F; and excellent resistance to abrasion.

Dr. Taub's talk then focused on reactive polyurethane coatings, which include moisture curing prepolymers, two-component urethanes, and blocked isocyanate prepolymers.

The speaker also discussed, in detail, some of the disadvantages of urethanes.

DENNIS CAHILL, *Secretary*

Future Society Meetings

Birmingham

(Apr. 4)—"1992: A LEGISLATIVE UPDATE FOR THE PAINT INDUSTRY"—Tony Newbold, Paintmakers Association of Great Britain.

(May 2)—62nd Annual General Meeting.

Cleveland

(Mar. 19)—"CHOOSING THE MOST EFFECTIVE DISPERSANTS FOR HIGH SOLIDS COATINGS SYSTEMS"—Marvin Schnall, Troy Chemical Corp.

(Apr. 16)—"COATINGS CHARACTERIZATION BY THERMAL METHODS"—Michael Neag, The Glidden Company.

(May 21)—"FORMULATION OF NEW VARNISHES FOR OLD MASTER PAINTINGS"—Dr. E. Rene´ de la Rie, National Gallery of Art.

Kansas City

(May 10)—"DEFORESTATION AND ITS EFFECTS ON OUR GLOBAL ENVIRONMENT"—Sierra Club Representative.

(June 2-3)—Joint Meeting of St. Louis/Kansas City Societies.

Montreal

(Apr. 3)—"MODIFIED S/B TO THE RESCUE FOR MEETING VOC AND STILL PRODUCE QUALITY COATING"—Violet L. Stevens, The Dow Chemical Co.

(May 1)—Progress Report on Technical Committee Projects—A. Brisson, Technical Committee.

New York

(Apr. 9)—DIATOMACEOUS SILICA TOPICS—Title to Be Announced— Sid Lauren.

(May 14)—PaVAC Night—"LOW VOC ARCHITECTURAL COATINGS"—Richard Johnson, Cargill.

Piedmont

(Mar. 20)—"NEW THIXOTROPES FOR HIGH SOLID SYSTEMS"—Benjamin Dent and Rudy Berndlmaier, King Industries.

(Apr. 24)—"AIR TOXICS"—Jim Husted, Husted & Associates, Inc.

(May 15)—"STEEL SHIPPING CONTAINERS"—Speaker to be announced.

(June 19)—Past-Presidents' Night.

Rocky Mountain

(Mar. 11)—"ANTI-MICROBIALS/MERCURY

(Apr. 8)—"PIGMENTED COATINGS PROBLEMS AND SOLUTIONS ASSOCIATED WITH PARTICULAR SIZE"—Elio Cohen, Daniel Products Co.

(May 6)—"RAMA-POLY ALKA-METHACRYLATE"—Joachim Buchse, Rohm Tech.

DALLAS

Active

Bennett, Kenneth W.—Stonetech International Inc., Dallas, TX.
Choung, Hun—Schnee-Morehead Inc., Irving, TX.
Foxworthy, LaVonna D.—DeSoto, Inc., Garland, TX.
Hilbun, Joseph B.—Sherwin-Williams, Garland.
Hooker, Thomas H.—DeSoto, Inc., Garland.
Jones, Kevan W.—Dallas Laboratories, Dallas.
Lagowski, Marcilla R.—DeSoto, Inc., Garland.
Lagowski, Walter J.—DeSoto, Inc., Garland.
Peden, Nancy A.—DeSoto, Inc., Garland.
Tritch, Tim P.—DeSoto, Inc., Garland.
Woolwine, William—Proko Industries Inc., Mesquite, TX.

Associate

Bushart, Richard D.—Bushart & Associates, Richardson, TX.
Evans, Michael K.—J.M. Huber, Richardson.
Hedgepeth, Alan C.—Degussa Corp., Plano, TX.
Kaplan, Paul D.—Cookson Pigments, Inc., Plano.
Mrazek, Tommy—Delta Distributors Inc., Dallas, TX.
Newman, Robert D.—Stamat Inc., Dallas.
Olson, Brian—Nyco, Austin, TX.

LOUISVILLE

Active

Anderson, David L.—Akzo Coatings, Louisville, KY.
Gronet, Arthur T.—Estron Chemical, Inc., Calvert City, KY.
Hollingsworth, Nada J.—Akzo Coatings, Louisville.
Martin, Mark J.—Akzo Coatings, Louisville.
Nold, Mike W.—Akzo Coatings, Louisville.
Tilley, Mark—GE Plastics, Mount Vernon, IN.
Van Hook, John D. Jr.—Valspar Corp., Louisville.

MONTREAL

Active

Bush, Peter J.—Luzenac Inc., Oakville, Ont.
Childs, Barry A.—International Paints, Baie d'Urfe, Que.
Clayton, John A.—Tioxide Inc., St. Laurent, Que.
Desilets, Clement—Akzo Coatings Inc., St. Jerome, Que.
Deziel, Jacques—Kronos Canada Inc., Varennes, Que.
Forget, Marc—International Paints, Baie d'Urfe.
Frenette, Daniel A.—Sico Inc., Outremont, Que.
Green, Jeremy E.—Tioxide Inc., St. Laurent.
Hutchinson, Jean J.—Bapco Inc., Boucherville, Que.
Lim, Ho Man—Dept. of National Defense, Ottawa, Ont.
Margossian, Varouj—Sico Inc., Outremont.
Peloquin, Francois—Tioxide Inc., St. Laurent.
Rayment, Thomas J.B.—Sico Industries, Inc., Longueuil, Que.
St.-Jean, Eric—International Paints, Baie d'Urfe.
Trudeau, Maryse—Sico Inc., Outremont.

Associate

Cote, Jean-Pierre—AR Monteith 77 Ltd., Repentigny, Que.
Grondin, Guy—Shell Chimie Du Canada, Montreal, Que.
Kraushaar, Douglas—Tioxide Inc., St. Laurent, Que.
Lamarche, Yves Olivier—Pigment & Chemical, Laval, Que.
Lambert, Christopher—Tioxide Inc., Montreal.
Maillette, Brigitte—Products Nacan Ltee., Boucherville, Que.

Federation of Societies for Coatings Technology

AUDIO/VISUAL PRESENTATIONS

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People

Thomas E. Hill has been appointed to the newly created position of Corporate Director of Total Quality for Pratt & Lambert, Inc., Buffalo, NY.

Mr. Hill will be responsible for coordinating and overseeing the development and implementation of total quality programs at each of the company's operating divisions.

He has been with Pratt & Lambert since 1975, having served at various posts within the technical department. Most recently, he was Manager/Technical Services for the Architectural Finishes Division.

Mr. Hill served on the Federation's Executive Committee from 1987-90 and was the Western New York Society Representative to the Board of Directors from 1983-90.

Rhône-Poulenc, Cranbury, NJ, has announced that **John Grubesic** has been named to the newly created position of Manager/Technical Services for the company's Container Coatings Business. Mr. Grubesic joined Rhône-Poulenc's Container Coatings Business in 1988 as an Account Executive for the Eastern Region.

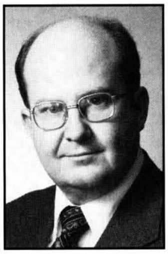
The Plastics Division of Eagle-Picher Automotive Group, Grabill, IN, has assigned **Donald Norris** to the post of Vice President of Engineering Services. In this newly created position, Mr. Norris will oversee technical functions which encompass advanced engineering, automotive product engineering, tool engineering, material development, and compound production.

ANGUS Chemical Company, Northbrook, IL has announced the following appointments.

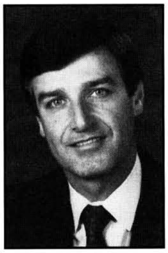
John F. Alderman has been named Director of Technical Services. In this position, Mr. Alderman will be responsible for directing the efforts of ANGUS' technical service support for both domestic and international markets. He previously served as Director of Planning and Special Projects.

Scott W. Borst has been promoted to Director/Coatings Business Unit, and will assume responsibility for the management of the company's coatings-additives business.

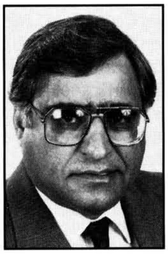
The position of Director/Marketing Operations has been accepted by **Ralph M. Eichmiller**. Responsibilities of this title include coordinating marketing strategies with those of operations, including production planning and scheduling, manufacturing expansions, and total quality management of all ANGUS nitroparaffin products.



T.E. Hill



B. Radulski



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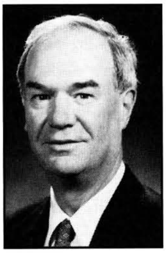


P.J. Johnston

Barry Radulski has been named Vice President/Marketing for J.M. Huber Corporation Chemicals Division, Havre de Grace, MD. Prior to this appointment, Mr. Radulski was Business Development Director for the division. He also served as Manager of New Business Development at Huber's corporate staff headquarters located in Edison, NJ.

In addition, **Sushil K. Bhalla** has been appointed Vice President/Quality & Technology. He has been Technical Director since joining Huber in early 1989. Dr. Bhalla spent nearly 18 years with FMC Corporation, involved in the management of research & development, process engineering and technology assessment activities.

The naming of **Robert L. Niccol** to National Sales Director for Degussa Corporation's Pigment Group, Ridgefield Park, NJ, has been announced. In this position, Mr. Niccol will direct the U.S. sales of Aerosil fumed silica and other non-tire specialty products sold to the plastics, adhesives, coatings, and other industries. He previously served as Sales Manager for the Southwest Region. Mr. Niccol is a member of the Dallas Society.

Rick Engle has joined the staff of Hilton Davis Company, Cincinnati, OH, as Southeast Sales Representative for Georgia, Florida, Tennessee, Alabama, Mississippi, and the Carolinas. Mr. Engle will be responsible for marketing the company's pigments and dispersions in the paint and coatings industry.

PPG Industries, Coatings and Resins Group has named **James E. Jones** as Research Associate. He will work out of the company's Research and Development Center at R&D laboratory facilities located in Allison Park, PA. Mr. Jones is a member of the Pittsburgh Society.

Paul J. Johnston has been appointed Vice President and General Manager of UCAR Emulsion Systems, Cary, NC, a unit of Union Carbide Chemicals and Plastics Company, Inc., Danbury, CT. Mr. Johnston previously served as Vice President and General Manager of UCAR Coatings Resins department of Union Carbide's Solvents and Coatings Materials Division.

M.A. Bruder & Sons, Inc., Broomall, PA, has announced the appointment of **James J. Kelly** as Vice President of Manufacturing and Research.

Van Waters & Rogers, Seattle, WA, has announced the addition of four industry specialists who will focus their expertise on serving the coatings, ink, and adhesives industries.

Ron Zimmerman will serve the company's customers in the Los Angeles area. He previously spent 15 years with Rohm and Haas in several capacities, including research and polymer sales to the adhesive industry.

Diana Mertz-Noyes, who has extensive coatings industry sales experience, will also be based in Los Angeles. She was also formerly with Rohm and Haas.

Tom McNally will be responsible for much of the coatings industry in the metropolitan Cleveland area. Mr. McNally has served the Cleveland coatings industry for more than nine years, having worked with both a specialty raw materials supplier as well as a coatings manufacturer.

Charles Harris recently joined Van Waters & Rogers/Denver as an industry specialist. Mr. Harris previously served Exxon Chemical for eight years, during which time he was responsible for a number of corporate coatings and ink accounts as well as the development of Exx-Print for major ink producers.

Hercules Incorporated, Wilmington, DE, has announced the following organizational and managerial position changes: **Thomas L. Gossage**—Chairman and Chief Executive Officer; **Fred L. Buckner**—President and Chief Operating Officer; **D.W. DiDonna**—President, Absorbent & Textile Products; **V.J. Corbo**—President, Advanced Materials & Systems Company; **C.D. Miller**—President, Aqualon Company; **T.G. Tepas**—President, Fragrance & Food Ingredients Group; **P.A. Bukowick**—President, Packaging Films Group; **R.J.A. Fraser**—President, Paper Technology Group; and **W.E. Hosker**—President, Resins Group.

Other appointments include: **James D. Beach**—Vice President, Operations Support; **W. Wells Hood**—Vice President, Management Processes; **Michael B. Keehan**—Vice President and General Counsel; **Thomas V. McCarthy**—Vice President, Human Resources; and **Donald R. Kirtley**—Vice President, Public Affairs.

In addition, Hercules announced that **Arden B. Engebretsen**, Vice Chairman and Chief Financial Officer, has elected to retire at the end of the year. No replacement has been named.

James J. Schmeding has recently been promoted to Vice President of Sales/North America, for Rheox, Inc., Hightstown, NJ. He previously served as Director of Sales for the company's U.S. operations. In this new position, Mr. Schmeding will maintain responsibility for Rheox sales in the U.S. and will also supervise the company's network of sales agents in Canada.

Harold T. Michels has been named President of the LaQue Center for Corrosion Technology, Inc., a subsidiary of Inco, Ltd., Wrightsville Beach, NC, effective January 1. He succeeds **Wilber W. Kirk**, who will retire in July 1991. In the interim, Mr. Kirk will serve as Senior Technical Advisor.

Sanncor Industries, Inc., Leominster, MA, has announced recent changes in the organization. **Henry Barbanel** has been appointed Chairman of the Board. He previously served as President. **Steven Barbanel** has been promoted from Vice President/Treasurer to President of the company. He has been active in the business for the past 15 years, having served in several areas of responsibility.

Stephen A. Gattoni has joined the staff of Hüls America Inc., Piscataway, NJ, as Regional Sales Manager for Construction Chemicals in the company's silanes and silicones group. He will be responsible for assisting East Coast Sales Representatives in the sales of the Chem-Trete®, Aqua-Trete™, and Dyna-Trete™ lines of silane-based clear, penetrating weatherproofing materials.

Union Camp Corporation, Wayne, NJ, has announced the election of **Julian W. Boyden** as a Vice President of the company. Mr. Boyden currently serves as President and General Manager of Bush Boake Allen, a subsidiary of Union Camp.

The naming of **Carl G. Cabel** as Sales Representative has been announced by Inland Leidy, Inc., Baltimore, MD. As Sales Representative covering the state of New Jersey, Mr. Cabel will promote the company's line of industrial chemicals, oils, and lubricants.

Donald L. MacLean has been appointed Vice President of Gases and Vacuum Technologies for The BOC Group, Murray Hill, NJ. In this capacity, he will be responsible for leadership of research and development efforts for gases and vacuum processes and products at The BOC Group Technical Center. Mr. MacLean has been with the company since 1984.

Lloyd J. (Buzz) Pickering, Manager of Quality Assurance at the Gordon Company in Richmond, IL, is a 1990 recipient of the ASTM Award of Merit. The Award of Merit and the accompanying title of Fellow of the Society, were established to recognize productive service to ASTM, market leadership, outstanding contributions, or publication of papers. A member of ASTM and Committee E-20 on Temperature Measurement for 23 years, Mr. Pickering was cited for outstanding contributions in the development of standards and specifications for sheathed thermocouples and thermocouple materials. He was recognized by the committee for his contributions by receiving the Robert D. Thompson Memorial Award and an Award of Appreciation.

In other ASTM news, the election of a new chairman, vice chairmen, treasurer, and six directors to the 1991 Board of Directors has been announced. They are: **John A. Millane**—Chairman; **Nancy M. Trahey**—Vice Chairman; **Henry J. Roux**—Treasurer. Elected Director include: **Donald S. Abelson**, **Norma L. Bottone**, **Betty I. Dunbar**, **Jon A. Epps**, **Allen W. Grobin, Jr.**, and **Cyrus P. Henry, Jr.**

Obituary

Mark F. Dante, of Exxon Chemical Company, Linden, NJ, died December 25, 1990.

Dr. Dante's career in the coatings industry began in 1954 when he joined Shell Chemical Company as a Chemist. He worked on a variety of materials, but was known principally for work in epoxy chemistry. In 1969, he became a Senior Research Chemist with Shell, and in 1983, joined Hempel Technology, Inc. as a Senior Research Associate. Dr. Dante rejoined Exxon as a Staff Chemist in 1987, and served in that position until the time of his death.

Among Dr. Dante's technical achievements were five U.S. patents for curing of saturated epoxy resin compositions, curing agents, curing adducts, and latent catalysts for two epoxy reactions. He also investigated solvents and the use of computers in the lab.

Dr. Dante was a graduate of Fordham College in New York, where he earned the B.S. Degree in Chemistry in 1952. He received the M.S. Degree in Chemistry from Seton Hall University, South Orange, NJ, in 1964, and attended Alexander Hamilton Institute, New York, studying management. In 1983 he received the Ph.D. Degree in Chemistry from Pacific Western University in Encino, CA.

For 15 years, Dr. Dante was active in the Houston Society, serving in many capacities. He was also a member of the New York Society and a former member of the Educational Committee of the Federation.

Dr. Dante is survived by his wife, Beatrice; and a son, Joseph.

Robert F. Purcell, retired Director of New Product Development, ANGUS Chemical Company, died December 25, 1990. He was 65 years old.

In 1947, Mr. Purcell began his career with The Sherwin-Williams Company as a Paint Chemist. He joined the Commercial Solvents Corporation in 1957 as a Group Leader in the company's product development area. After numerous increasingly responsible positions, Mr. Purcell was transferred to Chicago in 1977, and became Director of R&D for ANGUS Chemical Company. His most recent position had been Director of New Product Development until his retirement in May 1987, when he continued as a consultant until his death.

A Chicago Society Retired Member, Mr. Purcell had also been active in the National Paint and Coatings Association where he served on several committees.

Mr. Purcell is survived by his wife, Norine; three children; and two grandchildren.

Southwestern Paint Convention to Focus On 'Surviving the 90s,' March 13-15, in Dallas

The 48th Annual Southwestern Paint Convention, sponsored by the Dallas and Houston Societies for Coatings Technology, will be held at the Loews Anatole Hotel, in Dallas, TX, on March 13-15.

The theme of this year's program is "Surviving the Nineties." Speakers and topics scheduled for presentation are:

"TCLP Rules Update"—Alan Hayes, of the Texas Water Commission;

"Eliminating Hazardous Waste"—Kevin Reid, of Orr and Boss;

"Environmental Update"—Hugh Smith, of Sun Chemical Corporation;

"Flow Agents for High Solids Coatings"—Marvin Schnall, of Troy Chemical Corporation;

"Waterborne Acrylic Maintenance Finishes"—David Watson, of Rohm and Haas Company;

"Design and Processing of Polyester Resins for Coatings Applications"—Clive J. Coady, of Amoco Chemical;

"The Dynamics of Surface Properties of Surfactants"—Paul Berger, of Witco Chemical;

"Polyurethane Coatings Can Meet Performance and VOC Requirements for the 90s"—Jack Bracco, of Mobay Corporation; and

"Coalescent Solvents"—Speaker to be announced, Dow Chemical Company.

The program also will include an activities update of the Federation of Societies for Coatings Technology presented by President Kurt F. Weitz and Executive Vice President Robert F. Ziegler.

General Chairman of this year's event is P. Leon Page, of Pioneer Chemical, Inc. Assisting Mr. Page are: Vice General Chairman and Hospitality Chairman—Steve Stephens, of Ribelin Sales, Inc.; Program Chairman—Leo Michaelewicz, of Proko Industries; Registration Chairman—Noel Harrison, of The Sherwin-Williams Company; Publicity Chairman—John F. Rothermel, of The Sherwin-Williams Company; Suppliers Reception Chairman—Joseph S. Jedrusiak, of Crozier-Nelson Chemical; and Ladies Program Chairman—Linda Elliot, of SCM Chemicals, Inc.

The Ladies Program includes a fashion seminar at Umphrey's, in Highland Park Village; lunch at the casual, upscale Italian restaurant Patrizo's; and a visit by psychic Marie Burkhart, who will help "unlock your future to a brighter tomorrow," in additional to performing Tarot card readings, personality character traits, and expectations for this life.

For more information on the Southwestern Paint Convention, contact General Chairman P. Leon Page, Pioneer Chemical, Inc., 100 N. Sam Houston Rd., Mesquite, TX 75149, (214) 289-1901.

Cleveland Society Conference To Focus on Additives Technology

The Cleveland Society for Coatings Technology will hold its Annual Technical Conference at the B.F. Goodrich R&D Center, in Brecksville, OH, on June 6.

The program will focus on the needs for additives in water-based, high-solids, and powder coatings in the coatings industry. The objectives of the conference are to stimulate research and to exchange knowledge on the complex interaction of additives in the high-solids, water-based, and powder coatings industries.

The one-day conference will consist of contributed papers and a possible poster session on the subject. An award will be presented to the best paper given during the program.

Additional information may be obtained from: Victor Sandorf, Coatings Development Co., 1895 B. Blase Nemeth Rd., Painesville, OH 44077.

SUNY to Sponsor Course on High Temperature Polymers

A seminar highlighting the research and development, manufacturing, and applications of "High Temperature Polymers: Chemistry, Properties, and Applications" is scheduled for Orlando, FL, on March 18-20. The course is sponsored by The Institute of Materials Science with the cooperation of the Center for Continuing Education, State University of New York (SUNY) at New Paltz, New Paltz, NY.

The class is designed to present an overview of research advances in the research and development of polymeric materials useful in the range of 200°C and above. Up-to-date methods for preparing high temperature polymers will be discussed. Aerospace and commercial applications of high-performance polymers as composite matrix resins, adhesives, molding powders, films, fibers, and coatings are slated to be presented.

The course is geared toward the practicing polymer chemist, engineer, or materials scientist who currently is working with or contemplating the use of advanced polymers.

Continuing Education Units may be earned for those who attend the course.

For additional information, contact Angelos V. Patsis, Director, Institute of Materials Science, CSB 209, SUNY, New Paltz, NY 12561.

Louisville Society Cosponsors Surface Coatings Course

The course "Surface Coatings Technology III: Coating Uses and Formulation" is currently being offered at the University of Louisville, Louisville, KY. The class, the third of four courses in surface coatings technology, is being cosponsored by the Louisville Society for Coatings Technology and the Department of Chemical Engineering, Speed Scientific School, the university.

The course is providing a review of the various types of chemical coatings for trade sales, industrial, and special purpose coatings. The overview is being done within the context of formulation.

The class is designed for chemists, chemical engineers, technicians, other coatings personnel, and those who have an interest in coatings technology.

Information on the course may be obtained from Paul R. Baukema, Akzo Coatings, Inc., P.O. Box 37230, Louisville, KY 40233.

Kent State University's Spring Short Courses To Feature Rheology, Dispersion, and Adhesion

The Rheology and Coatings Laboratory at Kent State University (KSU), Kent, OH, is offering a series of short courses to be presented in the spring. The courses are designed to present relevant scientific fundamentals, followed by extensive application of principles to practice discussions.

The class schedule is as follows: "Applied Rheology for Industrial Chemists"—April 22-26; "Dispersion of Pigments and Resins in Fluid Media"—May 6-10; and "Adhesion Principles and Practice for Coatings and Polymer Scientists"—May 20-24.

The "Rheology" program features a discussion of instrument selection and meaningful measurements. The rheology of high-solids coatings, latexes, thermosetting coatings, and additional industrial problems will be highlighted. Additional topics include stress rheometry, mechanical properties, cure characterization, and additives for rheology control.

Subjects in the "Dispersion" class are the chemistry and physics relative to the dispersion process; dispersing agent selection; dispersion of inorganic, organic, and carbon black pigments; and the measurement of dispersion quality and particle size. Discussions on dispersion of resins and latexes in water and organic solvent systems are scheduled. Also, the course will contain lectures on dispersion equipment and selection of mixers, ball, sand, and other media mills.

Highlighting the "Adhesion" program will be surface chemistry related to adhesion, rheology and fracture mechanics of glassy and elastomeric adhesives, surface preparation, plasma treatment, and adhesion promoters. Talks also will be conducted on rubber-to-metal and polymer-to-metal bonding, release coatings, structural adhesives, and bond durability.

The short courses are designed for research and development personnel who have an interest in coatings, adhesives, elastomers, inks, and composites.

For additional information, contact Program Chairman Carl J. Knauss, KSU, Chemistry Dept., Kent, OH 44242.

Electrostatic Coating Program Slated for Ontario, May 23-24

The Applied Electrostatics Research Centre, of The University of Western Ontario, London, Ontario, Canada, and the Electrostatics Research Group, of the University of Southampton, have announced that the Seventh International Symposium on "Theory and Trends in Electrostatic Coating Technology," will be conducted at The University of Western Ontario, on May 23-24.

The program will focus on fundamental and practical aspects of powder coatings and liquid spraying, will put safety aspects into perspective, and will outline trends in the industry. The symposium will conclude with a panel discussion featuring representatives from major manufacturers and users of equipment and paints for electrostatic coating.

The conference is designed for marketing personnel, product planners, and production and design engineers in the electrostatic coating industries.

For further information, contact Professor I.I. Inculet, Director, Applied Electrostatics Research Centre, The University of Western Ontario, London, Ont., Canada, N6A 5B9.

13th Congress of Scandinavian Technologists Slated for Stockholm, Sweden, May 12-15

The 13th Congress of the Federation of Scandinavian Paint and Varnish Technologists (SLF) is scheduled for the Scandic Crown Hotel, in Stockholm, Sweden, on May 12-15.

The conference will feature technical sessions and a visit to a paint production facility.

Technical session presentations and speakers are:

"Construction of Business in the Coatings Industry"—Ove Mattsson;

"Science and Paint"—Anders Hult;

"Product Development in the Future"—panel discussion;

"Rot Degradation of Wooden Sidings—An Accelerating Problem"—Kolbjörn Mohn Jensen, of NMLF;

"Can Moisture Uptake in Concrete and Plastered Facades Be Better Controlled by Surface Coating?"—Kristinn Erlingsson, of NMLF;

"Adsorption of Tensides and Polymers in Latex Paints"—Margareta Huldén, of FLFS;

"Test Methods for Printing Ink in a Web Press"—Rolf Dinborn;

"Analytical Determination of the Penetration of Printing Inks into Paper"—Eva Wallström;

"Emission Reduction of Volatile Compounds from Decorative Paints"—J.M. Akkerman, of FATIPEC;

"What Does the Green Approach Mean to the Coatings Industry"—Frank Jones, of North Dakota State University;

"Road Marking Paint Technique in Japan"—Takehide Sakabe, of JSCM;

"Crystal Size and Shape of Mono Azo Pigments and Rheology of Decorative Paints"—R.B. McKay, of OCCA;

"Calculating Technique for Formulation of Alkyd Resins"—T. Misev, of FATIPEC;

"Moisture Transport in Coated Wood Substrates"—Pirjo Ahola, of FLFF;

"Effect of Surface Treatment of TiO_2 Pigments on Color Uniformity"—Tuomo Losoi, of FLFF; and

"Hyperbranched Polymers: Preparation, Properties, and Potential Applications in Coatings"—Jean Fréchet.

Also, a trip is plannted to the recently modernized production facilities of Alcro-Beckers AB at Lövholmen. The plant produces consumer and trade sales paints.

For more information, write 13th SLF Congress, c/o Börje Andersson, Asögatan 192, II, S-116 32 Stockholm, Sweden.

ISCC and CAUS to Cosponsor Color and Fashion Conference

The Inter-Society Color Council (ISCC) and The Color Association of the United States (CAUS) are cosponsoring the conference "Trends in Color and Fashion," at the Doral Inn, in New York City, on May 5-8.

The conference is designed to stress new and emerging trends in the color fashion industry. General sessions on directions and the latest trends in color forecasting and color merchandising in the fields of fashion, decorating products, cosmetics, transportation, building products, publishing, and advertising will be featured.

Also scheduled for presentation are programs dealing with technical problems associated with color. This part of the program will take place during the ISCC-sponsored meetings on "Color Measurement," "Color Imaging," "Color Education," and the "Art and Psychology of Color."

For more details, contact Jim DeGroff, ISCC, Colortec Associates, Inc. (908) 236-2311; Evelyn Stephens, ISCC, Fashion Institute of Technology (212) 760-7871; or Margaret Walch, CAUS (212) 582-6884.

Polymer Research Institute to Sponsor Thermal Analysis Conference in Spring

The 15th Annual Conference on "Thermal Analysis in Research and Production" is slated for the Conference Center of the Park Ridge Marriott Hotel, in Park Ridge, NJ, on April 29-May 1. The course is sponsored by the Polymer Research Institute, Polytechnic University, Brooklyn, NY.

The course is designed to emphasize the practical aspects and applications of thermal analysis, with a survey of its theoretical background. Among the topics to be discussed are: instrumentation; parameters measurable by thermal techniques; thermal characterization of organics and polymers (e.g., thermoplastics, elastomers, thermosets, fibers); study of copolymers, blends, and polymer compatibility; thermal analysis in polymer flammability; thermal analysis of additives in polymers; thermal characterization of inorganic materials (e.g., ceramics and superconductors); characterization of alloys; prediction of catalyst performance; hazards evaluation by thermal techniques; energy saving; stability determination, processability, and quality control; and problem solving by thermal techniques.

At the end of the conference, instrument companies will exhibit and demonstrate their new products.

The conference is intended for professionals involved in research, application, production, testing, technical service, and characterization of materials; also supervisors responsible for materials management.

Immediately following the conference will be the Fourth Short Course on "Viscoelastic Properties of Polymers," scheduled for May 2.

The course program has been expanded and will feature a new topic, "Dynamic Mechanical Analysis and Toughness of Composites."

Lectures to be presented include:

"Dielectric Properties and Measurements"—M. Bachmann, of ICI Americas, Inc.;

"Characterizing Viscoelastic Properties of Polymers"—R.P. Chartoff, of University of Dayton;

"Dynamic Mechanical Analysis and Toughness of Composites"—R.J. Morgan, of Michigan Molecular Institute; and

"Dynamic Mechanical Measurements in the Frequency Domain"—H. Starkweather, of Du Pont Centr. Res.

For more information, contact Eli M. Pearce, Director, Polymer Research Institute, Polytechnic University, 333 Jay St., Brooklyn, NY 11201.

SSPC National Conference To Be Held on Nov. 10-15

The 1991 National Conference and Exhibition of the Steel Structures Painting Council (SSPC) will be held at the Long Beach Convention Center, Long Beach, CA, on November 10-15. This marks the first time in its 41-year history that SSPC will conduct its national annual meeting on the West Coast.

"Maintaining Structures with Coatings" is this year's theme. The conference will deal with the problems and opportunities which confront everyone engaged in protecting steel, concrete, and other industrial substrates with coatings, linings, and floor toppings. These problems and opportunities include: complying with regulations, protecting the safety and health of workers, achieving economic benefits from effective maintenance programs, evaluating performance of new coatings and linings, selecting appropriate cleaning methods, and maintaining quality control of cleaning and coating operations.

The SSPC technical program will consist of 40-50 papers in 10 seminars, 15 tutorials, and 45 committee meetings.

The exhibition is expected to include 200 indoor booths and 10-12 outdoor exhibits or equipment demonstrations.

A National Painter Competition will feature teams of industrial painters who will demonstrate good painting practice.

For further information, contact Rose Mary Surgent, SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213-2683.

Building Products Emulsion

A new brochure highlights an emulsion for a wide range of building products. The literature outlines the use of the emulsion in caulks, extenders, spackling compounds, wood fillers, and mastics. A copy of "Airflex® 500 Emulsion for Building Products" is available from Air Products and Chemicals, Inc., Polymer Chemicals Div., 7201 Hamilton Blvd., Allentown, PA 18195-1501.

Process Control Instruments

A new 36-page condensed catalog of instruments and systems for process control is being offered. Included in the publication are L&N recorders, single-loop controllers, data acquisition and distributed process control systems, energy management systems, analytical equipment, process transmitters, primary elements, parts, supplies, systems, and training services. A copy of catalog H0.0003-CA, "Solutions for Process Measurement & Control" is obtainable from Leeds & Northrup, Sumneytown Pike, North Wales, PA 19454.

Lubricant Injection Systems

A product bulletin introduces two newly designed, self-contained lubrication injection systems for chains, conveyors, and bearings in high-temperature environments, fast-moving equipment, inaccessible locations, and other demanding applications. Features of the systems include precision metering, programmed lubrication intervals, proximity or photoelectric sensors, and a self-contained operating design. Details on Kelgraf® Automatic Injection Lubricators may be obtained from Allied-Kelite, Witco Corp., 2701 Lake St., Melrose Park, IL 60160.

Aliphatic Isocyanate

A publication describes the applications and reactivity of an unsaturated aliphatic isocyanate. The 20-page brochure contains the end-use applications of the unsaturated aliphatic isocyanate, including coatings; modification of plastics, rubbers, and polyols; and its use in oil field chemicals (demulsifiers), textile finishes, viscosity modifiers, and reactive chemicals. Additional details on TMI® are obtainable from American Cyanamid Co., One Cyanamid Plaza, Wayne, NJ 07470.

Electronic Enclosures

An eight-page brochure detailing coatings systems, technical support, distribution, and comprehensive support for finishing electronic enclosures is in print. The literature describes VOC-compliant, high-solids polyurethanes, and water-reducible coatings, which are specified for finishing business machine enclosures. For a copy of "A Strong Case for Sherwin-Williams: Peformance-Proven Systems and Services for Finishing Electronic Enclosures," write to Sherwin-Williams Stores Group, c/o HKM Direct, 5501 Cass Rd., Cleveland, OH 44102 and ask for Electronic Enclosures Brochure (SWS-3527).

Industrial Silanes

A fully illustrated, four-page, color publication which introduces a line of VOC-compliant industrial silanes is available. The new water-soluble products include amine, epoxy, mercapto, methacrylate, vinyl, alkyl, and mixed functional vinyl-amino silanes for a wide variety of industrial applications. A copy of the Hydrosil® brochure may be obtained from Hüls America Inc., Silanes and Silicones, P.O. Box 456, 80 Centennial Ave., Piscataway, NJ 08855-0456.

Pigment Synergism

The fourth brochure in a continuing series aimed at the research efforts designed to explore the pigment synergism between chemically surface modified engineered pigments and different corrosion inhibiting pigments is available. This 32-page publication's results are centered on a water-based acrylic/urethane coating system. For a copy of the brochure, including the test procedures and results, write NYCO, P.O. Box 368, Willsboro, NY 12996.

Solvent Recovery System

A new, self-contained, on-site solvent recovery system is the focus of technical literature. The system possesses a built-in vacuum unit, and reportedly can recover virtually any solvent at low temperatures, including the new, high boiling point, environmentally safe solvents that now are being introduced to replace CFCs, chlorinated solvents, and acetone. Information on the S-8V is available from Siva International Inc., 405 Eccles Ave., S. San Francisco, CA 94080.

Spray Phosphating

A new troubleshooting guide and checklist for users of spray phosphating materials and systems has been published. The four-page brochure identifies 28 potential problem areas that could occur in the spray phosphating operation and offers probable causes and suggested corrective action to be taken for each. Write Man-Gill Chemical, 23000 St. Clair Ave., Cleveland, OH 44117 for a copy of the guide and checklist.

Storage Tanks

A new four-page, four-color brochure which highlights composite underground storage tanks is in print. Features and benefits of the tanks, illustrations of their composite construction, and specifications are provided in the literature. More information on Enviro-Clean composite underground storage tanks is obtainable from Clawson Tank Co., 4701 White Lake Rd., Clarkston, MI 48016-0350.

Spectrophotometers

Two new hand-held spectrophotometers which reportedly provide both precision tristimulus and spectral data measurement are highlighted in technical literature. The instruments weigh less than three pounds, and possess a storage capacity for up to 50 color standards and 500 batches. Write Applied Color Systems, Inc., Corporate Headquarters, 5 Princess Rd., Lawrenceville, NJ 08648 for information on the new PCS-500 and PCS-500D portable spectrophotometers.

Color Software

A new color software package designed to add color measurement capability to an existing series of UV/VIS spectrophotometers is the subject of technical literature. The software provides color measurement for a wide range of sample types, including opaque and transparent solids, translucents, and liquids. Write The Perkin-Elmer Corp., 761 Main Ave., Norwalk, CT 06859-0177 for details on the PECOL software.

Acrylic Emulsion

Literature focuses on a new acrylic emulsion designed to provide both high gloss and corrosion resistance. The emulsion is primarily intended for use as an industrial lacquer for OEM general metal finishes, including applications for metal furniture and fixtures, machinery enamels, and automotive components. Details on Joncryl® SCX-1520 are obtainable from Monty Ann Black, Public Relations Director, Bellwether Communications, 4956 Memco Ln., Racine, WI 53404.

Portable Formulation System

Literature introduces a portable color formulation system which uses a personal computer to store formula and inventory information. The system is designed for use in the coatings, screen printing, plastics, and dyeing industries. Contact Janet Whaley, Communications Specialist, HunterLab, 11491 Sunset Hills Rd., Reston, VA 22090 for more on the MatchMaker color formulation system.

Batch Bead Mill

A self-contained batch bead mill which combines pre-mix, grinding, and dispersing operations to produce fine dispersions is the focus of literature. Typical applications of the batch bead mill include inks, paper coatings, paints, finishes, pharmaceuticals, cosmetics, and catalysts. For a free brochure describing the HSF Batch Bead Mill, write Union Process, 1925 Akron-Peninsula Rd., Akron, OH 44313.

Colorimeters

A new line of tri-stimulus colorimeters designed specifically for locations requiring multi-unit usage and color management systems is the focus of technical literature. Functions of the colorimeters include data printout, statistical calculations, data output, data storage with memory backup, and automatic measurement at user selected intervals. For further details on Chroma Meters CR-300, CR-310, and CR-331, write Minolta Corp., Industrial Meter Div., 101 Williams Dr., Ramsey, NJ 07446.

Flame Ionization Detector

A new, four-page, full-color brochure which describes a gas detection sensor is in print. Reported features include true linear response time, air aspirator flow system without pumps, easy access to components, compatibility with all control monitors, and pre-configuration at the factory for fast installation. Free copies on the Model FID can be obtained from Control Instruments Corp., 25 Law Dr., Fairfield, NJ 07004-3295.

Flow Timer

An automatic flow timer designed to provide precise flow cup viscosity measurement is the topic of literature. Details on the Autovisc are available from Sheen Instruments Ltd., 8 Waldegrave Rd., Teddington, Middlesex TW11 8LD, England.

Outdoor Test Program

An outdoor test program with controlled wetting cycles has been introduced in a product bulletin. The new program adds moisture to the dry, hot atmosphere to which samples are exposed in the desert. Information on the Desert Environment with Wetting, DEWW®, can be obtained from South Florida Test Service, Desert Site, 31818 N. 203 Ave., Wittmann, AZ 85361.

Pump

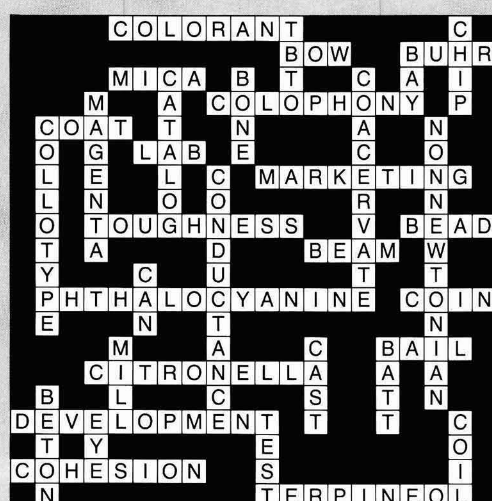
A line of pumps which is designed to provide a broad range of chemical compatibility is the subject of a product bulletin. The pumps are available with lip type seals, mechanical seals, or other options. For data on the VI-CORR® Composite Pump, write to Viking Pump, Inc., A Unit of IDEX Corp., 406 State St., Cedar Falls, IA 50613.

Formulating Journal

A new interdisciplinary journal has been published. *For Formulation Chemists Only* features short articles and comprehensive reviews on raw materials, chemistry, applied research, formula and testing for efficacy, stability, and packaging. For complete details, contact CITA International, Industrial Publications Division, F_2CO, P.O. Box 70, Phoenix, AZ 85001.

High Speed Mixer

Technical literature focuses on a new high speed mixer for the volume paint operator. The mixer is designed to handle five-gallon, gallon, quart, and pint containers, and has a new push button control with a dial timer providing up to four minutes mixing time. For more details on the 5001 High Speed Mixer, write Red Devil, Inc., 2400 Vauxhall Rd., Union, NJ 07083-1933.



Solution to February's *"CrossLinks"*

Opaque Satin Finishes

A line of opaque satin finishes in a solid pigmented finish for exterior wood such as cedar, pine, and redwood is the subject of a product release. The products are designed to be water repellant and the microporous qualities allow any excess moisture within the wood to escape, inhibiting blistering and cracking. Write Akzo Coatings Inc., Decorative Finishes, P.O. Box 7062, Troy, MI 48007-7062 for data on the Rubbol System.

Viscosity Cups

A six-page pamphlet outlining the importance of updating many old specifications referencing a line of viscosity cups has been published. The literature also enumerates many reasons for the use of calibrated cups in current day specification writing. A copy of "30 Seconds in a Zahn Cup!!—What Does It Really Mean?" is available by writing Paul N. Gardner, Sr., Paul N. Gardner Co., Inc., 316 N. E. First St., Pompano Beach, FL 33060.

Compliance Software

A new program designed to generate MSDSs in a format required for submission to a 24-hr emergency telephone response service is the subject of a technical bulletin. The software reportedly allows the generation of MSDSs selectively for a product line or for individual items, and can also generate MSDSs in other formats. Additional information and a free demo disk on the system are available from Pacific Micro Software Engineering, 35 59th Place, Long Beach, CA 90803.

Maintenance Coatings

The American Society for Testing and Materials (ASTM) Subcommittee D33.10 on Protective Coatings Maintenance Work for Power Generation Facilities announced the availability of a guide book for selecting and applying maintenance coatings in nuclear plants. The *Manual on Maintenance Coatings for Nuclear Power Plants* contains 11 chapters which cover: significance of maintenance coatings; inspection, preparation, planning, and scheduling; safety; qualification of coatings; coating materials; surface preparation; and methods of application. A glossary of terms and a list of applicable ASTM standards are included for reference. The 41-page book is available for $32, member price is $25.60. For more information, write ASTM, 1916 Race St., Philadelphia, PA 19103.

National Standards

The 1990-91 catalog of all approved American National Standards has been published by the American National Standards Institute (ANSI). The publication indexes some 9,400 American National Standards. The listed standards provide dimensions, performance and safety requirements, test methods, ratings, terminology and symbols for equipment, components, materials, and products from a variety of industry sectors. A subject index is included to simplify the search for the needed standards. The catalog is available to ANSI members and libraries that serve the general public for free. All others can obtain a copy of the catalog for $20 plus shipping and handling. Write to ANSI, 1430 Broadway, New York, NY 10018 for additional details.

Wallcoverings

A how-to-hang and decorate with wallcoverings video is now available. The almost 70-min video features presentations on hanging and decorating wallcoverings, and an update on wallcovering decorating trends. Information on the videotape package can be obtained from National Decorating Products Association Dealer Services, 1050 N. Lindbergh Blvd., St. Louis, MO 63132.

Scanning Electron Miscroscope

A product data sheet introduces a new scanning electron microscope that is designed specifically for the inspection of integrated circuits. For additional details on the Model ABT-2200, contact Robert Buchanan, International Scientific Instruments, 6940 Koll Center Pkwy., Pleasanton, CA 94566.

Stress Meter

A technical bulletin introduces a new instrument to examine and measure internal stress in organic coatings. The instrument is designed to accurately measure stress using the cantilever beam and plate principle. Additional details on the Coating Stress Meter (Model 660/8300) are available from Frank Rueter, Marketing Mgr., Zorelco Ltd., P.O. Box 25500, Dept. A1, Cleveland, OH 44125-0500.

Drainable Drum

A product data sheet highlights a new 55-gal drum designed for complete drum draining. The drum was manufactured to protect the environment and help meet Environmental Protection Agency regulations. Write The Dow Chemical Co., 2020 Bldg., Midland, MI 48674 for details on the drainable drum.

Rheological Testing Of Thermoplastics

A new 24-page booklet which explains the basic aspects of rheological testing and focuses on its beneficial application to thermoplastics and products is available. The literature is designed to show how rheological testing can help users understand and correct processing and performance problems. Over 40 graphs and illustrations support the text. For a copy of "Understanding Rheological Testing: Thermoplastics," write to Marketing, Rheometrics, Inc., One Possumtown Rd., Piscataway, NJ 08854.

Compressed Air Technology

A new publication describes how to use compressed air to more efficiently spot cool, amplify air, reduce noise, and eliminate static in hundreds of manufacturing processes. The six-page, four-color brochure covers four different product lines: vortex tubes, transvectors/blowoff, enclosure cooling systems, and static control products. Write Vortec Application Engineering, 10125 Carver Rd., Cincinnati, OH 45242 for a copy of the new literature.

Coloring Planning System

A technical bulletin introduces a computer-based coloring planning system designed to allow the consumer to test and match colors in the paint store. The system allows the consumer to test colors on "model" homes. For more information on Colorvision, write to Commodore Business Machines, Inc., 1200 Wilson Dr., West Chester, PA 19380.

Liquid Coloring System

A technical data sheet introduces a new liquid coloring system for use in reactive thermoset applications such as RIM and urethane foam. The product is a highly pigmented, pumpable liquid designed to offer pigment dispersion for a superior finished product appearance. Information on Color Flo II™ is available from Spectrum Colors, 9101 International Pkwy., Minneapolis, MN 55428.

Foam Control Agent

Foam control technology for architectural gloss paints and waterborne industrial coatings with low VOC emission requirements is the subject of a technical product bulletin. The agent is designed to exhibit persistency, product stability, gloss retention, and compatibility with most systems. More data on Drewplus® L-407 may be obtained from Marketing Services, Drew Industrial Div., One Drew Plaza, Boonton, NJ 07005.

Coming Events

FEDERATION MEETINGS

For information on FSCT meetings, contact Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422 (215) 940-0777, FAX: (215) 940-0292.

1991

(May 13-17)—Federation "Spring Week." Seminar on the 13th and 14th; Board of Directors Meeting on May 15; and Society Officers Meeting on May 16. Sheraton Society Hill Hotel, Philadelphia, PA.

(Nov. 4-6)—69th Annual Meeting and 56th Paint Industries' Show. Convention Center, Toronto, Ontario, Canada.

1992

(Oct. 21-23)—70th Annual Meeting and 57th Paint Industries' Show. McCormick Place, Chicago, IL.

1993

(Oct. 27-29)—71st Annual Meeting and 58th Paint Industries' Show. World Congress Center, Atlanta, GA.

SPECIAL SOCIETY MEETINGS

1991

(Mar: 13-15)—Dallas and Houston Societies. Southwestern Paint Convention. Dallas, TX. (Leo Michaelewicz, Proko Industries, 1860 LBJ Freeway, Ste. 400, Mesquite, TX 75150).

(Apr. 3-6)—Southern Society Annual Meeting. The Peabody Hotel, Memphis, TN. (Vernon Sauls, McCullough & Benton, P.O. Box 272360, Tampa, FL 33688).

(May 2-4)—Pacific Northwest Society. Annual Symposium. Meridien Hotel, Vancouver, British Columbia, Canada. (John P. Berghuis, Kronos Canada, Inc., 3450 Wellington Ave., Vancouver, B.C., Canada V5R 4Y4).

(June 6)—Cleveland Society. 34th Annual Technical Conference. B.F. Goodrich R&D Center, Brecksville, OH. (Devilla Moncrief, Sherwin-Williams Co., Cleveland Technical Center, 601 Canal Rd., Cleveland, OH 44113).

(June 7-8)—Joint Meeting of the St. Louis and Kansas City Societies. Holiday Inn, Lake of the Ozarks, MO.

OTHER ORGANIZATIONS

1991

(Mar. 18-20)—"Polymer Blends and Alloys: Phase Behavior, Characterization, Morphology, Alloying Technology." Short course sponsored by The Institute of Materials Science, State University of New York (SUNY), New Paltz, NY. (Institute of Materials Science, SUNY, New Paltz, NY 12561).

(Mar. 18-20)—Fourth Annual Conference on Lead Paint Removal from Industrial Structures. Sponsored by Steel Structures Painting Council (SSPC). Omni Charlotte Hotel, Charlotte, NC. (Rose Mary Surgent, SSPC Meetings Manager, SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213-2683).

(Mar. 19-21)—"farbe + lack 91." The First Congress Exhibition for the Coating, Printing Inks, Adhesives, and Sealants Industry. Sponsored by *farbe + lack*. Nuremberg Exhibition Grounds, West Germany. (Klaus Geissler, Manager, Events Division, Curt R. Vincentz Verlag, Postfach 62 47, 3000 Hannover 1, West Germany).

(Mar. 25-29)—22nd Introductory Short Course on Paint Formulation. Sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Norma R. Fleming, Sr. Continuing Education Coordinator, UMR, 119 M.E. Annex, Rolla, MO 65401-0249).

(Mar. 26)—"Screen Process Symposium." Sponsored by the Society of British Printing Ink Manufacturers and the Screen Process Technicians Association. Runnymede Hotel, Egham, England. (Chris Pacey-Day, The Oil & Colour Chemists' Assoc., Priory House, 967 Harrow Rd., Wembley, Middlesex, England HA0 2SF.)

(Apr. 3-5)—Hazardous Materials Management Conference and Exhibition/Central (HazMat/Central '91). O'Hare Exposition Center, Rosemont, IL. (Tower Conference Management Co., 800 Roosevelt Rd., Bldg. E—Ste. 408, Glen Ellyn, IL 60137-5835).

(Apr. 8-12)—Advanced Technology Short Courses on "Advanced VLSI Processing Devices and Technology." Hotel Il Ciocco, Pisa, Italy. (Tina Persson, Marketing Manager, CEI-Europe/Elsevier, P.O. Box 910, S-61225 Finspong, Sweden).

(Apr. 9-10)—"Environmental Regulations: A New Ball Game." Annual symposium sponsored by The Washington Paint Technical Group. Washington, D.C. (Mary McKnight, United States Department of Commerce, National Institute of Standards and Technology, Gaithersburg, MD 20899.)

(Apr. 13-14)—"Applications of FT-IR to Polymer Characterization." Two-day lecture and course. Atlanta, GA. (Clara D. Craver, Chemir Laboratories, 761 W. Kirkham Ave., Glendale, MO 63122).

(Apr. 15-17)— Surface Coating 1991. Sponsored by Chemical Coaters Association. Indian Lakes Resort, Bloomingdale, IL. (Chemical Coaters Assoc., P.O. Box 44275, Cincinnati, OH 45244).

(Apr. 22-25)—The Euro-Asian Interfinish Isreal 1991. Conference sponsored by the Metal Finishing Society of Isreal. Herzlia, Isreal. (Secretariat, Ortra, Ltd., 2 Kaufman St., Tel-Aviv 61500, Isreal).

(Apr. 22-26)—"Applied Rheology for Industrial Chemists." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry, KSU, Kent, OH 44242).

(Apr. 25-27)—Second Annual "Surfaces '91" Trade Show. Sponsored by The Western Floor Covering Association. Las Vegas Convention Center, Las Vegas, NV. (Sheila Harman, B.P. Rice & Co., Inc., 13079 Artesia Blvd., Ste. 228, Cerritos, CA 90701-3312).

(Apr. 29-May 2)—15th Annual Conference Course on "Thermal Analysis in Research and Production," on Apr. 29-May 1, and Fourth Intensive Short Course on "Viscoelastic Properties of Polymers," on May 2. Park Ridge Marriott Hotel, Park Ridge, NJ. (Edith A. Turi, Polytechnic University, 333 Jay St., Brooklyn, NY 11201.)

(Apr. 29-May 3)—Evaluation and Durability Conference. Cosponsored by Steel Structures Painting Council (SSPC), Pittsburgh, PA. (SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213-2683).

(May)—ASTM Committee B-8 on Metallic and Inorganic Coatings meeting. Atlantic City, NJ. (George A. DiBari, International Nickel Co., Park 80 West—Plaza Two, Saddle Brook, NJ 07662).

(May 5-8)—"Trends in Color and Fashion." Conference co-sponsored by the Inter-Society Color Council (ISCC) and The Color Association of the United States. Doral Inn, New York, NY. (Jim DeGroff, ISCC, Colortec Associates, Inc., P.O. Box 636, Old Wick, NJ 08858).

(May 6-10)—"Dispersion of Pigments and Resins in Fluid Media." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry, KSU, Kent, OH 44242).

(May 7-9)—"Formulating Chemical Products." Short course sponsored by McMaster University. Venture Inn, Burlington, Ontario. (Stienna Thomas, JHE 136, Dept. of Chemical Engineering, McMaster University, Hamilton, Ont., Canada L8S 4L7).

(May 12-15)—AOCS 82nd Annual Meeting & Expo. Sponsored by The American Oil Chemists' Society. Chicago Marriott Hotel, Chicago, IL. (Myra Barenberg, AOCS, P.O. Box 3489, Champaign, IL 61826-3489).

(May 13-18)—"Interpretation of IR and Raman Spectroscopy Course, Lectures, and Workshops." Vanderbilt University, Nashville, TN. (Fisk Infrared Institute, Box 15, Fisk University, Nashville, TN 37203).

(May 14-16)—PaintCon '91. Conference and exhibition sponsored by *Industrial Finishing* magazine. O'Hare Expo Center, Chicago (Rosemont), IL. (PaintCon '91, 2400 E. Devon Ave., Ste. 205, Des Plaines, IL 60018).

(May 15-17)—Sixth Annual Conference of the Architectural Spray Coaters Association (ASCA). Loews Ventana Canyon Resort, Tucson, AZ. (ASCA, 230 W. Wells St., Ste. 311, Milwaukee, WI 53203).

(May 20-24)—"Adhesion Principles and Practice for Coatings and Polymer Scientists." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry, KSU, Kent, OH 44242).

(May 22-24)—"Environmental Protection, Control and Monitoring." Conference organized by the European Region of the Instrument Society of America (ISA) and co-sponsored by BAMBICA, The Association for Instrumentation, Control and Automation Industry in the U.K., and The Institute of Measurement Control in the U.K. Birmingham, England. (ISA, 67 Alexander Dr., P.O. Box 12277, Research Triangle Park, NC 27709).

(May 23-24)—Seventh International Symposium on "Theory and Trends in Electrostatic Coating Technology." The University of Western Ontario, London, Ont., Canada. (Prof. I.I. Inculet, Director, Applied Electrostatics Research Centre, The University of Western Ontario, London, Ont., Canada N6A 5B9).

(May 29-31)—Fourth International Symposium on Polymer Analysis and Characterization; June 1-2—Short course "Major Polymer Characterization Techniques and Methods." Baltimore Inner Harbor, MD. (Judith A. Watson, Professional Association Management, 750 Audubon, East Lansing, MI 48823).

(June 3-7)—22nd Annual Short Course on "Advances in Emulsion Polymerization and Latex Technology." Sponsored by Lehigh University, Bethlehem, PA. (Mohamed S. El-Aasser, Emulsion Polymers Institute, Lehigh University, 111 Research Dr., Bethlehem, PA 18015).

(June 5-7)—5th International Conference on Crosslinked Polymers. Sponsored by State University of New York (SUNY). Luzern, Switzerland. (Angelos V. Patsis, Institute in Materials Science, SUNY, New Paltz, NY 12561).

(June 10-14)—"High Solids and Low-VOC Coatings." Short course sponsored by North Dakota State University (NDSU), Fargo, ND. (NDSU Continuing Education, P.O. Box 5819, University Station, Fargo, ND 58105-5819).

(June 12-14)—International Bridge Conference: Painting Seminar on the 12th. Administered by Steel Structures Painting Council (SSPC) and sponsored by the Engineers Society of Western Pennsylvania. SSPC Bridge Painting Forum on the 13th and 14th. Sponsored by SSPC. The Pittsburgh Hilton, Pittsburgh, PA. (SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213-2683).

(June 12-14)—SURCON '91, "Developments in the Science of Surface Coatings." Moat House International Hotel, Stratford-upon-Avon, England. (Simon Lawrence, CIBA-GEIGY Pigments, Hawkhead Rd., Paisley, Renfrewshire PA2 7BG, Scotland).

(June 17-28)—"Coatings Science." Short course sponsored by North Dakota State University (NDSU), Fargo, ND. (NDSU Continuing Education, P.O. Box 9, University Station, Fargo, ND 58105-5819).

(June 19-21)—First International Symposium on Environmental Effects on Advanced Materials. Sponsored by National Association of Corrosion Engineers (NACE). Catamaran Resort Hotel, San Diego, CA. (NACE Customer Service Dept., P.O. Box 218340, Houston, TX 77218).

(July 7-12)—Seventh International Conference on Surface and Colloid Science (ICSCS). Sponsored by the International Association of Colloid and Interface Scientists, Université de Technologie de Compiègne, France. (M. Clausse, Secretariat of the 7th ICSCS, c/o Wagons-Lits Tourisme, B.P. 244, 92307 Levallois-Perret Cedex, France).

(July 8-12)—17th International Conference in Organic Coatings Science and Technology. Sponsored by State University of New York (SUNY). Athens, Greece. (Angelos V. Patsis, Institute in Materials Science, SUNY, New Paltz, NY 12561).

(July 17-19)—Introductory Short Course on "Basic Coatings for Sales and Marketing Personnel." Sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Norma Fleming, Sr. Continuing Education Coordinator, UMR, 119 M.E. Annex, Rolla, MO 65401-0249).

(Sept. 3-5)—2nd International Paint Congress. Sponsored by The Brazilian Association of Paint Manufacturers (ABRAFATI). Anhembi Convention Centre, São Paulo, Brazil. (Específica S/C Ltd., Rua Augusta, 2516—2nd Floor, Ste. 22, 01412, São Paulo, SP, Brazil).

(Sept. 9-13)—63rd Introductory Short Course on "The Basic Composition of Coatings." Sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Norma Fleming, Sr. Continuing Education Coordinator, UMR, 119 M.E. Annex, Rolla, MO 65401-0249).

(Sept. 10-12)—North American Hazardous Materials Management Conference and Exhibition. Sponsored by *HazMat World* magazine. Cobo Hall, Detroit, MI. (Tower Conference Management Co., 800 Roosevelt Rd., Bldg. E, Ste. 408, Glen Ellyn, IL 60137).

(Sept. 17-20)—Eurocoat 91. XIX International Congress/Exibition. Nice, France. (A. Chauvel, AFTPV, 5, rue Etex, 75018 Paris, France).

(Sept. 24-26)—The Polyurethanes World Congress 1991. Cosponsored by the European Isocyanate Producers Association and the Polyurethane Division of The Society of Plastics Industry (SPI), Inc. of the USA. Acropolis Arts & Convention Center, Nice, France. (Fran Lichtenberg, Polyurethane Div., SPI, 355 Lexington Ave., New York, NY 10017).

(Sept. 29-Oct. 2)—RADTECH Europe '91 Conference and Exhibition. Edinburgh Exhibition and Trade Centre, Edinburgh, Scotland. (Exhibit Manager, RADTECH 91, c/o FMJ International Publications Ltd., Queensway House, 2 Queensway, Redhill, Surrey, RH1 1QS, United Kingdom or Conference Secretary, RADTECH '91, c/o PRA, Waldegrave Rd., Teddington, Middlesex, TW11 8LD, England).

(October)—ASTM Committee B-8 on Metallic and Inorganic Coatings meeting. Philadelphia, PA. (George A. DiBari, International Nickel Co., Park 80 West—Plaza Two, Saddle Brook, NJ 07662).

(Oct. 2-4)—Hazardous Materials Management Conference and Exhibition/South (HazMat/South). Sponsored by *HazMat World* magazine. Georgia World Congress Center, Atlanta, GA. (Tower Conference Management Co., 800 Roosevelt Rd., Bldg. E, Ste. 408, Glen Ellyn, IL 60137-5835).

(Oct. 7-10)—"Introduction to Coatings Technology." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry, KSU, Kent, OH 44242).

(Oct. 9-11)—"Verbundwerk '91." 3rd International Trade Fair on Composite Technology, Reinforced Plastics, Metals, and Ceramics. Rhein-Main-Halls, Wiesbaden, Germany. (Diana Schnabel, DEMAT, Postbox 110 611, 6000 Frankfurt 11, Germany).

(Oct. 16-18)—"Accelerated and Natural Weathering Techniques for Coatings and Polymers." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry, KSU, Kent, OH 44242).

(Oct. 21-25)—23rd Introductory Short Course on "Paint Formulation." Sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Norma Fleming, Sr. Continuing Education Coordinator, UMR, 119 M.E. Annex, Rolla, MO 65401-0249).

(Oct. 28-Nov. 1)—"Fundamentals of Chromatographic Analysis." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry, KSU, Kent, OH 44242).

(Oct. 28-Nov. 1)—Ninth International Conference on "Photopolymers," on Oct. 28-30, and Fourth International Conference on "Polyimides," on Nov. 1. Sponsored by the Society of Plastics Engineers, Inc. (SPE). The Nevele Country Club, Ellenville, NY. (Prabodh Shah, c/o SPE, Mid Hudson Section, P.O. Box 546, Hopewell Junction, NY 12533).

(Nov. 4-5)—"Electrochemical Impedance: Analysis and Interpretation." Symposium sponsored by ASTM Committee G-1 on Corrosion of Metals. San Diego, CA. (John R. Scully, Sandia National Labs., Org. 1834, P.O. Box 5800, Albuquerque, NM 87185).

(Nov. 6-8)—POWDEX. Organized by Cahners Exhibition Group. Georgia World Congress Center, Atlanta, GA. (Angela Piermarini, Show Manager, Cahners Exposition Group, 1350 E. Touhy Ave., P.O. Box 5060, Des Plaines, IL 60017-5060).

(Nov. 8-12)—1991 International Surface Finishing & Coatings Exhibition (SF China '91) and the 1991 International PC Board Making & Electro-Chemicals Exhibition (PCB China '91). Shanghai Exhibition Center, Shanghai, P.R. China. (Sinostar International Ltd., 10A Harvest Moon House, 337-339 Nathan Rd., Kowloon, Hong Kong).

(Nov. 10-15)—1991 National Conference and Exhibition of Steel Structures Painting Council (SSPC). Long Beach Convention Center, Long Beach, CA. (SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213-2683).

1992

(Feb. 23-26)—Williamsburg Conference, "Comparison of Color Images Presented in Different Media." Co-sponsored by the Inter-Society Color Council and the Technical Association of Graphic Arts, Colonial Williamsburg, VA. (Milton Pearson, RIT Research Corp., 75 Highpower Rd., Rochester, NY 14623).

(Oct. 25-30)—Fourth Corrosion and Protection Iberoamerican Congress and First Panamerican Congress on Corrosion and Protection. Mar del Plata, Argentina. (CIDEPINT, 52 entre 121 y 122, 1900 La Plata, Argentina, South America).

Advertisers Index

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'Humbug' from Hillman

Fortunate coincidence brought separate contributions from the Laurens, father and daughter—Sid and Barbara. Sid has been long honored for his contributions to the Federation and to Humbug. Barbara has made her mark with a doctorate in English Lit., and now, in law, and from time to time has favored us with some choice bits of humor.

Sid proudly tells the gospel truth story about his grandnephew, age 6. It seems that Sid was visiting the family just after Halloween and asked the youngster whether he had gone out "trick or treating," and, if so, how was he costumed.

"I was a skunk," the boy answered.

"A skunk," Sid questioned, "and did you smell like a skunk?"

"I did."

"How did you get to smell like a skunk?"

"I used my mommy's perfume—a lot of it."

Sid, in his communication, goes on to complain about the sudden jump in domestic air fares. For example, when he was arranging a flight to attend a Federation committee meeting, he was amazed that the fare from Boston to Cleveland was quoted at $360, one way. The same day he spotted an ad for Boston-Frankfurt, Germany, ROUND TRIP for $406. He suggests that the Federation could save money by holding committee meetings in Frankfurt. *(Any faithful readers who wish to alert Sid of better prices, please write to him, not to Humbug!)*

Barbara sent the following plucked from the *American Bar Association Journal*: Judge William C. Miller, of Montgomery County, MD, was hearing a case in which the defendant had skipped his court date. Miller announced he was going to issue a bench warrant to have the defendant picked up.

"You can't do that," said the public defender. "The man is a schizophrenic."

"In that case," replied the judge, "I'll issue two."

Gordon Major of the Toronto Society forwarded a clipping from the November 21st *Toronto Star* which tells of a new product derived from aspergillus niger, that appears to have the potential of saving the world from much embarrassment. Publication herein does not indicate an endorsement from "Humbug."

Benign Beans

Another novel product aimed at removing unseemly side effects from food is Beano. Beano is a liquid solution you add to beans or cruciferous vegetables (broccoli, cabbage, Brussel sprouts, and the like) to remove their gas producing properties, claims its U.S. manufacturer (the same firm that makes Lactaid for those with lactose intolerance).

Beano, says the Lactaid press release, is an enzyme derived from aspergillus niger, a fungal source. The enzyme breaks down indigestible sugars in gas producing veggies and legumes into digestible sugars.

As with user-friendly garlic, I (the writer, not Humbug) decided to find out first-hand (nice way to put it, Humbug) if Beano works. As directed I (not Humbug) added five drops of Beano (odorless and tasteless) to my first spoonful of kidney beans one recent lunch time, then proceeded to down a bowlful of these powerful legumes.

The result: I had none of the after effects for which beans are infamous.

Beano, say the folks at Lactaid, is a "scientific and social breakthrough." They even recommend it as a stocking stuffer for Christmas with the slogan "Merry Christmas and Goodbye Gas."

And then, Ray Dickie, of the Detroit Society, in a quote from C.E.K. Mees, of Eastman Kodak, offers this for everyone in R&D to consider.

The best person to decide what research work shall be done is the man doing the research. The next best is the head of the department. After that you leave the field of best persons and meet increasingly wrong groups. The first of these is the Research Director, who is probably wrong more than half the time. Then comes the committee, which is wrong most of the time. Finally, there is the committee of company vice-presidents which is wrong all of the time. *(Research Directors and Vice Presidents please note: The preceeding does not necessarily reflect the views of Humbug; so no threatening letters, please.)*

Also from Ray:

Well Know Axioms Translated into Governmental Language

- It is fruitless to attempt to indoctrinate a superannuated canine innovative maneuvers.
- Scintillate, scintillate, asteroids minified.
- Members of an avian species of identical plumage congregate.
- Surveillance should precede saltation.
- It is fruitless to become lachrymose over precipantly departed lacteal fluid.
- Pulchritude possesses sole cutaneous profundity.
- Freedom from incrustation is contiguous to rectitude.
- The stylus is more potent than the claymore.
- Eschew the implement of correction and vitiate the scion.
- The temperature of the aqueous content of the unremittingly ogled saucepan does not reach 212°F.
- All articles that coruscate with resplendence are not truly auriferous.
- Where there are visible vapors having their prevalence in ignited carbonaceous material, there is conflagration.
- Sorting on the part of mendicants must be interdicted.
- A plethora of individuals with expertise in culinary techniques vitiate the possible concoction produced by steeping certain comestibles.
- Male cadavers are incapable of yielding any testimony.

Note: For translations, write to your nearest government agency.

—Herb Hillman
Humbug's Nest
P.O. Box 135
Whitingham, VT 05361

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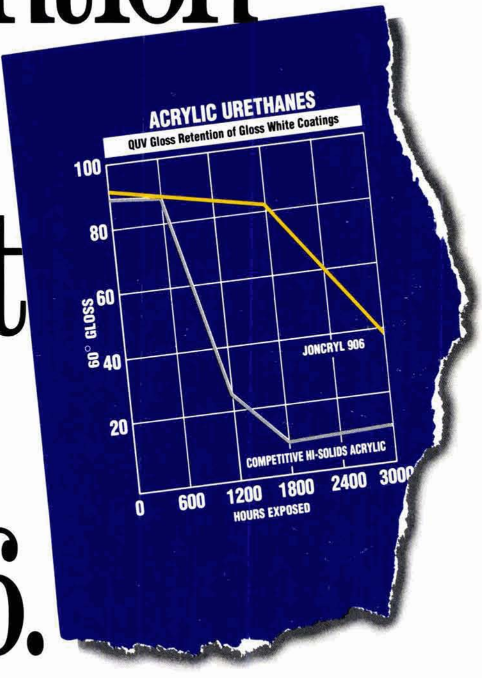

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