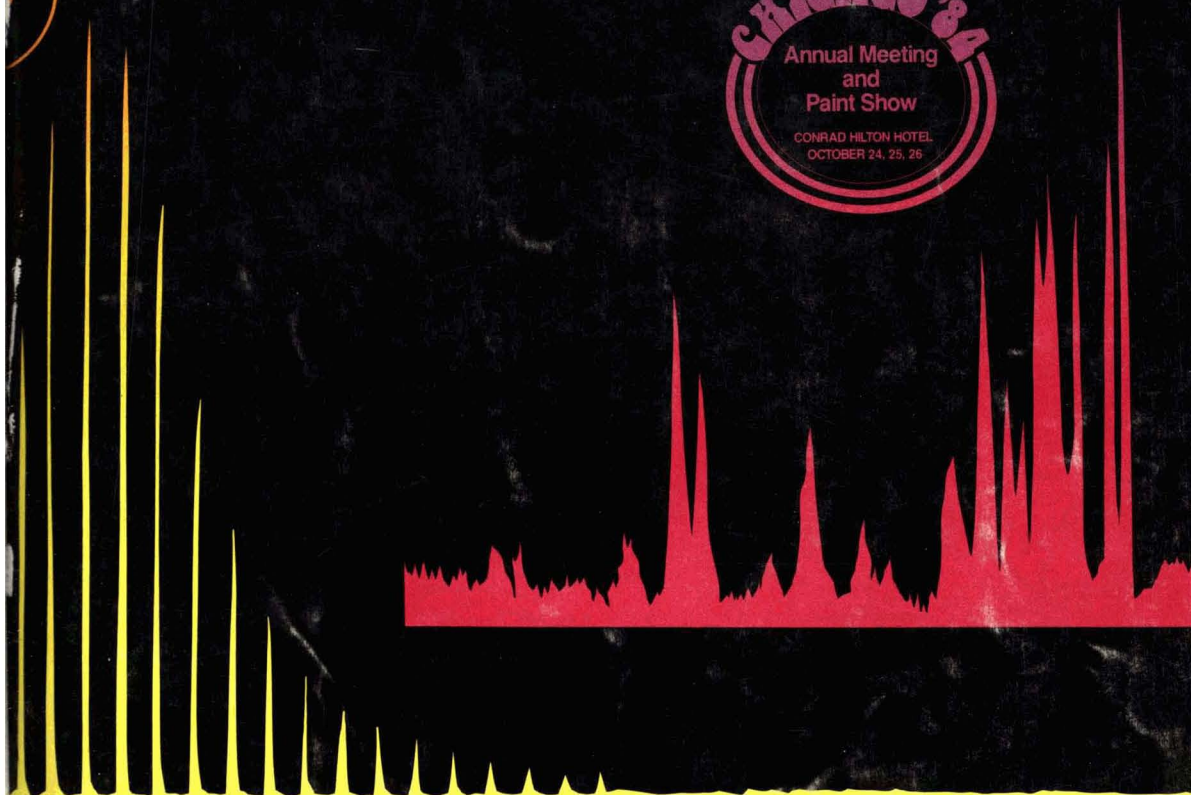


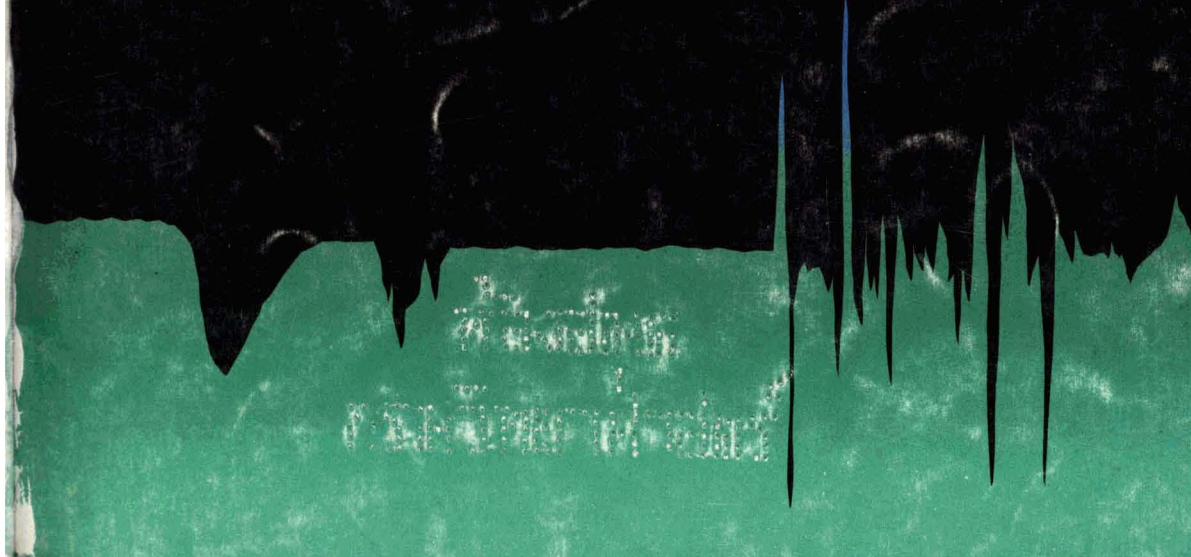
JCTAX 56 (710) 1-76 (1984)

March 1984

jct JOURNAL OF COATINGS TECHNOLOGY



Techniques to Measure Melamine/Polyol Reactions in a Film





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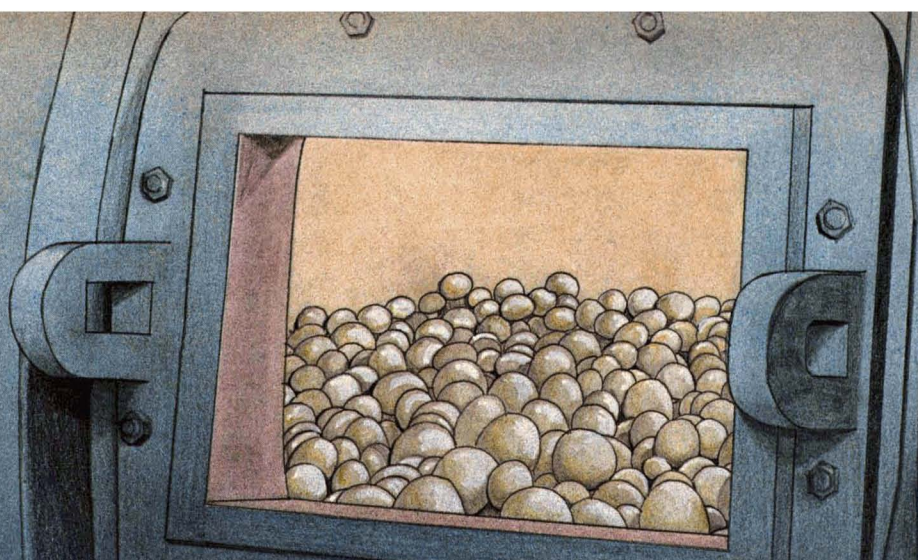
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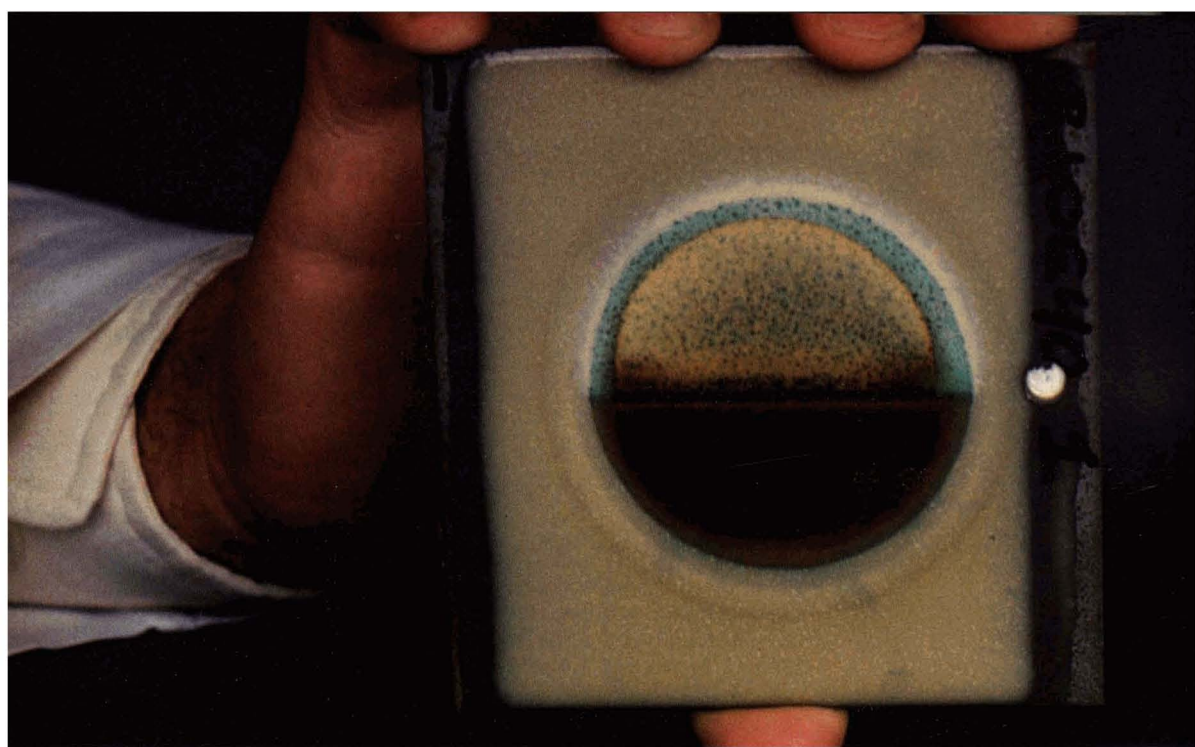


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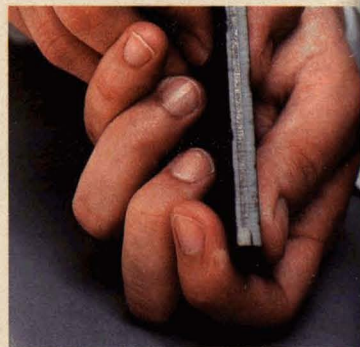
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**You can now formulate
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Conditions are so hostile inside a coal-burning utility's flue gas desulfurization unit that, until today, no completely satisfactory coating has existed. Traditional coatings for carbon steel have been too



Encapsulated in our XU 252 and XU 264 system, this strip of steel was immersed in a 50% sulfuric acid bath for two hours at room temperature then, without rinsing, put into a 350° oven for 30 minutes. This was followed by quenching in sulfuric acid. After 10 such cycles, there was slight surface charring—but no penetration.

brittle. And exotic alloys have been too costly.

Now, however, there is an answer. An answer that, for the first time, allows you to formulate an organic coating with the characteristics you need to meet the demands of this particularly difficult application.





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Start with a high performance resin.

Our system begins with XU 252, a high performance epoxy resin that has already proven its worth against chlorinated solvents, ethanol, methanol, aromatic amines, acids, caustic and ammonia—and proved it under a wide range of service temperatures.

But you require more than a high performance resin to formulate a superior coating. You also need a high technology hardener that can produce the desired physical qualities in the cured system.

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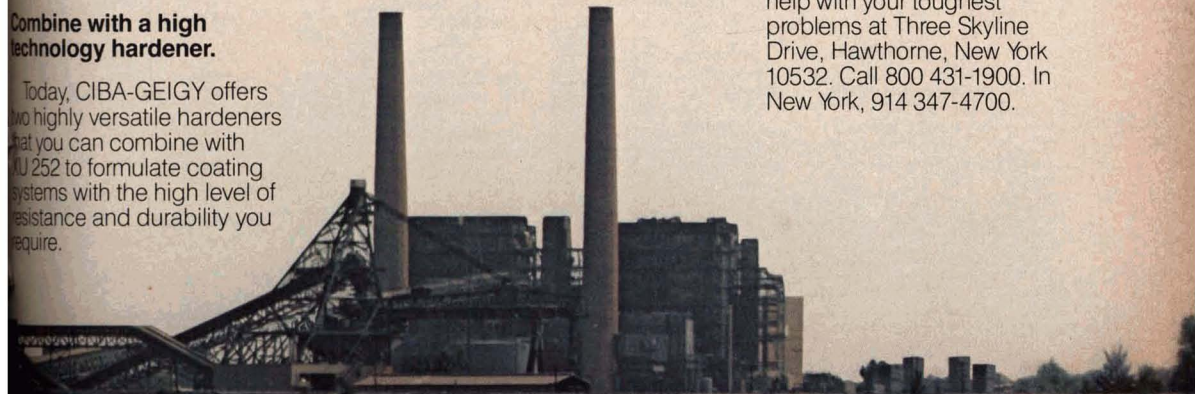
The first, XU 264, is a toughened aromatic amine-based epoxy hardener that is particularly suitable for high temperature service. It provides good flexibility, superior toughness, and excellent resistance to sulfuric acid—properties that make it the ideal hardener for use in high performance coatings for the scrubbers, ducts and stacks in flue gas desulfurization units.

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An Idea Whose Time Has Come

Anyone who has ever been involved in round-robin testing programs is aware that participating laboratories, all testing the same paint, often report such varying results that valid comparisons are difficult, if not impossible.

Does such disagreement stem from faulty or worn test equipment, careless operator performance, or poorly conceived test methods? Or, perhaps, all three?

Reliable testing is basic to quality control. If laboratories are to obtain results that are in agreement, they must be able to evaluate materials and products by means of standard procedures.

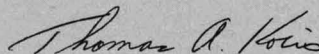
Accordingly, the Federation is sponsoring a program designed to improve the reliability of paint and coatings testing, and to develop reproducible test methods.

The program offers participating laboratories the means to periodically check their testing proficiency by comparing results with those of other cooperating laboratories (confidentiality will be maintained through assignment of code numbers).

An important by-product of the program is that it will provide a realistic assessment of the state of paint and coatings testing efficiency.

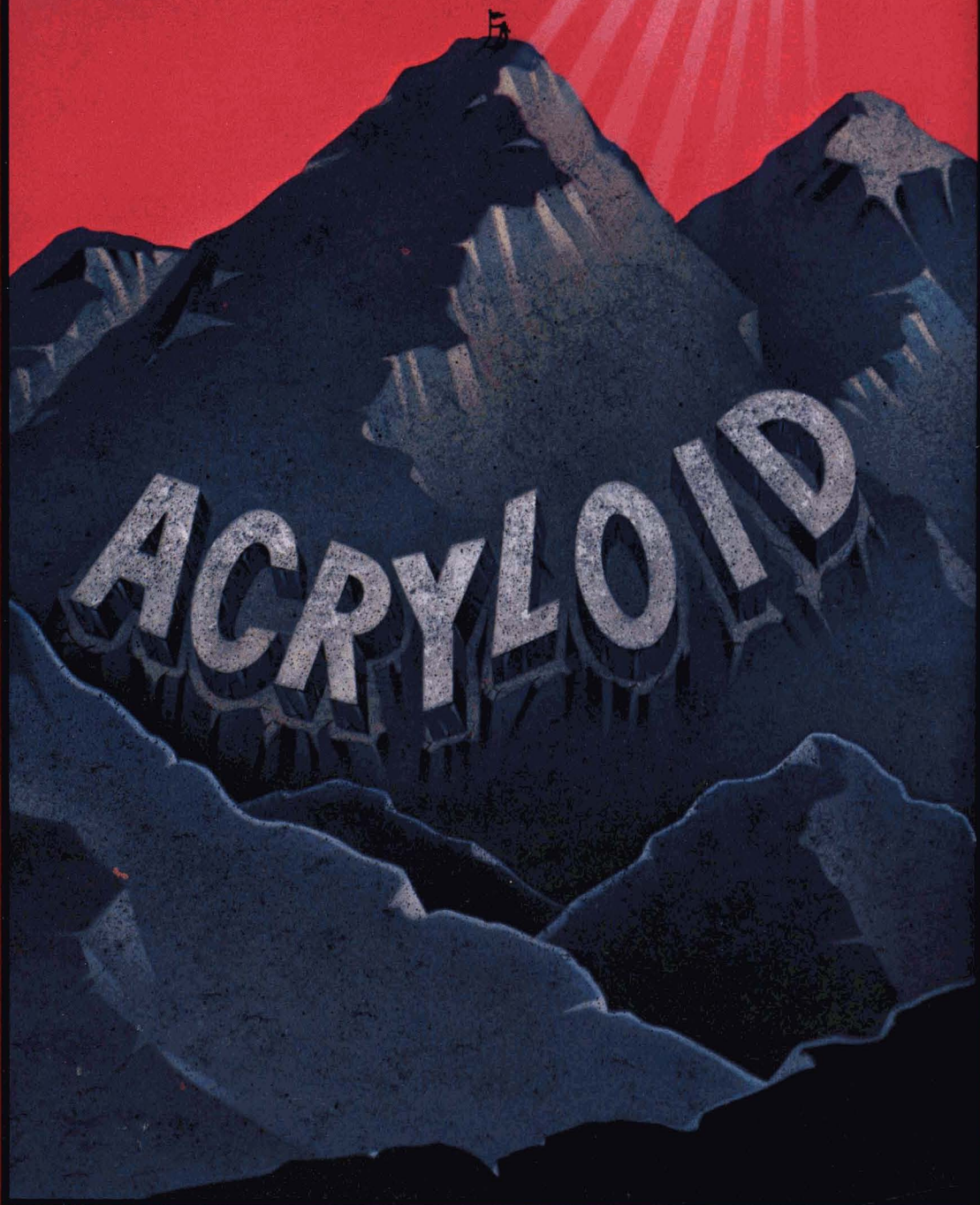
If you'd like to learn more about it, descriptive brochures and enrollment forms are available from the Federation office.

The program has the potential to be of great benefit to the industry, and we hope members will support it and recommend their company's participation.



Thomas A. Kocis,
Contributing Editor

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Abstracts of Papers in This Issue

TECHNIQUES TO MEASURE MELAMINE/POLYOL REACTIONS IN A FILM—M.G. Lazzara

Journal of Coatings Technology, 56, No. 710, 19 (Mar. 1984)

This paper describes some of the newer analytical techniques developed at Du Pont to quickly and accurately assess the cure chemistry of melamine/polyol mixtures. These techniques use a Fourier Transform/Infrared spectrometer, a solid state ^{13}C Nuclear Magnetic Resonance spectrometer, and a flow oven/gas chromatograph interfaced to a Hewlett Packard 9835A desk top computer. These techniques continuously measure functional group changes and reaction volatiles produced while films cure.

To illustrate how useful and efficient these techniques are, some melamine/polyol cures as a function of baking condition and formulation are discussed.

QUICK WEATHERING TEST FOR SCREENING SILICONE SEALANTS—K.K. Karpati

Journal of Coatings Technology, 56, No. 710, 29 (Mar. 1984)

Thirteen different silicone sealants were exposed on strain-cycling racks simulating movements in external building joints. Following the use of differential scanning calorimetry to confirm that the sealants were indeed silicones, it was found that a quick outdoor exposure screening test, described here, could eliminate unsatisfactory materials within two months.

Papers to Be Featured in the April Issue

Performance Comparison of Exterior Flat Finishes on Hardboard Siding—Kansas City Society for Coatings Technology

A Simple Model for the Numerical Simulation of Reflectance of Black Chrome Coating Systems—S.T. Wu and L.W. Masters

Autooxidative Crosslinking of Vegetable Oils and Alkyd Emulsions—G.C. Wildman, J.W. Gooch, and B.G. Bufkin

Degradation Chemistry of Primary Crosslinks in High Solids Enamel Finishes: Solar Assisted Hydrolysis—A.D. English and H.J. Spinelli

Displacement of Water from a Steel Surface—C.R. Hegedus

Lawyer Vis-A-Vis Chemist in Paint Product Liability Situations—C.L. Rechin

STUDY OF THE CURING MECHANISMS OF THERMOSETTING RESINS BY DYNAMIC VISCOELASTIC MEASUREMENT. PART II: EFFECT ON THE CURING BEHAVIOR OF A LOW MOLECULAR WEIGHT ADDITIVE IN AN ACRYLIC-MELAMINE RESIN SYSTEM—T. Izumo and S. Yamamoto

Journal of Coatings Technology, 56, No. 710, 39 (Mar. 1984)

The effect of a low molecular weight additive in an acrylic-melamine resin system on its curing behavior was studied by DSA (Dynamic Spring Analysis). Dioctyl phthalate (DOP) was selected as an additive, and its content in the acrylic-melamine resin was varied.

The following results were obtained: (1) The curing behavior of resin varied as a function of DOP content; and (2) DOP was found not to affect the curing mechanisms but did decrease the viscosity of the resin. This indicates that the probability of collisions between functional groups increased the curing rate.

MULTIFUNCTIONAL MONOMERS IN WATER-REDUCIBLE ALKYDS—E.J. Kuzma and E. Levine

Journal of Coatings Technology, 56, No. 710, 45 (Mar. 1984)

Modification of film properties of water-reducible air drying and baking alkyds by inclusion of trimethylolpropane triacrylate is discussed. Evidence is presented to demonstrate improvements in drying rate, early water resistance, color retention, outdoor durability, and salt spray resistance as a result of monomer modification. Five percent, on weight of reactants, is suggested as a useful monomer level, and the monomer is best added toward the end of the process.

TOXICOLOGY, THE LAW, AND THE COATINGS CHEMIST—H.E. Myer

Journal of Coatings Technology, 56, No. 710, 51 (Mar. 1984)

Toxicology, the science concerned with the setting of "no effect" levels, is basic to the scientific effort known as risk assessment. The judgment of risk goes one step further in that it involves value judgments as to what society considers an acceptable level of risk. Such judgments are reflected in the passage of health and safety regulations as well as in the decisions handed down in product liability cases. The coatings chemist must consider these concerns when planning work. Only in this way can the chemist best serve society and also hope to avoid delays and hassles as the work progresses.

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FSCT Seminar on Paint Manufacturing Practices Set for Louisville Convention Center, May 15-16

Helpful, in-depth information on the many aspects of paint production will be presented at a 1-1/2 day seminar sponsored by the Federation of Societies for Coatings Technology. The seminar on "Producing Paint Efficiently, Safely, and Economically," will be held May 15-16, at the Commonwealth Convention Center, Louisville, KY.

The manufacturing segment is probably the most fertile area to effect cost savings and increase profitability, and the seminar will feature presentations by well-known coatings industry personnel who will offer practical, down-to-earth information on various elements of the paint manufacturing process.

Included will be discussions of efficient time-tested methodology, as well as insights into newer, innovative practices. Among the subject areas to be covered are:

- Choosing and motivating manufacturing employees
- Production planning and scheduling



- Raw materials management
- Finished products inventory management
- Pigment dispersion
- Resins and polymers

- Production, storage, use and handling of intermediates and additives
- Color matching and color control
- Filtration and straining
- Automatic filling and packaging of containers
- Finished products warehousing and shipping
- Controlling bacterial and fungal contamination during waterborne paint manufacture
- Waste management
- Managing employee health and safety programs

Registration fee is \$125 for FSCT members; \$155 for non-members. After May 1, registration fee is \$165 for everyone. The fee includes complete set of papers presented, continental breakfast, luncheon, coffee breaks, and bus transportation to the airport at conclusion of the seminar.

To obtain complete program information and registration/housing forms, contact Federation of Societies for Coatings Technology, 1315 Walnut St., Suite 832, Philadelphia, PA 19107. Telephone (215) 545-1506.

1984 FSCT Guide to Coatings Courses Now Available

Publication of the 1984 edition of "Guide to Coatings Courses, Symposia, and Seminars," compiled by its Educational Committee, has been announced by the Federation of Societies for Coatings Technology.

Based on information supplied by the Constituent Societies, educators, and various industry sources, the "Guide" lists a comprehensive variety of coatings educational offerings in the U.S. and

Canada, grouped by geographic region. The listings are updated annually to reflect current information.

Copies of the 38-page "Guide" are available at a price of \$10.00 each, postage paid.

To order, write to Educational Committee (Coatings Courses), c/o Federation of Societies for Coatings Technology, 1315 Walnut St., Suite 832, Philadelphia, PA 19107 (215/545-1506).

Federation's 1984 Membership Directory Now Available

The 1984 Annual Membership Directory (Year Book) of the Federation of Societies for Coatings Technology (FSCT) has just been published and is now available.

The names, companies, addresses, and telephone numbers of the 7,000 members of the FSCT are contained in the Year Book (by Society), making it an indispensable reference for those working in, or supplying raw materials, equipment or services to, the coatings industry. An alphabetical index of members is also provided.

The Year Book also details other FSCT areas, such as Officers, Board of Directors, Committee Members, and By-Laws.

The Year Book, included with membership in the FSCT, is available to non-members for \$20.00. Orders should be sent to Ms. Kathleen Wikiera, Federation of Societies for Coatings Technology, 1315 Walnut St., Suite 832, Philadelphia, PA 19107.

Special Discount Fares Available from United Airlines To Annual Meeting in Chicago

Special arrangements have been made with United Airlines to offer a \$15.00 discount off Supersaver fares within the U.S. to/from Chicago for the October 24-26 Annual Meeting and Paint Show at the Conrad Hilton Hotel. The seven-day minimum stay requirement is waived. These special fares are available only when you call the unlisted toll-free number (800-521-4041) of United's Convention Desk. You must give the FSCT Convention number which is:

4405

FSCT-Sponsored Collaborative Testing Program Now Available to Paint and Coatings Laboratories

A Proficiency Testing Program is being offered under the sponsorship of the Federation of Societies for Coatings Technology, aimed at improving the reliability of paint and coatings testing, and developing reproducible test methods.

The program offers each participating laboratory the means to periodically check the level and uniformity of its testing proficiency by comparing test results with those of other cooperating laboratories. Results will provide a realistic assessment of the state of paint and coatings testing efficiency.

The program will be administered by Collaborative Testing Services, Inc., McLean, VA, who conduct collaborative and proficiency testing programs in cooperation with various organizations for a wide range of industries. Royal Brown, FSCT Technical Advisor, will monitor the program.

CTS will send liquid paint samples to each participating firm, along with instructions and copies of test methods to be used. The test results will then be returned to CTS, who will issue a summary report for each test method, showing data from all participants. Confidentiality is maintained through assignment of code numbers to each participant.

Samples will be distributed for testing six times during the program year. Two different tests will be conducted on each sample, i.e., six sample mailings to cover all 12 tests.

The coatings program will cover 12 different ASTM test methods: Stomer and Ford Cup Viscosity; Fineness of Dispersion; Volatile Organic Content; Pigment Content; Density of Paint; Specular Gloss; Rheological Property; and Hiding Power.

Both architectural and industrial type coatings will be used in the program, and will be representative of those produced by most coatings manufacturers.

Greatest benefits will be gained by those companies who subscribe to the full program of 12 tests. A participant may, however, select fewer tests, if desired.

Annual charges for participating in the program are \$40 per test, or \$360 for all 12 tests. Laboratories may enter the testing program at any time during the testing year on a prorated basis in accordance with the frequency of sample mailings remaining.

The program is open to any company manufacturing paints or raw materials, commercial testing laboratories, and other organizations involved with paint and coatings.

Brochures and enrollment forms are available from Collaborative Testing Services, Inc., 8343-A Greensboro Dr., McLean, VA 22102 (703) 442-0433 or from the Federation of Societies for Coatings Technology, 1315 Walnut St., Suite 832, Philadelphia, PA 19107 (215) 545-1506.

FSCT Paint Laboratory Seminar Papers Available

Papers presented at the 1983 seminar, "Efficient Operation of an Up-to-Date Paint and Coatings Laboratory," sponsored by the Federation of Societies for Coatings Technology in Kansas City, April 26-27, are available in limited quantities.

The package includes all 14 presentations made at the seminar. Included are the following:

- "Designing the Laboratory to Fit the Business"—O.H. Bullitt, Jr.
- "Planning the Research Budget"—W.O. Manley.
- "Laboratory Instrumentation and Equipment"—D.R. Brezinski.
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- "The Anatomy of Synthetic Resins"—J.A. Hoeck.
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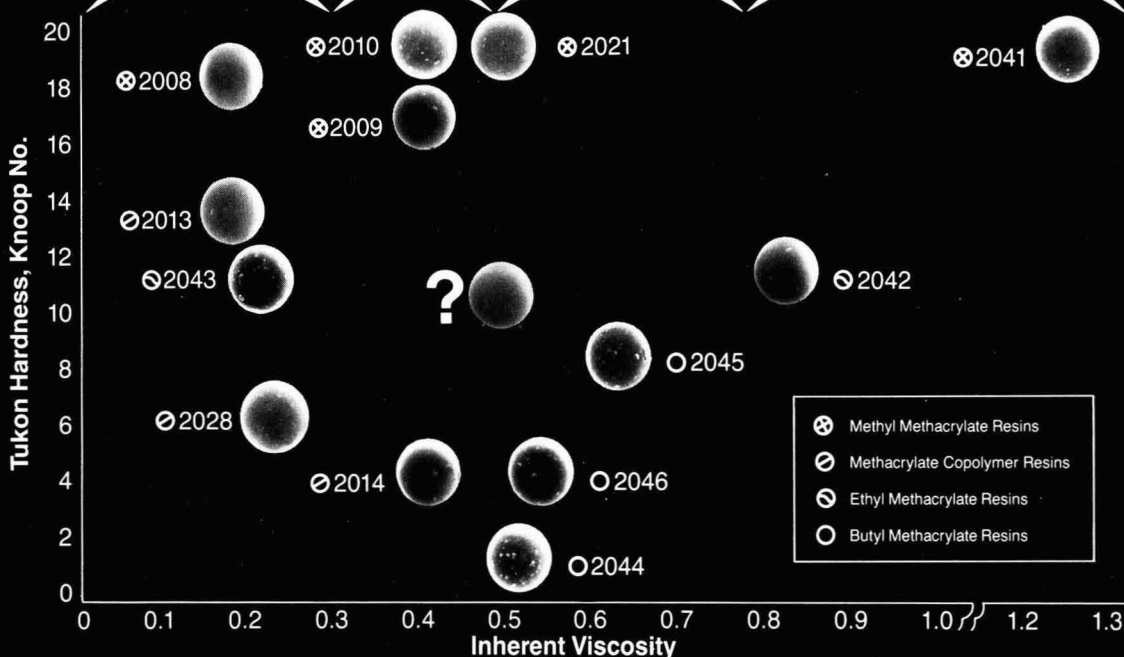
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Government / Industry

Battelle Reports U.S. R&D Funding To Be Over \$94 Billion in 1984

Expenditures in calendar year 1984 for research and development in the United States are expected to reach \$94.2 billion, according to the annual forecast of Battelle Memorial Institute's Columbus Division. This represents an increase of \$7.7 billion (8.9%) over the \$86.5 billion that the National Science Foundation estimates was to be actually spent for R&D in 1983.

While much of the increase will be absorbed by continued inflation (estimated at 5% for R&D in 1984), Battelle forecasts a real increase in R&D expenditures of 3.7%. This is slightly higher than the 10 year average rate of 3.3% in real R&D effort that has been experienced since 1973.

Sources of Funds

Industrial funding for R&D, projected to increase more significantly than government support, will account for 51.8% of the total R&D funding. Industrial support is forecast to be \$48.8 billion, up 10.3% from 1983.

Battelle sees an increase of 7.8% in federal support for R&D, with funding expected to be \$42.7 billion. This is 45.3% of the total R&D expenditures for 1984.

Funding by academic institutions in 1984 is expected to be \$1.7 billion (1.8% of the total), and other nonprofit organizations will provide slightly less than \$1 billion (1.1%).

The report notes that during the past decade industrial support of R&D has increased at an average compounded rate of 5.2% per year, while federal support has increased at 2.9% on average. The trend toward increased industrial support has especially been developing in recent years, since up until 1979 government supported more R&D than did industry.

Performers of Research

Industry will remain as the dominant performer of R&D, according to the Battelle report. In 1984, performance of R&D by industry is expected to rise to \$70.8 billion, or 75.2% of all research performed.

This compares with \$10.3 billion (10.9%) for the federal government, \$10.5 billion (11.1%) for academic institutions, and \$2.6 billion (2.8%) for other nonprofit organizations.

The Battelle forecast notes that federal

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

Industry absorbs almost all of its own funds, either performing the R&D itself or contracting with other industrial performers. Its contracts and grants to nonprofit organizations are slightly less than those to colleges and universities. The nonprofit organizations finance both themselves and the academic institutions about equally, and colleges and universities use up all the funds they originate.

Costs of R&D

The Battelle forecast also compares the four performing sectors in terms of their relative costs of R&D.

During 1984, the overall cost increase for all R&D is estimated to be 5.0%. By sectors, the increases are estimated as government, 5.3%; industry, 5.3%; colleges and universities, 3.7%; and other nonprofits, 2.7%.

From 1972-1984, costs of all R&D, as an average, are estimated to have risen by 123.9%. Increases in the individual performing sectors—over this same time period—are expected to be: federal government, 118.3%; industry, 123.0%; colleges and universities, 136.3%; and other nonprofits, 121.0%.

Long-Term Outlook

As part of the forecast, Battelle also examined R&D trends during the past and identified what impact they may have on the future.

The report concludes that over the past few years, federal support has tended to shift toward more "development" and less basic and applied "research." If such trends continue, the long-range consequences may pose significant problems in terms of the science base upon which economic vitality grows.

Such problems may, in part, be mitigated by a continuation of the recent resurgence of basic research support by industry, the forecast notes. However, the volatility of indicators—such as sales, profits, and cash flows—which influence industrial R&D budgets, precludes stability for long-term planning.

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Techniques to Measure Melamine/Polyol Reactions in a Film

Michael G. Lazzara
E.I. DuPont de Nemours & Company, Incorporated*

This paper describes some of the newer analytical techniques developed at Du Pont to quickly and accurately assess the cure chemistry of melamine/polyol mixtures. These techniques use a Fourier Transform/Infrared spectrometer, a solid state ^{13}C Nuclear Magnetic Resonance spectrometer, and a flow oven/gas chromatograph interfaced to a Hewlett Packard 9835A desk top computer. These techniques continuously measure functional group changes and reaction volatiles produced while films cure.

To illustrate how useful and efficient these techniques are, some melamine/polyol cures as a function of baking condition and formulation are discussed.

INTRODUCTION

Du Pont incorporates melamine-formaldehyde resins into many of its coatings formulations. In support of these products and the efforts to develop new and better melamine crosslinked coatings, a program was initiated to establish a basic understanding of the chemical reactions involved in the actual film forming process.

A putative theory states that a melamine enamel's final film properties and durability properties are dependent on the type and extent of the various chemical reactions that occur during film formation. To test this theory, one needs first to be able to measure these reactions. Current methods of collecting reaction volatiles¹ or monitoring spectral changes on a dispersive type infrared spectrometer² are tedious and are prone to some error. This report describes analytical techniques for quickly and accurately assessing melamine/polyol cure chemistry.

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Chemical Reactions of Melamine

The chemical reactions of melamine formaldehyde resins are detailed in the literature.³ The predominant chemical changes that occur when a polyol reacts with a fully alkylated melamine are shown in *Scheme 1*.

Pathway (1) illustrates an ether exchange reaction which creates a chemical bond between a melamine and the polyol. The reaction produces a mole of alcohol for every mole of hydroxyl group consumed.

Pathway (2) illustrates hydrolysis of the melamine ether linkage to produce a mole of alcohol and an N-methylol group. This group is thermally labile and loses formaldehyde. The resulting amine N-H can remain unreacted or self-condense with another melamine to produce a diaminomethylene link and another mole of alcohol [Pathway (3)].

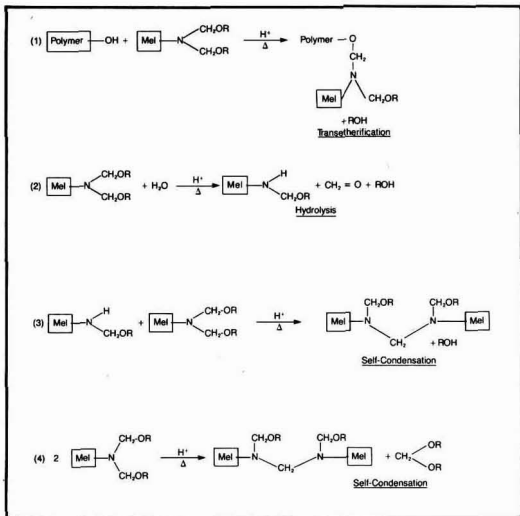
Melamines can self-condense without an initial hydrolysis taking place. This alternative route also produces a diaminomethylene linkage, but, instead of formaldehyde and alcohol as by-products, a mole of the dialkylacetal of formaldehyde is produced [Pathway (4)].

No single analytical tool could yield enough information to determine the extents of all the chemical reactions in *Scheme 1*. Therefore we combined information from a solid state ^{13}C NMR spectrometer (SS ^{13}C NMR), a Fourier Transform IR spectrometer (FT/IR), and a flow oven/gas chromatograph (FO/GC) to tell us the rates and extents of the reactions in *Scheme 1*.

Analytical Tools

There are several general approaches that one may take to monitor the chemical reactions of melamine enamels: (1) follow the fates of carbon nuclei during cure; (2) follow the fates of various reactive functional groups during cure; and (3) follow the production of volatile reaction by-products during cure.

For soluble materials, the ^{13}C NMR spectrometer is an extremely powerful tool for monitoring the fate of carbon nuclei from starting material to product. Generally the instrument is sensitive enough to produce distinct, well



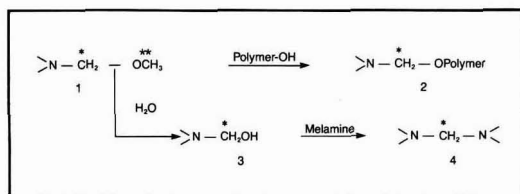
Scheme 1—Chemical reactions of a polyol with a fully alkylated melamine resin

resolved carbon absorbances from minor changes in chemical environment.

In a melamine/polyol film where the melamine is hexamethoxymethylmelamine (HMMM), we could elucidate the chemical pathways by following the fates of the starred carbons shown in *Scheme 2*. The methoxy carbon on melamine is involved in all the chemical reactions that will take place during cure. The change in its intensity could tell us the total amount of chemical reaction that took place. The carbon α to the nitrogen is common to the starting material 1, the transesterified product 2, the hydrolysis product 3, and the self-condensed product 4. In the solution state, these carbons are all well resolved.⁴

A proven instrument for the investigation of functional group changes during the cures of organic films is the infrared (IR) spectrometer. The IR spectrometer can monitor a majority of the chemical changes since most of the important functional groups absorb in the infrared region. Thin films cast onto salt plates are convenient in obtaining IR spectra.

An IR spectrum of an acrylic polyol/melamine mixture contains several absorbances of potential interest. They are: (1) the -OH stretching mode at $\sim 3500\text{ cm}^{-1}$, (2) the -NH stretch at $\sim 3450\text{ cm}^{-1}$, (3) the $>\text{N-CH}_2\text{-O-CH}_3$ ether



Scheme 2—Important carbons to monitor in solid state ^{13}C NMR spectra of acrylic polyol/HMMM films

stretch at $\sim 1090\text{ cm}^{-1}$, (4) the $>\text{N-CH}_2\text{-O-CH}_3$ deformation at $\sim 900\text{ cm}^{-1}$, and (5) the triazine ring mode at $\sim 810\text{ cm}^{-1}$. The % change in the hydroxyl absorbance at 3500 cm^{-1} yields directly the percent consumption of the hydroxyl group from the prepolymer by melamine (see *Scheme 1*, Pathway 1). The magnitude of the NH absorbance at 3450 cm^{-1} gives us information on the amount of melamine hydrolysis that occurred (*Scheme 1*, Pathway 2). The ether absorbances at 1090 and 900 cm^{-1} could yield information on the total extent of melamine reaction. (All reactions of fully formylated, fully alkylated melamines require loss of ether functionality for reaction of any kind.) The triazine ring mode at 810 cm^{-1} could serve as an internal standard for quantification of the absorbance changes.

Presumably, the IR spectrometer would be the only tool necessary for systems crosslinked with HMMM. But as the melamines grow more complicated (i.e. mixed ether melamines, partially alkylated melamines, etc.), the IR spectrum cannot yield all the information necessary to measure all the reactions. An analysis of the volatile reaction products along with the IR data completely elucidate the various pathways.

By analyzing the total alcohol liberated during crosslinking, we can determine the total extent of reactions (1), (2), and (3) in *Scheme 1* since each yields 1 mole of alcohol per mole of reaction. Formaldehyde is unique to reaction (2) and its analysis directly measures the hydrolysis and demethylolation reaction. Acetals are unique to Pathway (4). Analyzing for acetals gives a direct measure of melamine self-condensation via the "dry" mechanism.

RESULTS AND DISCUSSIONS

Solid State ^{13}C NMR Spectra Of Melamine/Polyol Films

Recent studies have shown that the SS ^{13}C NMR spectrometer is useful in examining the chemistry of intractable polymer systems.⁵ This gave us hope that we could examine the environments of some key carbons in a cured melamine/polyol film. Thus, we cured a 70/30 mixture of an acrylic resin (STY/MMA/BA/HEA, 15/30/25/30) with Cymel® 300 (nominally HMMM) and 0.2% PTSA at 250°F and 350°F , each for 30 minutes. The films were removed from the substrate and cryogenically ground into a powder. The powders were then incorporated into rotors of either Delrin® or perdeuteropoly-methylmethacrylate and SS ^{13}C NMR spectra taken at 64 KHz ⁶ using cross polarization and dipolar decoupling techniques.⁷ *Figures 1* and *2* are SS ^{13}C NMR spectra of the films cured at 250°F and 350°F respectively. Qualitatively, the main difference between the two spectra is the intensity of the absorbance of the residual methoxy carbon on melamine at 55.5 ppm . This indicates

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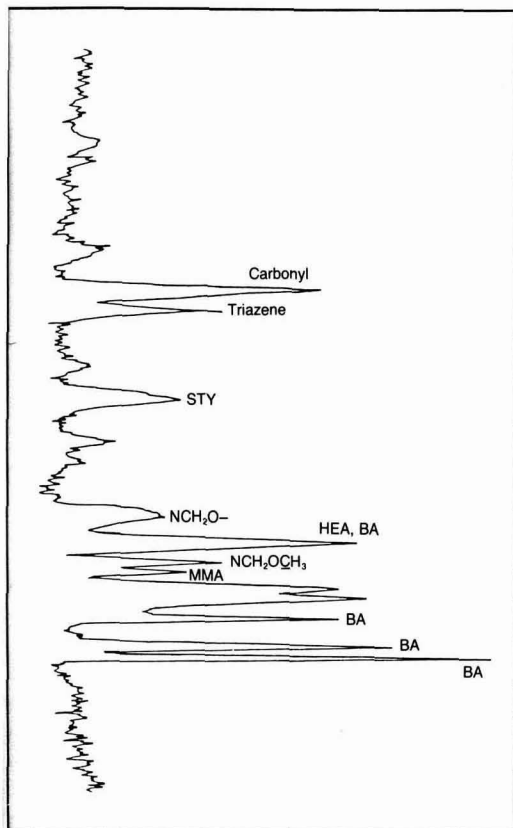


Figure 1—Solid state ^{13}C NMR spectrum of an acrylic polyol/HMMM mixture cured 30 min at 250°F

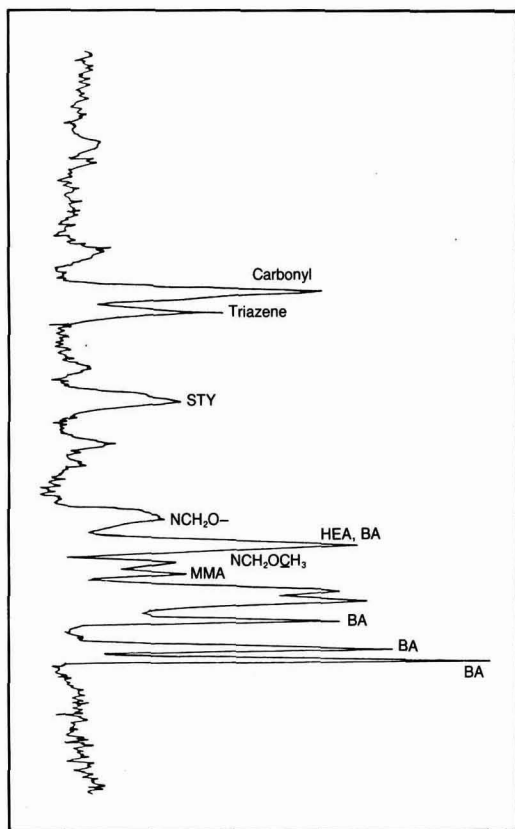


Figure 2—Solid state ^{13}C NMR spectrum of an acrylic polyol/HMMM mixture cured 30 min at 350°F

that more reactions involving melamine took place at 350°F than at 250°F. This is consistent with the harder, more brittle films from the 350°F cure.

Unfortunately, we cannot see distinct absorbances for the various methylene carbons alpha to melamine's exocyclic nitrogens. These data are critical for determining extents of competing melamine reactions (*Scheme 2*). A potential solution to this problem would be to isotopically enrich this site with ^{13}C to enhance the signal. This could be done by using ^{13}C labeled formaldehyde in the melamine formaldehyde resin synthesis. This is an expensive solution to a problem which can be solved by more conventional means.

English, et al.,⁸ have taken SS ^{13}C NMR spectra of similar systems and integrated the intensities of the carbon resonances. The integrated values for the 250°F cure correlate well with calculated values knowing the initial composition, assuming complete reaction of the hydroxyl group on the polymer, and having no competing reactions.

It appears that, at this time, the SS ^{13}C NMR can be used to obtain semiquantitative data on the total extents of reaction on "simple" melamine crosslinked systems (i.e. HMMM). It is primarily used to corroborate infrared and reaction volatile analyses.

FT/IR Spectra of Curing Enamel Films

A major advance in IR spectroscopy was the introduction of the fourier transform infrared spectrometer. This computer controlled instrument has the ability to store in its memory an IR spectrum for subsequent comparison to other spectra. In the case of a curing film, one can easily compare spectra from different points during the cure.

The changes in a curing enamel's spectrum may often be very subtle. Since the instrument can subtract spectra it can effectively cancel out unchanging spectral bands and highlight only the absorbances which are diminishing or growing in intensity. *Figures 3 and 4*⁹ illustrate absorbance spectra of an acrylic polyol/melamine mixture before and after cure at 250°F. *Figure 5* is a 1-to-1 spectral subtraction of *Figure 3* from *Figure 4*. The subtraction spectrum graphically highlights the chemical changes that occurred during cure. (Any area below 0.0 absorbance in *Figure 5* indicates a loss in intensity upon curing. Areas above the 0.0 absorbance mark indicate a gain in intensity. Differential shaped peaks generally indicate band shifts.)

We observe significant loss of intensity at 3500, 3100, 1090, and 910 cm^{-1} . These changes are expected since they correspond to the OH stretching, CH stretching, melamine

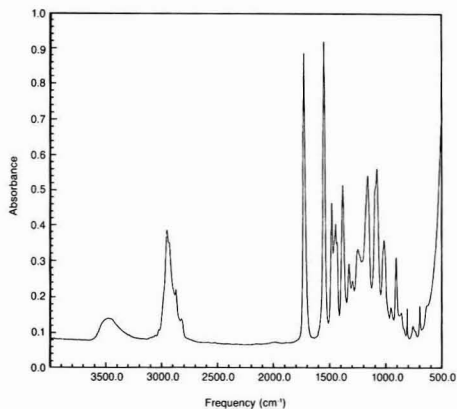


Figure 3—Infrared absorbance spectrum of an acrylic polyol/HMMM mixture before cure

mine ether stretching, and melamine ether deformation modes respectively. Since we are in the absorbance mode, the areas under the specific absorbances are directly proportional to their concentration. Using standard quantitative IR analysis techniques, one can easily calculate the fractional percent consumption of each of these absorbances.

Quantifying the changes in the high energy hydroxy and NH absorbances is relatively straightforward while quantifying changes in the low energy region (i.e. ether stretching and deformation modes) is complicated for a number of reasons. One is that these absorbances lie on the tails of other large absorbances. One never really knows if changes in that region are due solely to changes in the band of interest or a combination of changes in more than one absorbance. Secondly, alkyl groups other than methyl groups on melamine often times have smaller absorption coefficients. Thus, more and more error is

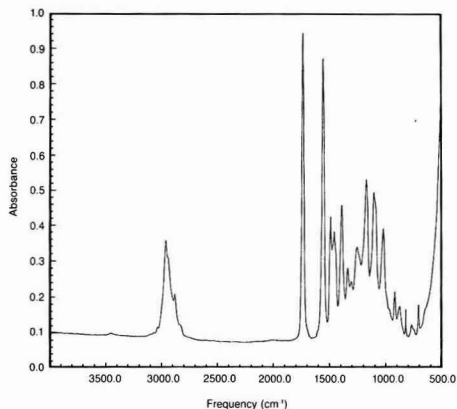


Figure 4—Infrared absorbance spectrum of an acrylic polyol/HMMM mixture after a 30 min at 250°F cure (cooled to room temperature)

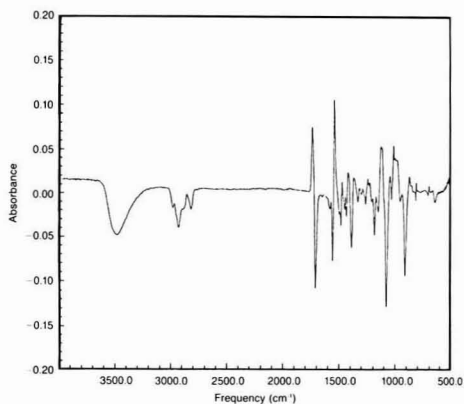


Figure 5—Difference spectrum (Figure 4—Figure 3)

introduced as one attempts to measure changes in the bands.

Additionally, as the melamines become more complicated (i.e. mixed ether type), one observes a net change in the ether absorbances, but does not know which alkyl group ratio remains and is responsible for the remaining peaks. Because of these complications the bands in the lower energy region of the IR are used to corroborate the gas chromatographic analysis of the total alcohol liberated during the cure.

Spectra can be taken in as little as four seconds using the FT/IR spectrometer. This capability, coupled with a sample cell which can be heated to cure the film directly in the IR beam, allows us to observe the curing process on virtually a continuous basis. Figure 6 shows the changes in both the hydroxyl and methoxy absorbances vs time for an acrylic polyol/HMMM/0.2% PTSA mixture when cured at 95°C. This system has only one predominant chemical reaction occurring, transesterification. This is evident since the rate of loss of hydroxyl groups exactly parallels that of the methoxy groups.

At higher temperatures this situation is quite different. Figure 7 shows the changes in the hydroxyl and methoxy absorbances for a 175°C cure. After 2–3 minutes of cure, the hydroxyl group absorbance does not change, but the methoxy group continues to decrease in intensity. Inspection of the absorbance spectra shows that the hydroxyl group has been completely consumed. Thus the continued loss of methoxy groups must be due to melamine-melamine self-condensation.

When spectral subtraction is used, it is important that all spectra be recorded at the same temperature. Substantial changes in the IR spectrum can take place due to purely thermal factors. Figure 8 is a difference spectrum of an uncatalyzed mixture of an acrylic polyol and HMMM where the initial spectrum (room temperature) is subtracted from the final spectrum (250°F). Since the difference spectrum of the same mixture where the final spectrum has cooled to room temperature shows no net change (i.e. no chemical reaction), the changes shown

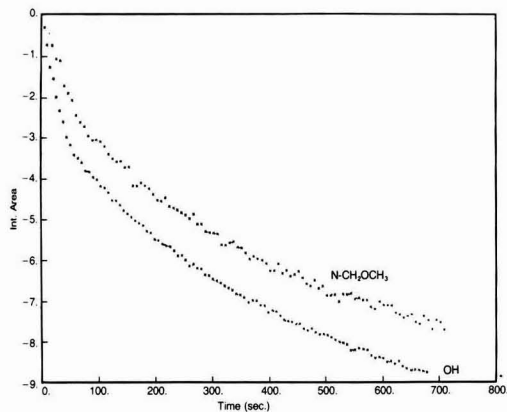


Figure 6—Change in hydroxyl and methoxyl absorbances vs time (95°C cure)

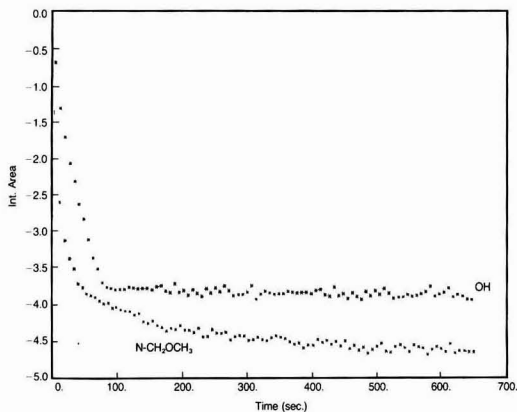


Figure 7—Change in hydroxyl and methoxyl absorbances vs time (175°C cure)

in Figure 8 are purely thermally induced. It is important to realize that the thermal spectral changes are the same order of magnitude as the chemical changes that are of general interest (i.e., OH, CH, and other absorbances). Thus, if extents of chemical reactions are inferred from a final (hot) — initial (R.T.) difference spectrum, the results would be misleading since one is looking at a superposition of both chemical and thermal IR changes.

Continuous Analysis of Reaction Volatiles

Quantitative analysis of the reaction volatiles evolved from a curing film is necessary to completely determine the extent of the various reactions that occur. Our initial efforts were directed at collecting the volatiles in a suitable solvent and then analyzing the solution via GC. We found this operation tedious and very time consuming.

To alleviate this problem we designed a flow oven/gas chromatograph (FO/GC) system (Figure 9) to monitor the volatiles continuously.¹⁰ This apparatus will cure a melamine enamel film on any conventional substrate and sweep the reaction volatiles to an awaiting analytical GC. We sample the off-gas stream with an in-line gas sampling valve. This gas sampling valve diverts a small portion of the gas stream at a specified point in time and "injects" it onto the GC column, which then separates the mixture into its components. When we sample the gas stream once or twice per minute over the span of the bake period, we generate profiles of each reaction volatile vs time. Figure 10 illustrates one such trace for MeOH produced over a 20 minute cure for a HMMM/acrylic polyol/PTSA mixture baked at 250°F.

Using the GC column packed with Carboxieve S column is used to monitor formaldehyde and methanol.

The GC is interfaced to a HP 9835 desk top computer. When a cure is completed, the GC output report is automatically transferred to a file in the computer. After

entering the gas sampling sequence (i.e. one gas sample every 30 seconds) and the retention times of the volatiles of interest (i.e. MeOH = 0.7 minutes, BuOH = 1.7 minutes), the computer searches for peaks at 0.7 and 1.7 minutes past each gas sampling point and sets up new files of GC response values vs time for both MeOH and BuOH. The files can be edited to correct for any solvent interferences and/or plotted. The computer will calculate and print the areas under each cure profile (Figure 11).¹¹

The area under each of these cure profiles is related to: (1) the initial film weight; (2) the reaction volatile's response to the flame ionization detector (FID); and (3) the total extent of reaction to produce that volatile. One can easily normalize these areas for film weight and FID response differences. Thus, the relative extents of volatile production for a whole series of cure profiles can be compared.

We calibrate this FO/GC system externally with a standard formulation run which evolves a known amount

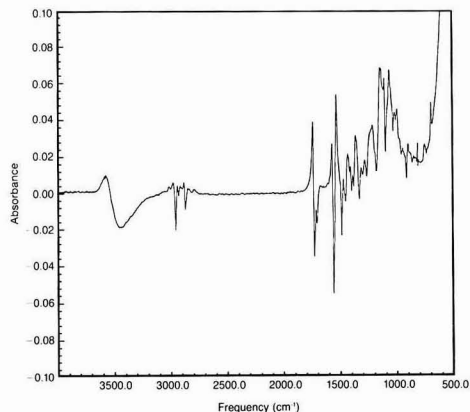


Figure 8—Difference spectrum of an uncatalyzed acrylic polyol/HMMM mixture [final spectrum (250°F) — initial spectrum (R.T.)]

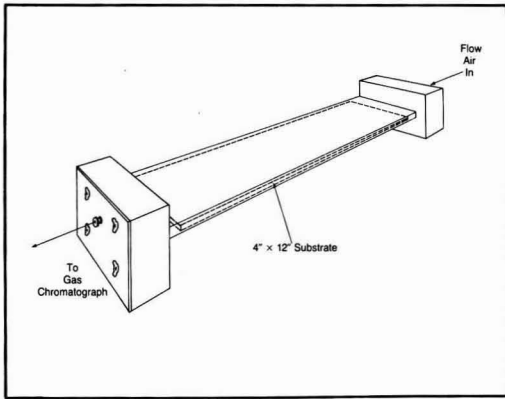


Figure 9—Flow oven apparatus

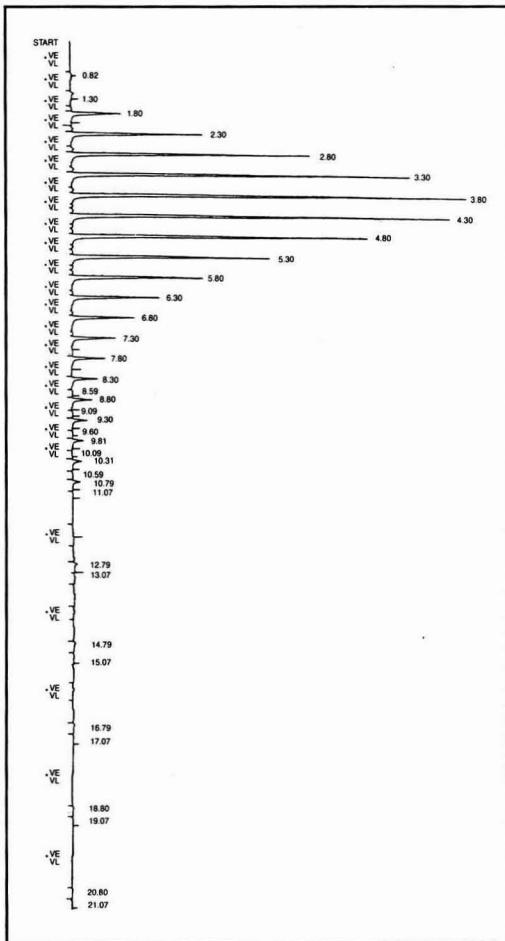


Figure 10—Methanol production vs time profile from the gas chromatograph (250°F cure)

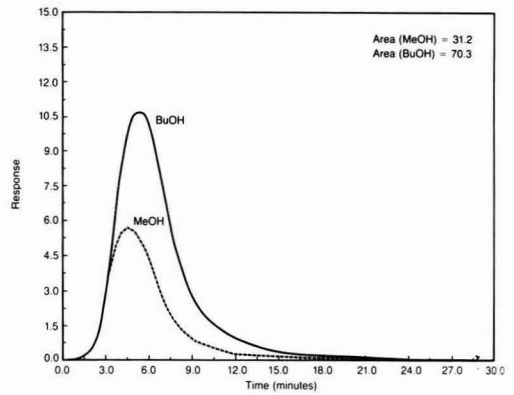


Figure 11—Computer generated cure profiles for methanol and butanol with calculated areas under each curve

of reaction volatiles. Our standard formulation is a 70/30 mixture of an acrylic polymer (30% HEA) and HMMM (Cymel 300) catalyzed with 0.2% PTSA. This system, cured 30 minutes at 250°F, was carefully characterized and we assigned a weight of MeOH evolved to the area under the MeOH vs time profile.

We had previously determined the relative FID responses of the other reaction volatiles to MeOH by injecting a carefully prepared mixture of the various volatiles on to the GC and measuring the FID responses. Knowing the FID response of the other reaction volatiles relative to MeOH, the only reaction volatile that needs standardization is MeOH. Because the calibration is sensitive to the oven flow rate and the FID response, the system is calibrated each day.

The FO/GC apparatus interfaced to the desk top computer increases the number of experiments that can be studied many fold. We can run up to eight different cures in an eight hour day (duplicates of each, including the standard). In addition, problems can easily be identified and corrected without ruining an entire day's efforts. This was not true of collecting reaction volatiles.

Cure Studies of Melamine Enamels

To ensure that the instrumentation and techniques were quantitative and reliable, we ran a series of experiments similar to those reported in the literature¹ using our particular polymers. The results agree well with these studies. More importantly the results from the three independent techniques were all in agreement.

Variation in Cure Temperature

A 70/30 mixture of an acrylic polymer (30% HEA) and HMMM (Cymel 300) was cured at various temperatures. The MeOH vs time profiles for 30 min cures of this enamel (0.2% PTSA) at 65, 95, and 121°C are shown in Figure 12. The MeOH evolved for these cures are shown in Table 1. Assuming that transesterification was the predominant reaction producing MeOH at these temperatures, then

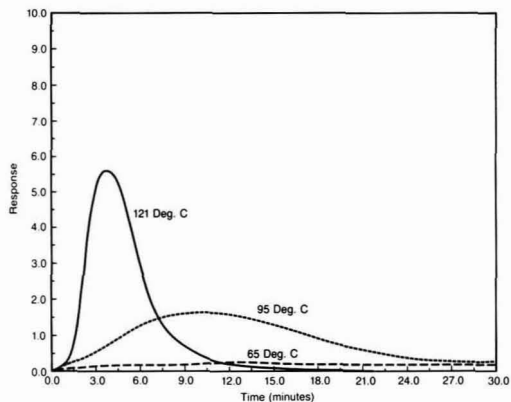


Figure 12—Methanol production vs time for an acrylic polyol/HMMM mixture cured at various temperatures

he MeOH values correspond to 23, 74, and 100% reaction of the hydroxyl group respectively. Evidence hat the only reaction that produces MeOH is indeed ransetherification comes from IR analysis of these cures. These indicate 26, 79, and 100% consumption of the hydroxyl group at 65, 95, and 121°C cures respectively. In addition, the changes in the methoxy band at 910 cm^{-1} for these cures are equivalent to the changes in the hydroxyl absorbance only.

No melamine self-condensation is evident at 65 or 95°C by either mechanism. At 121°C, the first evidence of self-condensation appears with the production of methylal (see Figure 13). At 121°C or less the formaldehyde produced is approximately the amount predicted from the demethylation of the unalkylated, N-methylol sites on melamine.¹²

Variation in Catalyst Level

At 121°C, the rate of MeOH production increases as the catalyst level is increased (see Figure 14). This is consistent with specific acid catalysis. Even though the rate of MeOH production increases, the total MeOH evolved does not (see Table 2). These data agree well with the observations of Blank.¹ It is also consistent with the transesterification reaction being 100% complete with 0.2% PTSA cured at 121°C. Additional acid catalyst cannot produce more methanol by this pathway. Hydrolysis is also not enhanced by additional PTSA. This is expected for the relatively dry environment of the flow-oven cavity.

We observe progressively higher methylal levels at

Table 1—MeOH Evolved for HMMM Cures At Various Temperatures

Temperature (°C)	MeOH Evolved (mg/(1 g of Film))
65	13
95	42
121	57

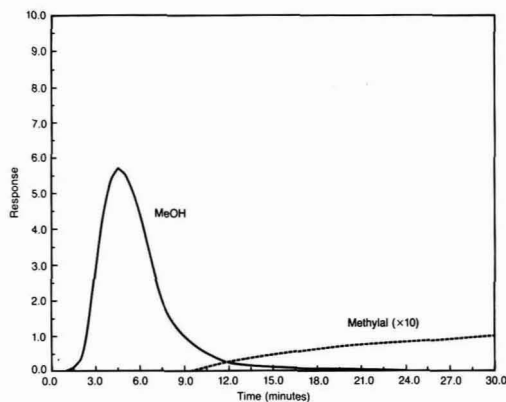


Figure 13—Methanol and methylal production vs time for an acrylic polyol/HMMM mixture cured at 250°F

121°C as the PTSA is increased, however (see Table 3). The methylal also begins to appear at progressively earlier points during the cure. Thus, the self-condensation reaction becomes slightly more competitive with the additional acid catalyst.

Variation of the HEA Content in the Polymer

There is very little self-condensation by either mechanism at 121°C or below. This appears to be a consequence of the relatively high level of hydroxyl groups in the film. This high level allows the transesterification reaction to predominate under cure conditions which would normally allow some level of self-condensation. Thus, we expect that the relative amounts of self-condensation and transesterification are effected by the film's total hydroxyl content.

When we vary the polymer's HEA content, the relative amounts of the competing reactions vary in a predictable

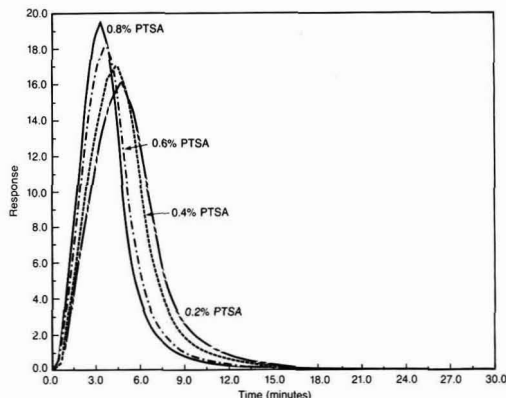


Figure 14—Methanol production vs time for an acrylic polyol/HMMM mixture at various PTSA levels (250°F cure)

Table 2—MeOH Evolved for HMMM Cures At Various PTSA Levels

PTSA Level (%)	MeOH Evolved [mg/(1 g of Film)]
0.2	57
0.4	56
0.6	58
0.8	58

Table 3—Methylal Evolved for HMMM Cures At Various Catalyst Levels

PTSA Level (%)	Methylal Evolved [mg/(1 g of Film)]
0.2	0.3
0.4	0.7
0.6	1.0
0.8	1.3

way. *Table 4* lists the moles of evolved MeOH and methylal vs the % HEA in the polymer for a 70/30/0.2 acrylic polymer/HMMM/PTSA mixture cured 30 min at 250° F. The IR spectrum for each cure shows no hydroxyl absorbance indicating complete reaction of the OH group. Thus, for the 30 and 40% HEA containing polymers, the only reaction producing MeOH is transesterification. At lower HEA levels, more MeOH is produced than would be expected for complete hydroxyl consumption. This indicates that the hydrolysis reaction is now becoming competitive. Higher methylal levels are produced and the self-condensation reaction also becomes competitive as the HEA level is reduced.

Type of Hydroxylated Monomer

If the polymeric hydroxyl group is involved in the rate determining step of the crosslinking reaction, then varying the type of hydroxyl group would have an effect on the crosslinking rate. We have examined various types of hydroxyl groups on the polymer and found them to have dramatic effects on the crosslinking rate. The reaction rate decreases with increasing steric hindrance around the hydroxyl group (i.e. 1°-OH > 2°-OH > hindered 2°-OH containing polymers).

Table 4—Reaction Volatile Evolution For Polymers with Various HEA Contents

% HEA	Moles OH (× 10 ³) (1 g of Film)	Moles of Evolved	
		MeOH (× 10 ²)	Methylal (× 10 ³)
0	0.00	0.39	5.4
10	0.60	0.75	2.1
20	1.21	1.30	1.0
30	1.81	1.81	0.39
40	2.41	2.39	^a

(a) None detected.

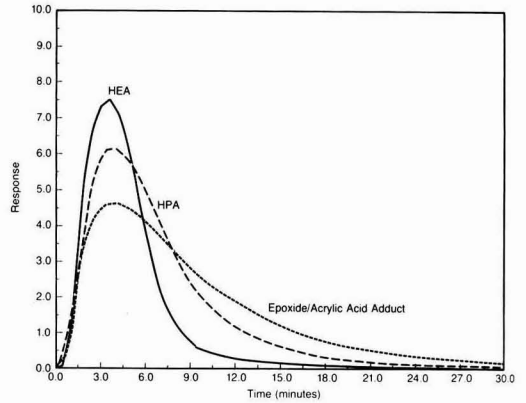


Figure 15—Methanol production vs time for acrylic polyol/HMMM mixtures with various types of hydroxyl groups (250° F cure)

Table 5 lists some of the many types and levels of hydroxylated monomers incorporated into acrylic polymer/HMMM/PTSA (70/30/0.2) cures. *Figure 15* shows the cure profiles of the polymer/HMMM blends for 30 min at 250° F bakes. It is obvious from these cure profiles that the net rate of MeOH production decreases as the steric hindrance around the hydroxyl group increases. The slower MeOH production is not a consequence of competing hydrolysis and self-condensation since the alcohol produced is within experimental error of that expected for complete hydroxyl consumption and the IR shows no hydroxyl absorbance remaining.

At 180° F (a typical automotive repair bake temperature), the cure profiles reveal the same relative hydroxyl group reactivity (*Figure 16*). But, in this case the hydroxyl groups do not completely react (see *Table 6*). Polymers with faster reacting hydroxyl groups react to higher percent completion than those polymers with slower reacting hydroxyls. Indeed, the polymers which contain the 2°-OH and hindered 2°-OH groups may show higher percent hydroxyl consumptions than would normally be realized since they each contain some 1°-OH groups.

The films baked at 180° F have inadequate properties due to insufficient curing. Generally, additional acid

Table 5—Hydroxylated Monomer Types And Levels in Acrylic Polymers

Monomer	Level (%)	Category of OH
HEA	30	1°
HPA	30	2° ^a
HEA, AA/epoxide adduct	10, 20	1°, Hindered 2°

(a) Contains ~25% 1°-OH, ~75% 2°-OH

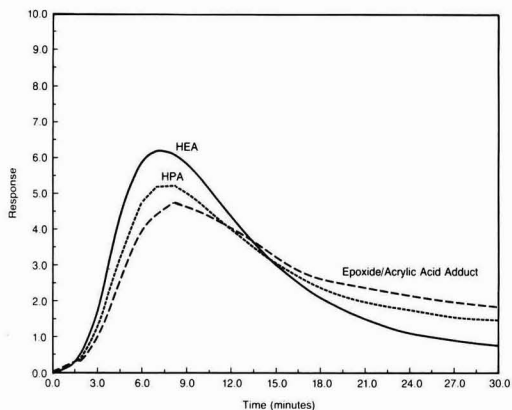


Figure 16—Methanol production vs time for acrylic polyol/HMMM mixtures with various types of hydroxyl groups (180° F cure)

catalyst is necessary to develop adequate film properties at 30 min at 180° F bakes. The same trend of hydroxyl reactivity is maintained when these enamels are cured with 2.0% PTSA for 30° at 180° F (see Table 7). This experiment implies that less acid catalyst is necessary for a faster reacting polymer to achieve the same hydroxyl consumption as a slower reacting polymer. If acid catalyst left in the film is detrimental to the film's hydrolytic stability, then lower catalyst levels should be a goal.

CONCLUSIONS

These experiments are a sample of the cure and formulation variations investigated in our laboratories. They illustrate the types of experiments which are conveniently carried out on a day to day basis using these automated analytical techniques. The results help us explain variations in enamel properties, as well as providing accurate data for assessing newer computer models for melamine crosslinking.

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Table 6—Hydroxyl Group Consumption at 30 min at 180° F Cures

Hydroxylated Monomer (Level)	OH Consumption (%)
HEA (30%)	64
HPA (30%)	47
HEA, AA/epoxide (10%, 20%) adduct	42

Table 7—Hydroxyl Group Consumption at 180° F Cures (2.0% PTSA)

Hydroxylated Monomer (Level)	OH Consumption (%)
HEA (30%)	94
HPA (30%)	86
HEA, AA/epoxide (10%, 20%) adduct	82

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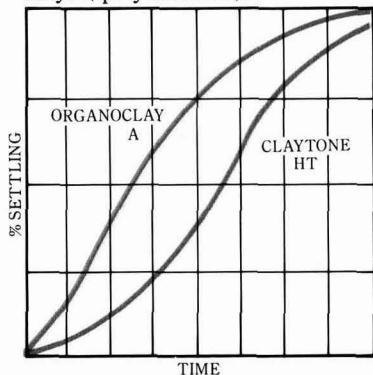
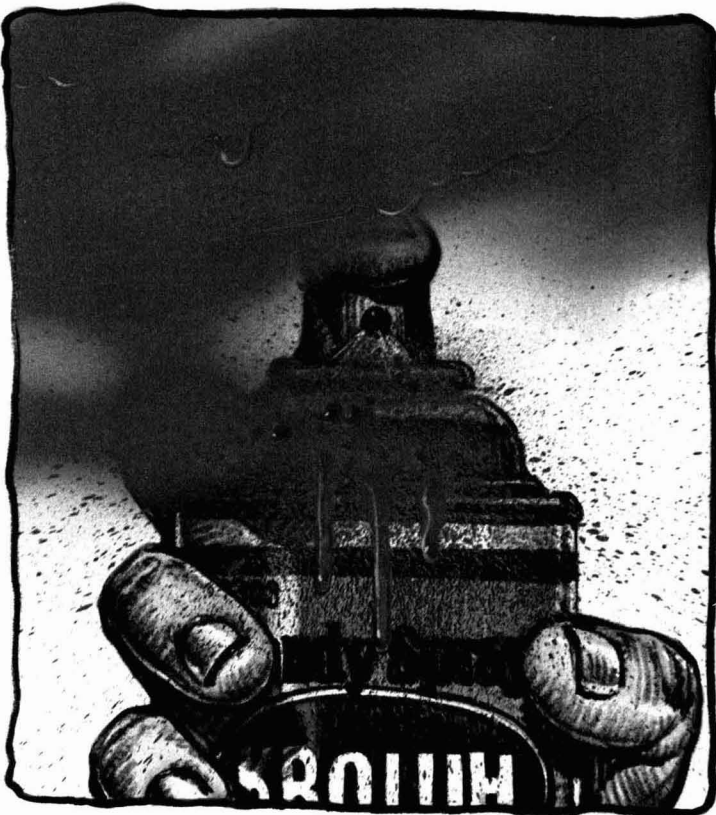
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Quick Weathering Test For Screening Silicone Sealants

Klara K. Karpati
National Research Council of Canada*

Thirteen different silicone sealants were exposed on strain-cycling racks simulating movements in external building joints. Following the use of differential scanning calorimetry to confirm that the sealants were indeed silicones, it was found that a quick outdoor exposure screening test, described here, could eliminate unsatisfactory materials within two months.

INTRODUCTION

With the expiry of patents for silicone sealants in 1979, the number of products multiplied on the market. It was believed that some of the new products might not perform as generally expected of silicones and that they might even show early failure. In previous investigations it had been found that strain cycling is the dominant factor causing failure during weathering.¹ An exposure study was therefore started to evaluate products available on the retail market, using a strain-cycling exposure rack.² Based on the results and on tests carried out in the laboratory using differential scanning calorimetry, a quick assessment of silicone sealants was made, as described in this paper.

EXPERIMENTAL

Thirteen sealants were compared, using the lightest color available on the market, or clear. Only materials No. 1 and 2, both from the same manufacturer, required primer, but they were tested both with and without it. All other materials were applied without primer, as recommended. Sealant beads $12.7 \times 12.7 \times 5.8$ mm ($0.50 \times 0.50 \times 2.00$ in.) were cast on $13.0 \times 25.0 \times 76.0$ mm ($0.50 \times 1.00 \times 3.00$ in.) aluminum bars (grade 6061T6) which were cleaned first manually and then with trichloroethylene vapors.

Specimens were exposed on an outdoor strain-cycling rack facing south, where movement ranged from $\pm 5\%$ to $\pm 30\%$ yearly, about 1/5th of that taking place daily. Within this range, each specimen received a different amount of movement that increased along the exposure rack. Specimens were exposed as soon as they could be handled (2-3 days) to simulate conditions in an actual joint where curing occurs in situ.

Specimens were installed in May 1981 and at the end of November 1981 at yearly average temperatures (0 to 3°C; 32 to 37°F) to ensure full extension in winter and compression in summer. Differential scanning calorimetry (DSC) was used to determine whether the materials were indeed composed of silicone resins. The characteristic transition temperature of silicone sealants was determined by heating about 10 mg of sample at a rate of 5 C deg/min.

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Table 1—Differential Scanning Calorimetry

Material	Peak Occurring on Heating at (°C)
No. 1	-37
No. 2c (clear)	-37
No. 2w (white)	-37
No. 3	none
No. 4	-38
No. 5	-39
No. 6	-36
No. 7	-37
No. 8	-38
No. 9	-37
No. 10	-38
No. 11	-37
No. 12	-40
No. 13	-35

DISCUSSION

An examination of the transition temperatures by DSC revealed no transition in the characteristic region (near -40°C) for sample No. 3 (Table 1). It was concluded that this sealant was not based on silicone resin, and it was therefore omitted from further investigation.

The results obtained for the materials exposed on the strain-cycling exposure rack are summarized in Table 2a for winter and in Table 2b for summer. Yearly movement imposed on the specimens, expressed as a percentage of specimen width, is presented at the top of the table; the time to reach the condition is recorded along the side. The numbers denote number of specimens observed at any particular condition. They were rated "failed" if they could transmit water when used in a real joint. Failures, denoted F, were all of adhesion; unchanged specimens are denoted by a filled circle; partially failed ones by an unfilled circle. This latter type showed partial adhesive failure without the possibility of water transmission along the length of the sealant specimen.

Winter Exposure

Materials No. 1p, 2cp, 2wp, 6, 8, and 11 were satisfactory for the first six weeks (p denotes a primed substrate, c a clear, and w a white specimen). Where

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failure did occur, about 80% of the specimens failed within six weeks and the remainder within three months. Those that performed well continued to do so until the end of the period of observation, viz, 15 months, including two winters. Some adhesion loss occurred along the edges of material No. 6 on the shaded side, increasing to a depth of 1 or 2 mm with increasing yearly cyclic movements, but it did not lead to failure nor increase significantly during the second winter.

There was no obvious dependence of failure on the amplitude of imposed yearly cyclic movement. Materials No. 1 and 2c held for longer times at small movements, that is, under $\pm 15\%$; No. 2w and 13 failed at various times for different imposed strains. No. 4, 5, and 12 failed in the first week for all imposed conditions (discounting one exception for No. 5).

The role of primers may be appreciated by comparing materials No. 1 and 2, which were applied on primed and unprimed substrates (both recommended by the manufacturer to be used on primed surfaces). The primed materials performed well (except for one of 8 specimens of material No. 2cp) during the two observation winters, while almost all unprimed ones failed after the first winter. Primers were not available in the retail outlets for the other materials, nor were they called for on the labels of materials No. 4, 5, 6, 7, 12, and 13, all of which failed (except for No. 6). Materials No. 8 and 11, for which use or omission of primer was left to the user's discretion in the trade literature, did not fail without it.

Summer Exposures

A less extensive exposure test was initiated in mid-May 1981 and continued for two months using nine materials, all without primer, to give equal exposure conditions for all products. Materials that behaved well in winter (No. 6 and 8) behaved well in summer. Most materials that failed completely in winter (No. 4, 5, and 7) also failed in summer. Material No. 1, and especially No. 2w, experienced failure at higher extensions and after longer exposures in summer than in winter. The summer exposures proved to be less severe than the winter ones. Materials No. 9 and 10c, which failed under summer conditions, were not included in the winter series.

SUMMARY

Winter and summer exposures indicate that a large number of silicone sealants available on the retail market will fail within a few months in an aluminum joint, even when subjected to only small movements. The use of primer improves performance, but it is not always available nor is it called for in most cases.

Good and poor materials were clearly separated by the exposure test, with very little scatter of results. Materials with weak adhesion failed faster and at lower movements in winter, demonstrating that winter exposures are more severe. Failures occurred within a few days in some cases. If they did not appear within the two months of winter, then the materials went through the second winter without failure (with one exception: of a total of 156 specimens, 60 performed well in the first winter; only one

Table 2a—Sealant Failures on Strain-cycling Exposure Rack, Winter

sample		±5 to 10%	±10 to 15%	±15 to 20%	±20 to 25%	±25 to 30%	Total of
No. 1	1 wk				1F	2F	
	2 wk			2F	1F		
	3 wk		1F		1F		
	4 wk						
	5 wk						
	6 wk						
No. 1p	3 mo	1:○; 2F	1:●				12 specimens
	3 mo		1:●	2:●	2:●	3:●	8 specimens
No. 2c	1 wk	1F	1F	2F	2F	2F	
	2 wk						
	3 wk						
	4 wk		1F				
	5 wk						
	6 wk	1F					
No. 2cp	3 mo	1F			1F		12 specimens
	3 mo		1:●	2:●	2:●, 1F	2:●	8 specimens
No. 2w	1 wk	1F	1F				
	2 wk						
	3 wk						
	4 wk						
	5 wk	1F	1F	2F	3F	2F	
	6 wk	1F					
No. 2wp	3 mo						12 specimens
	3 mo	—	1:●	2:●	3:●	2:●	8 specimens
No. 4	1 wk	3F	2F	2F	3F	2F	
	2 wk						
	3 wk						
	4 wk						
	5 wk						
	6 wk						
No. 5	3 mo						12 specimens
	1 wk	2F	2F	2F	2F	3F	
	2 wk						
	3 wk	1F					
	4 wk						
	5 wk						
No. 6	6 wk						12 specimens
	3 mo						12 specimens
No. 7	3 mo	3:●	2:●	2:○	1:●; 1:○	3:○	
	1 wk	3F	2F	2F	2F	3F	
	2 wk						
	3 wk						
	4 wk						
	5 wk						
No. 8	6 wk						12 specimens
	3 mo						12 specimens
No. 11	3 mo	3:●	2:●	2:●	2:●	3:●	12 specimens
	3 mo	2:●	2:●	3:●	2:●	3:●	12 specimens
No. 12	1 wk	2F	2F	3F	2F	3F	
	2 wk						
	3 wk						
	4 wk						
	5 wk						
	6 wk						
No. 13	3 mo						12 specimens
	1 wk			2F	1F	1F	
No. 13	2 wk						
	3 wk						
	4 wk	1F					
	5 wk						
	6 wk	1F	1F	1F	1F	1F	
	10 wk		1F			1F	12 specimens

●: good specimen
 ○: some adhesion loss but no possibility of leakage
 F: failure
 c: clear sealant
 w: white pigmented sealant
 p: primed substrate
 Fsm1: very small area that could leak

Table 2b—Exposure from Mid-May to Mid-July 1981

Sample		±10 to 15%	±15 to 20%	±20 to 25%	±25 to 30%	Total of
No. 1	1 mo	1:●	2:●	1:●; 2:○	1:●; 1:○	8 specimens
	2 mo	1:●	1:●	3F	2F	7 ^a specimens
No. 2w	1 mo	1:●	2:●	3:●	1:●; 1F	8 specimens
	2 mo	1:●	1:●	3:●	1:●; 1F	7 ^a specimens
No. 4	1 mo	1F	2F	3F	2F	8 specimens
	2 mo					8 specimens
No. 5	1 mo	1F	2F	3F	2F	8 specimens
	2 mo					8 specimens
No. 6	1 mo	1:●	2:●	2:●	3:●	8 specimens
	2 mo	1:●	1:●	1:●; 1Fsm1	3:●	7 ^a specimens
No. 7c	1 mo	1F	2F	2F	3F	8 specimens
	2 mo					8 specimens
No. 8	1 mo	1:●	2:●	2:●	3:●	8 specimens
	2 mo	1:●	—	1:●	3:●	5 ^a specimens
No. 9	1 mo	1F	2F	2F	3F	8 specimens
	2 mo					8 specimens
No. 10c	1 mo	1F	2F	2F	3F	8 specimens
	2 mo					8 specimens

- : good specimen
○: some adhesion loss but no possibility of leakage
F: failure
c: clear sealant
w: white pigmented sealant
p: primed substrate
Fsm1: very small area that could leak

(a) Specimens decreased in number being used for other experiments.

of the 60 failed in the second winter). Although an exposure of two months cannot predict long-term behavior, it makes possible the elimination of poor performers. This is comparable to the duration of standard laboratory tests that take close to 50 days.

CONCLUSION

It is proposed that for a quick scanning of silicone sealants, DSC tests should be run first to ascertain that the materials are, indeed, silicones showing the characteristic transition temperature. An exposure test should then be carried out on the strain-cycling exposure rack for a minimum of two winter months. The specimens should be fastened to the rack when it is at the yearly average or higher temperature (this often occurs even at the beginning of winter) in order to impose the maximum amount of strain possible.

This test simulates sealant behavior in an outside building joint, while standard laboratory tests do not, and may take just as long. It will identify unsatisfactory materials within two months. It could be used, as well, to determine whether a primer is required and whether there are batch-to-batch variations in a material. The test can help users to screen existing products, and could be of service to the formulator in improving his product.

It is hoped that observations currently being carried out using vises³ that simulate field conditions will correlate with results from the exposure rack and thereby, demonstrate a simple laboratory test.

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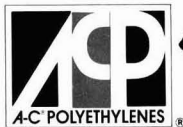
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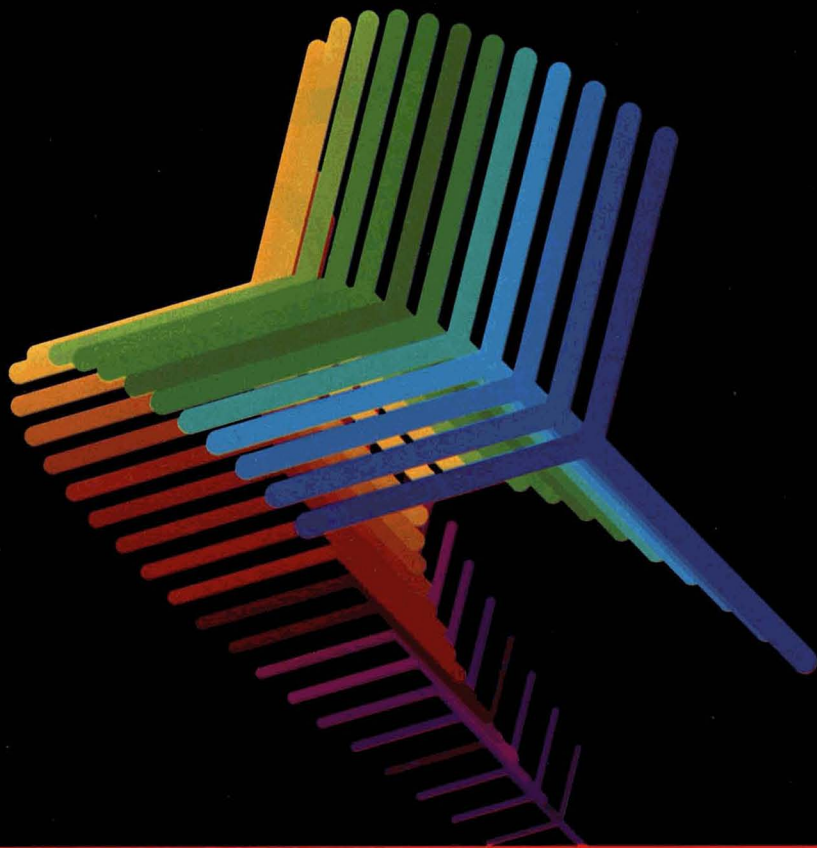
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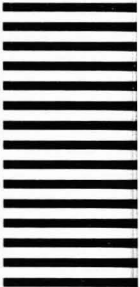


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Study of the Curing Mechanisms Of Thermosetting Resins By Dynamic Viscoelastic Measurement

Part II: Effect on the Curing Behavior Of a Low Molecular Weight Additive In an Acrylic-Melamine Resin System

Takaharu Izumo and Satoshi Yamamoto
Nippon Paint Company, Limited*

The effect of a low molecular weight additive in an acrylic-melamine resin system on its curing behavior was studied by DSA (Dynamic Spring Analysis). Dioctyl phthalate (DOP) was selected as an additive, and its content in the acrylic-melamine resin was varied.

The following results were obtained: (1) The curing behavior of resin varied as a function of DOP content; and (2) DOP was found not to affect the curing mechanisms but did decrease the viscosity of the resin. This indicates that the probability of collisions between functional-groups increased the curing rate.

INTRODUCTION

It is generally accepted that polymerization rates are affected by the solution viscosity in high concentrations of polymers or in bulk-polymerization reactions.¹ In studying the effect of diffusion in crosslinking reactions, numerous experimental results and discussions have been reported. For example, Gordon, et al., studied curing mechanisms by observation of the change in the glass transition temperature (T_g) in curing processes² and Důsec, et al., recently studied curing mechanisms both above T_g and below T_g in reaction systems.³ They reported their results as a function of the change of T_g and viscosity during curing of resin systems.

In this work, we investigated the effect of diffusion on the curing processes. This was done by adding a plasticizer (a low molecular material) that does not function as a reactant, but which only decreases the viscosity of reaction systems.⁴

EXPERIMENTAL

Materials

The acrylic copolymer was prepared by a solution polymerization procedure. The mole ratio of styrene/*n*-butyl methacrylate/2-hydroxyethyl methacrylate/acrylic acid/azobis-iso-butylonitrile was 3.85/1.18/1.98/0.23/0.12. The analytical results of the copolymer are summarized in *Table 1*.

N-butylated melamine-formaldehyde resin was used. Analytical results were summarized in the previous report.⁵

The sample resin mixture was prepared as follows. The acrylic copolymer was blended with melamine-formaldehyde resin at the weight ratio of 7/3.

Dioctylphthalate, generally accepted as a plasticizer, was added to the resin mixture at the ratio from 0 wt % to 6.54 wt %.

Sample mixtures were spread out on a tin plate using a doctor blade of the desirable thickness. Three days later, the sample resins were cured for a fixed period of time at 140°C. Cured films were removed from the tin plate by amalgamating the tin with mercury. Film thickness was about 100 microns. Curing times were 30 minutes and 300 minutes.

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*19-17, Ikeda-Nakamachi, Neyagawa-City, Osaka, 572, Japan.

Table 1—Analytical Results of Acrylic Copolymer

OH Value	Acid Value	Calc. Tg ^a	Molecular Weight ^b		
			M _n	M _w	M _w /M _n
67.0	13.0	25.7°C	7400	17700	2.39

(a) Calculated from the following equation: $1/T_g = \sum w_i / T_{g_i}$, where T_g: glass transition temperature of copolymer; and T_{g_i}: T_g of homopolymer, i.
 (b) Obtained from polystyrene calibration curve of GPC.

Analytical Procedures of the Curing Properties

In accordance with the description of the previous report,⁵ changes in the relative rigidity (Er') on the curing processes, obtained by DSA⁶ measurements, were analyzed according to equation (1).

$$\ln t = a \ln X + b \cdot X^c + d \tag{1}$$

$$a = (1 - n)$$

$$d = -\ln(1 - n)k$$

$$X = (Er'(t) - Er'(0)) / (Er'(\infty) - Er'(0))$$

where n, b and c are constants

Er'(0), Er'(t), and Er'(\infty) are relative rigidity at a time t = 0, t and \infty, respectively.

A Rheovibron DDV-II unit was employed for the DSA measurements. DSA measurements were carried out at 11 Hz in the temperature range from 100°C to 160°C.

Dynamic Viscoelastic Properties of Cured Films

Dynamic viscoelastic properties of cured resin were obtained by means of the direct reading dynamic viscoelastomer (Rheovibron DDV-II-EA made by Toyo Bouldwin Co., Ltd.) at 11 Hz and were scanned in the range from room temperature to about 160°C (heating rate was 2°C/min). The glass transition temperature was defined as a temperature, T_m, where the loss tangent has a maximum value in the primary temperature dispersion. Equation (2) was used to calculate the crosslinking density of the cure resin from Young's modulus in the rubbery region.

$$\nu = E_2' / 3\Phi RT \tag{2}$$

where E₂' is Young's modulus in the rubbery region, Φ is a front factor (assumed as 1.0 here), R is gas constant, and T is absolute temperature.

RESULTS AND DISCUSSION

Dynamic Viscoelasticity of Cured Resins

Before investigating the curing behavior of resin mixtures, the dynamic viscoelasticity of cured resins containing various amounts of DOP was measured. Temperature dispersions of the dynamic viscoelasticity of resins cured for 30 minutes at 140°C are shown in Figures 1 (a) and 1 (b). The relation between the crosslinking densities and DOP contents of the resin cured for 30

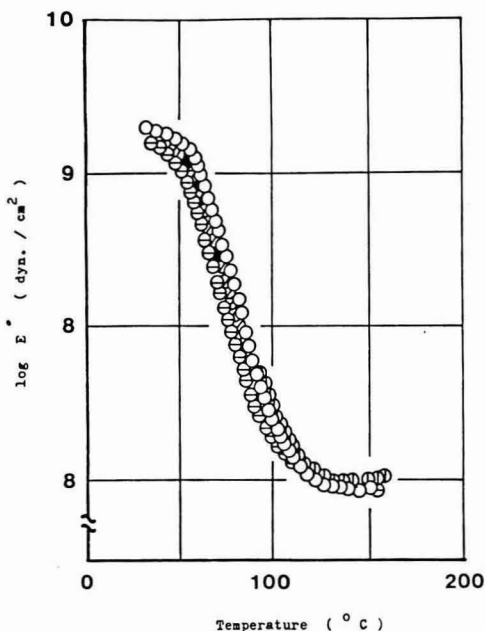


Figure 1(A)—Temperature dispersion of dynamic Young's Modulus. Curing conditions: 140°C, 30 min. DOP contents (wt %): ○—0; ⊙—0.99; ⊚—1.96; ●—2.91; ⊖—6.54

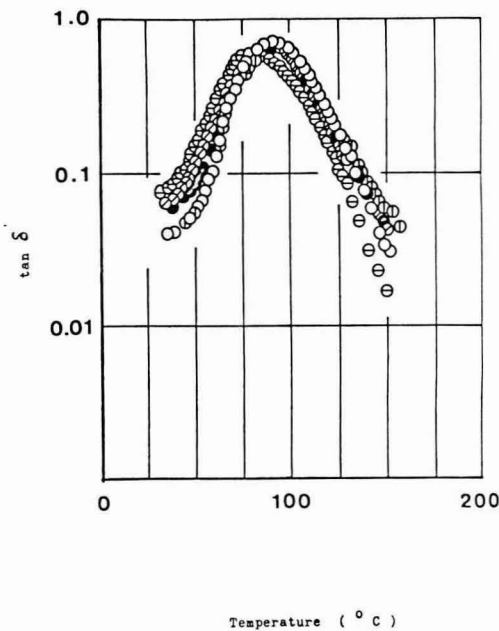


Figure 1(B)—Temperature dispersion of tan delta. Curing conditions and symbols for DOP content are same as in Figure 1(A)

minutes and 300 minutes at 140°C are shown in *Table 2* and *Figure 2*. In *Figure 2*, the crosslinking density of the resin cured at 30 minutes at 140°C has a maximum value near 0.99 wt % of the DOP content, and the crosslinking density of the resin cured 300 minutes at 140°C decreases with an increase of DOP contents. In this experiment, the viscoelastic properties were reproducible within 94% accuracy under the conditions of the cured resin preparation. The maximum value of 30 minutes for the cured resin in *Figure 2* has been valuable. The volume corrections of the crosslinking densities of the resins cured for 300 minutes were obtained. For example, assuming the density of DOP was 0.99, the crosslinking density of cured resin contained with 6.54 wt % DOP was 1.8×10^{-3} mol/cc. In the experimental regions, the change in the crosslinking densities of the cured resin as a function of DOP content was zero, having a constant value of about 1.8×10^{-3} mol/cc. As shown in *Figure 4*, the resin was cured sufficiently under the curing conditions of 300 minutes at 140°C. Therefore, it is proposed that the existence of a maximum value in the crosslinking density, plotted as a function of DOP content at a cure time of 30 minutes, has been caused not by a change in curing mechanisms but by the change of curing rate.

Figure 3 depicts T_m as a function of DOP contents. T_m of the resin cured for 300 minutes decreases with an

Table 2—Effects of DOP Contents on Viscoelastic Properties Of Melamine Cured Acrylic Resin Cured at 140°C

DOP cont (wt. %)		Curing Time (min)	
		30	300
0	T_m (°C)	92	104
	$\tan \delta$ max	0.636	0.385
	$\nu \times 10^3$ (mol/cc)	0.90	1.9
0.99	T_m	93	102
	$\tan \delta$ max	0.956	0.375
	$\nu \times 10^3$	0.98	1.9
1.96	T_m	89	100
	$\tan \delta$ max	0.654	0.383
	$\nu \times 10^3$	0.87	1.8
2.91	T_m	86	98
	$\tan \delta$ max	0.625	0.373
	$\nu \times 10^3$	0.82	1.9
6.54	T_m	83	95
	$\tan \delta$ max	0.580	0.387
	$\nu \times 10^3$	0.80	1.70

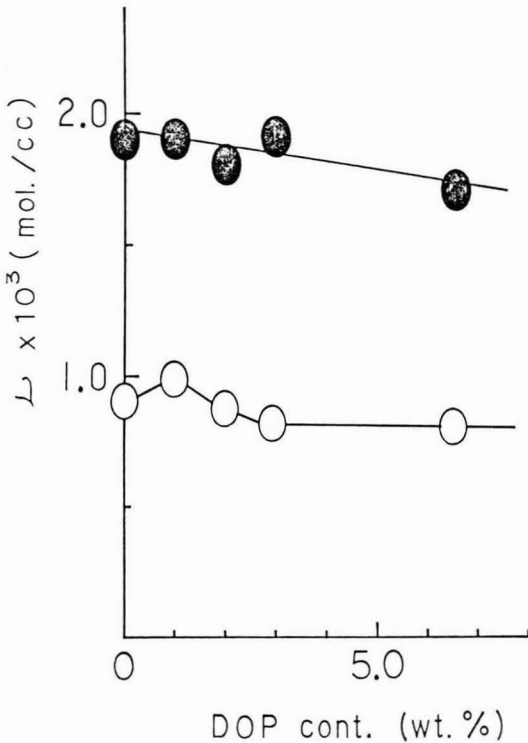


Figure 2—Plots of ν vs DOP content. Curing conditions: Temperature - 140°C; Time: ○ - 30 min; ● - 300 min

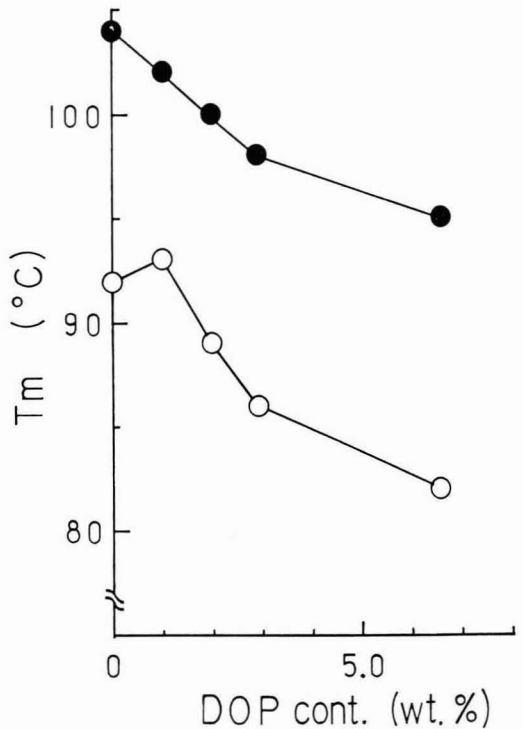


Figure 3—Plots of T_m vs DOP content. Curing conditions and symbols for time are same as in Figure 2

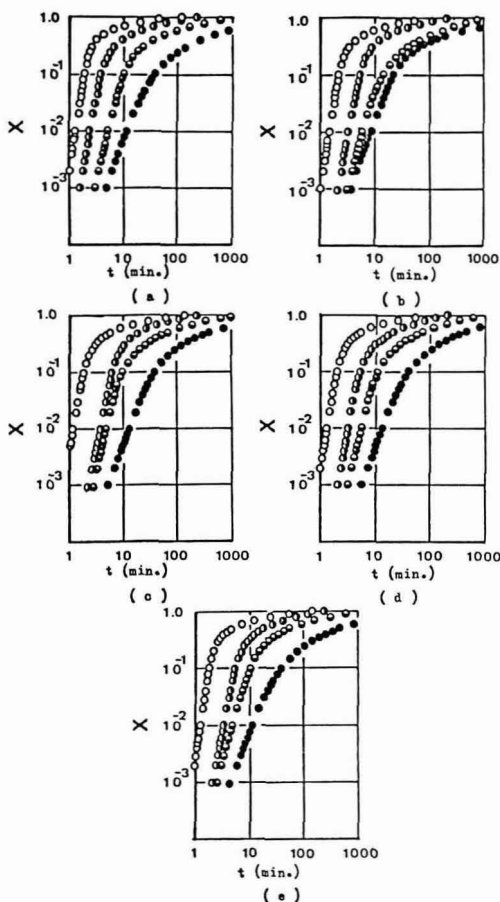


Figure 4—Log $X \sim \log t$ plots. DOP contents (wt %): (A) 0; (B) 0.99; (C) 1.96; (D) 2.91; (E) 6.54. Curing temperature: \circ —160°; \odot —140°; \ominus —120°; \bullet —100° C

increase of DOP contents, but for the resin cured for 30 minutes, T_m has a maximum value at DOP content of about 1.0 wt %. This means that the increase of T_m caused by the increase of the curing rate was larger than the decrease of T_m caused by the increase of plasticizer content.

Measurements of Curing Behavior by DSA

Figures 4 (a)–(e) depict the degree of cure by means of DSA for the resin which contained various amounts of DOP as a function of time at various cure temperatures. In Figures 4 (a)–(e), the slope of $\ln X$ in the first region plotted as a function of $\ln t$ increases with increasing cure temperature, and the temperature–time superposition rule cannot be applied easily. The coefficients in equation (1) (a, b, c, d, the apparent cure rate (k) and order (n)) and DOP content are collected in Table 3. They have been calculated in the way described in the previous report.⁵ The slope of $\ln X$ plotted as a function of $\ln t$, shown in

Table 3—Value of a, b, c, d, k and n in Equation (1)

DOP Cont. (wt %)	Temp. (°C)	a	b	c	d	k	n
0	100	0.440	5.058	1.158	4.230	0.0330	0.560
	120	0.260	4.262	1.698	2.940	0.210	0.740
	140	0.220	3.666	1.831	1.920	0.680	0.790
	160	0.157	3.738	2.738	1.037	2.254	0.843
0.99	100	0.372	5.467	1.690	3.855	0.0570	0.628
	120	0.240	4.209	1.113	2.879	0.234	0.760
	140	0.182	3.256	1.774	2.062	0.698	0.818
	160	0.156	3.504	2.079	1.143	2.044	0.844
1.96	100	0.392	4.920	1.376	4.355	0.0328	0.608
	120	0.249	4.381	1.378	2.707	0.268	0.751
	140	0.180	3.267	1.214	2.217	0.605	0.820
	160	0.175	3.634	2.043	1.005	1.897	0.814
2.91	100	0.368	4.859	1.174	4.261	0.0384	0.633
	120	0.244	4.177	1.395	2.847	0.238	0.756
	140	0.177	3.388	1.510	1.993	0.771	0.823
	160	0.186	3.682	2.436	1.154	1.700	0.814
6.54	100	0.397	4.975	1.181	4.248	0.0360	0.603
	120	0.297	4.227	1.735	2.948	0.177	0.703
	140	0.191	3.376	1.877	2.113	0.634	0.809
	160	0.148	4.076	2.511	0.928	2.671	0.852

Figure 4, corresponds with the value $1/(1-n)$. The reason why the temperature–time superposition rule cannot be applied easily was thought to be that value n changes gradually as a function of cure temperature. The answer to the cause for changes in n could not be obtained, and investigations will continue.

In Figure 5, the logarithm of k (the rate constant of cure) ($\log k$) is plotted as a function of the reciprocal of the absolute temperature of cure ($1/T$). As shown in Figure 5, $\log k$ decreases linearly with an increase of $1/T$. Except for the k values of the resin containing 1.96 wt % and 2.90 wt % of DOP measured at 100°C, which deviate largely from the straight lines shown in Figure 5, the slope of $\log k$ as a function of $1/T$ has been calculated by the least square method. The apparent activation energies (ΔE_a) have been calculated from the slope by using equation (3).

$$k = k_0 \cdot \exp(-\Delta E_a/RT) \quad (3)$$

where k_0 and R are the constant and gas constant, respectively, and T is the absolute temperature of curing. The results are shown in Table 4 and Figure 6. As is evident from Figure 6, the apparent activation energy (ΔE_a) changes with DOP content and has a minimum value at 2 ~ 3 wt % of DOP content. Considering that DOP does not act as a reactant now, the apparent activation energy of cure (ΔE_a) has a constant value independent of DOP content.

In the previous report,⁷ we discussed crosslinking reactions between acrylic copolymers containing various amounts of carboxyl groups and melamine resins (hexakis methoxymethyl melamine: Cymel® 300, American Cyanamide Co.). We found that the apparent activation energy for the network formation increased with an increase of carboxyl group content (decrease of flexibility). In bulk reactions, such as paint film formations from paint mixtures, we proposed that the reaction

Table 4—Effect of DOP Contents Against Apparent Activation Energy of Curing Process

DOP Cont. (wt%)	0	0.99	1.96	2.91	6.54
ΔE_a (kcal/mol)	23.2	16.7	14.9	15.0	21.3

rate was controlled by the mobility of the resin mixture, and the ΔE_a calculated had a value representing segmental mobility. Thus, the change of ΔE_a values was caused by the change in the temperature dependence of segmental mobility with the change of DOP content. With the results that ΔE_a decreased with increase of DOP content in the region where DOP content was from 0 to 2.0 wt %, it was considered that ΔE_a decreased as a function of DOP content. According to these results and the results described in the section of the Dynamic Viscoelasticity of Cured Resin, it was considered that the increase of crosslinking density of the resin cured for 30 minutes with an increase of DOP contents in the region where DOP content was from 0.0 to 0.99 wt % was caused by the increase of the probability of collision of functional groups caused by increase of segmental mobility. Decrease of the crosslinking density of cured resins with an increase of DOP content in the region where DOP content was more than 0.99 wt % was caused by a decrease of the probability of collision of functional groups by the dilution effect of DOP. The reason why ΔE_a increased again by dilution effect was not apparent.

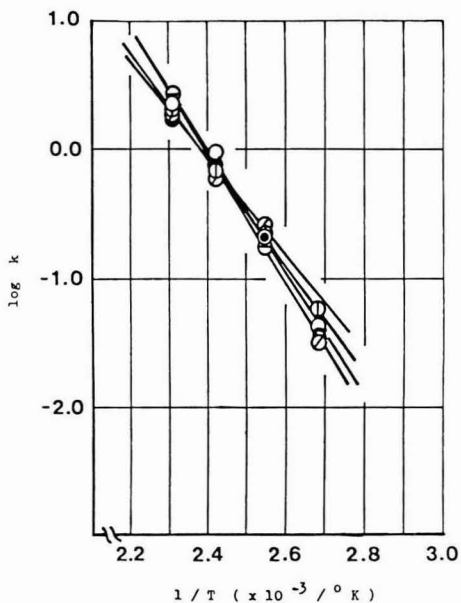


Figure 5—Log k vs 1/T plots. Symbols for DOP contents are same as in Figure 1(A)

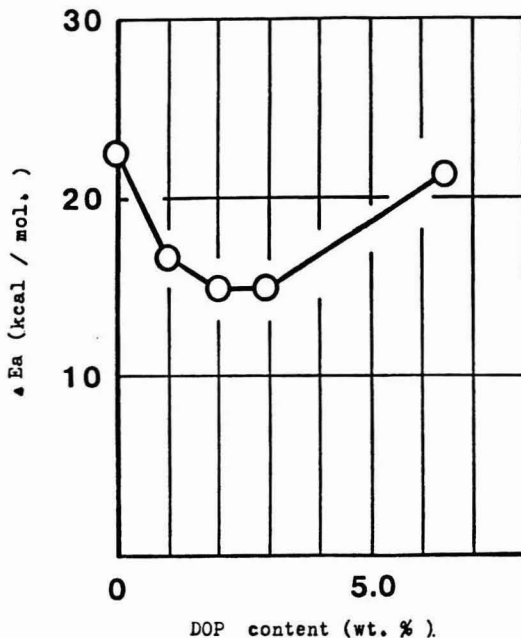


Figure 6—Plots of apparent activation energies of cure vs DOP content

CONCLUSIONS

The function of DOP in the curing behavior of thermosetting resins was as follows:

- (1) The probability of collision of functional groups increased by the plasticizer effect following to increase of DOP content, i.e., an increase of segmental mobility contained functional groups or an increase of mobility of melamine resin added as a hardener.
- (2) The dilution effect in the concentration of functional groups by an increase of DOP content and a decrease of the probability of collision of functional groups.

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Multifunctional Monomers In Water-Reducible Alkyds

Edward J. Kuzma and Eli Levine
Celanese Chemical Company*

Modification of film properties of water-reducible air drying and baking alkyds by inclusion of trimethylolpropane triacrylate is discussed. Evidence is presented to demonstrate improvements in drying rate, early water resistance, color retention, outdoor durability, and salt spray resistance as a result of monomer modification. Five percent, on weight of reactants, is suggested as a useful monomer level, and the monomer is best added toward the end of the process.

INTRODUCTION

The need for water-reducible alkyds with improved properties continues despite the significantly improved products introduced in the last few years.¹ The problems stem from the compromises necessary for the attainment of water miscibility,² not least of which is the presence of high boiling amines or alkanolamines.³ Further improvement in drying rates, early water resistance, and color retention will benefit producers and users of these products.

Recent work, described in this paper, has demonstrated that the inclusion of multifunctional monomers in water-reducible alkyds will effect substantial improvements in these properties. Illustrative formulations and procedures for the preparation of modified alkyds and evaluation of these resins versus suitable controls are given.

DISCUSSION

In any process involving the addition of materials as reactive as multifunctional monomers, the choice of monomer, the concentration employed, and the method of addition are of critical importance in determining the final properties of the modified alkyd. The precise nature of the reactions of multifunctional monomers under alkyd processing conditions is unclear, because several competing reactions can occur, among them Michael addition reaction, free radical polymerization, and ester interchange. There can be little doubt, however, that the ability of multifunctional monomers to modify alkyd solution and film properties is related to their ability to increase crosslink density.

Prior experience has shown that difunctional monomers such as hexanediol diacrylate (HDODA) promote an increase in crosslink density. However, levels of difunctional monomers required for optimum properties may make resin costs unacceptably high. On the other hand, materials such as pentaerythritol triacrylate (PETA) with an ester rank of 3.3 have so pronounced an effect on viscosity that processing becomes difficult. For this reason, the trifunctional monomer, trimethylolpropane triacrylate (TMPTA), was chosen as the modifying material for the resins under present discussion.

With respect to the method, and particularly the time of addition, the two principal options are the addition of TMPTA at (1) the start of the processing cycle, or (2) toward the end of the processing cycle, under conditions which would prevent excessive viscosity buildup. Our decision, based upon prior experience with TMPTA, was to take the latter approach. Formulations and procedures used are illustrated in *Tables 1 and 2*.

It was observed that the processing characteristics of the modified resin were similar in all respects to those of the control material. No unusual viscosity effects were observed, nor was resin clarity adversely affected.

Tables 1 and 2 show the formulations and procedures for the preparation of water-borne alkyds. The two resins, together with a commercial water-borne alkyd, were

*Marketing - Technical Development Laboratory, Summit, NJ 07901.

Table 1—Multifunctional Monomer Modified Alkyds

Component	Control #23374-17	Modified Resin #23374-16
	Parts by Weight	
Soya Fatty Acid	357.0	357.0
Trimethylolpropane	335.0	335.0
Isophthalic Acid	299.0	299.0
Trimellitic Anhydride	99.0	99.0
Trimethylolpropane Triacrylate	—	55.0
Viscosity @ 50% in 80/20	Z-4	Z-3
Water/MBEEG ^a		
Color (Gardner)	3-½	4

(a) monobutyl ether of ethylene glycol.

compounded into white gloss enamels (Table 3) and tested for physical properties as listed in Table 4.

The physical properties of the three coatings were all quite similar. All were tack-free in 50 minutes or less, all exhibited similar crosshatch adhesion and conical mandrel performance, and all exhibited 60° gloss readings, prior to exposure, between 93.8 and 96.8.

However, a significant difference in gloss developed* after one year of exterior exposure in Puerto Rico. The results, shown in Table 5, demonstrate that as little as 5% of TMPTA conferred sufficient “acrylic character” upon the modified alkyd to substantially improve gloss retention, despite the rigors of lengthy semi-tropical exposure. It should be stressed that no attempt was made to optimize the modification process. Such alterations in procedure as slight increases in TMPTA content, method of incorporation, blends of two multifunctional monomers, or other changes, might easily have improved the exterior performance of the modified resin even further.

The likelihood that TMPTA acts to increase crosslink

*As reported by Caribbean Testing, Inc., San Juan, Puerto Rico.

Table 3—White Gloss Paint Formulation

TiO ₂ Paste	Weight
TiO ₂ (OR-900, or equal)	60
Alkyd (Table 1), 50% in 80/20 water/MBEEG	40
Mix above thoroughly and grind on 3 roll mill to a 7.5 fineness.	
Enamel	Weight
TiO ₂ Paste	40.0
Alkyd (Table 1), 50% in 80/20 water/MBEEG	56.0
Water	3.1
Manganese naphthenate, 6%	0.3
Cobalt naphthenate, 6%	0.6
	100.0

Pigment/Resin = 24/36
 Film Thickness (mils) = 1.5
 Manganese = 0.05% based on resin solids.
 Cobalt = 0.1% based on resin solids.

Table 2—Procedure for Resin Preparation

1. Soya fatty acids, trimethylolpropane, isophthalic acid, and xylol were charged to a three-neck resin flask, equipped for use with inert atmosphere, and heat was applied.
2. The batch was heated to 245°C and processing was continued until an acid value of less than 10 was observed.
3. The resin solution was cooled to 180°C and the trimellitic anhydride component was added. (In the preparation of the modified resin, the TMPTA was also added at this point.)
4. Batch temperature was raised to 200°C and processing was continued until an acid value of 50-60 was obtained.
5. The xylol was stripped off and the batch temperature was reduced to 100°C. The batch was then diluted to 50% n.v. with an 80/20 water/MBEEG solution.

density within the polymeric matrix led next to a brief study of its effect upon the early water resistance of a benzoic acid-capped water-borne alkyd. Resin formulations are shown in Table 6. Monomer additions were carried out as previously described.

Two water-reducible enamels were then prepared using the experimental resins as the vehicles. Formulations for the test paints are shown in Table 7, and paint properties are to be found in Table 8.

The paints were evaluated for water resistance by placing a drop of water on the coating surface after one hour of air drying at ambient temperatures. After five minutes, the water drops were removed and the coatings rated for water resistance.

The results of this test, as well as the others described in Table 8, indicate that the concept of TMPTA modification merits serious consideration where improved alkyd performance is needed. A large reduction in tackfree time, substantial improvement in early water resistance, and more rapid development of hardness accompanied the use of TMPTA in resin #26734-35. These advantages are particularly important when it is considered that they

Table 4—Physical Properties

	Control #23374-17	Modified Resin #23374-16	Commercial Resin
Set-to-Touch (minutes)	8	7	7
Tack-free (minutes)	45	34	50
Tukon Hardness			
1 day	2.1	3.0	3.2
3 days	3.4	8.0	6.6
5 days	5.2	9.6	7.1
7 days	7.5	11.4	9.2
Crosshatch adhesion			
(Pass)	100%	100%	100%
Conical mandrel	Passed	Passed	Passed
Reverse impact			
(pass/fail)	0/4	0/4	0/4
Gloss, 60°	93.8	96.8	96.8

Table 5—One Year Outdoor Durability Evaluation (Caribbean Testing, Inc., San Juan, Puerto Rico)

	Mildew	Chalk	Crack	Rust	% Gloss Retention
<i>23374-16 Enamel (Modified Resin)</i>					
Primed Pine	9	9	10		
Chalked Pine	8	8	10		
Steel	8	10	10	9	23.7
<i>23374-17 Enamel (Control Resin)</i>					
Primed Pine	9	8	10		
Chalked Pine	8	8	10		
Steel	8	6	10	9	9.6
<i>Commercial Water Reducible Alkyd</i>					
Primed Pine	3	6	6		
Chalked Pine	3	8	10		
Steel	6	7	10	8	16.5

ASTM 10 = Good
0 = Failure

Table 6—Effect of TMPTA upon Resin Solution Properties

Material	Resin #26734-35	Resin #26734-41
	Parts by Weight	
Linoleic acid ^a	13.32	13.32
Pentaerythritol (mono)	26.24	26.24
Benzoic Acid	35.31	35.31
Phthalic Anhydride	8.92	8.92
Trimellitic Anhydride	16.21	16.21
TMPTA	5.00	—
	105.0	100.0
Physical Properties		
Acid Number	51.4	51.4
Viscosity @ 60% in 50/50 water/MBEEG	Z-6	Z-6
Color (Gardner)	3	4-½

(a) Pamolyn 200—Hercules, Inc.

decrease the vulnerability of the coating at the time when it is most susceptible to damage, immediately after application.

Salt spray resistance was another property in which substantial improvement was noted through inclusion of TMPTA. Resins were formulated and prepared for air drying and baking applications. The air drying resins (formulations in Table 9) were compounded into paints using the formulation in Table 7. The paints were applied to Bonderite® 1000 panels by spray, and the coated panels were evaluated (by an independent testing laboratory) for salt spray resistance.

*Bonderite is a registered trademark of Parker Rust Proof Co., Detroit, MI.

Despite the anomalous gloss retention results, the improvement in corrosion resistance and resistance to blistering are strong indications that the multifunctional monomer considerably improved the protective functions of the modified alkyd film.

Indications of coatings improvement in the thermo-setting paint application were even stronger. Resin formulations and results are shown in Table 10. In this test, the effects of TMPTA addition were studied in a trimethylolpropane-based polyester as well as a pentaerythritol-based polyester. Resistance to blistering in both types of TMPTA-modified resins was very great, relative to the respective controls. It may be speculated

Table 7—Air-Dry Paint Formulation Used in Alkyd Evaluations

TiO ₂ Paste	Weight
TiPure R-960 (or equal)	60.0
Alkyd (Table 6), 50% in 50/50 Proposal P®/sec-butanol	40.0
	100.0
Grind on a 3-roll mill to a 7.5 fineness.	
TiO ₂ Paste	40.0
Alkyd	56.0
Manganese naphthenate, 6%	0.77
Cobalt naphthenate, 6%	0.77
Zirconium naphthenate, 6%	0.77
Water	1.69
	100.00

Proposal P is a registered trademark of Union Carbide Corp.

Table 8—Effect of TMPTA upon Film Properties

Dry Times	Resin # 26734-35	Resin # 26734-41 (No TMPTA)
Set-to-Touch (minutes)	5	5
Tack-free (minutes)	12	45
Water Resistance		
1 hour air dry ^a	0	3
Tukon Hardness		
1 day	2.6	2.0
3 days	8.9	7.1
5 days	13.2	8.0
7 days	13.2	8.5
Conical mandrel	----no effect----	
Reverse impact (pass/fail)	0/4	0/4
60° Gloss	96.2	97.0

(a) 1 = Very slight etch
5 = Denuded

Note: All physical properties were evaluated after 7 days air dry.

Table 9—Composition and Salt Spray Resistance Of Water-Reducible Air-Dry Alkyd Formulations

Material	Weight, grams	
	Resin # 27003-18	Resin # 28709-39
Pentaerythritol (mono)	229.4	229.4
Linoleic acid ^a	232.8	232.8
Benzoic acid	308.7	308.7
Isophthalic acid	87.5	87.5
Trimellitic Anhydride	141.6	141.6
TMPTA	50.0	—
	1050.0	1000.0
Properties		
Viscosity @ 60% Solids in 50/50 Proposal P/MBEEG	Z1-½	Z-1
Salt spray exposure (hours)	500	500
Corrosion	6.5	5.0
Blistering	10.0	4.5
Gloss retention, %	79	86

(a) Pamolyn 200—Hercules, Inc.
 Corrosion Ratings: 10 = Perfect
 0 = No Value
 Blistering Ratings: 10 = None
 2 = Very large

Table 10—Composition and Salt Spray Resistance Of Bake-Type Water-Reducible Alkyds

Material	Weight, grams				Commercial Resin
	Resin # 27003-8	Resin # 28709-38	Resin # 27003-25	Resin # 28709-40	
Trimethylolpropane	390.2	390.2	—	—	
Pentaerythritol (mono)	—	—	277.1	277.0	
Soya Fatty Acid	200.8	200.8	281.2	281.2	
Benzoic Acid	—	—	155.4	155.4	
Phthalic Anhydride	269.3	269.3	188.5	188.5	
Trimellitic Anhydride	139.7	139.7	97.8	97.8	
TMPTA	50.0	—	50.0	—	
	1050.0	1000.0	1050.0	1000.0	
Salt spray resistance (hours)	500	500	500	450	500
Corrosion	7.5	7.5	7.5	1.5	7.5
Blistering	10.0	5.3	10.0	1.0	10.0
Gloss retention, %	96	96	86	X ^a	100

(a) X—Not rated due to failure before 500 hours.
 Corrosion Rating: 10 = Perfect
 0 = No Value
 Blistering Rating: 10 = None
 2 = Very Large

Note: Panels were aged for 7 days before exposure to salt spray resistance.

Table 11—Bake Systems

TiO ₂ Paste	Weight
TiPure R-960 (or equal)	60.0
Alkyd (Table 10), 50/50 in Proposal P®/MBEEG	40.0
	100.0
Grind on 3-roll mill to 7.5 fineness.	
Enamel	
TiO ₂ Paste	40.0
Alkyd, 60%	32.0
Cymel® 301	7.2
Water	20.8
	100.0
Alkyd: Melamine = 80/20 TiO: Resin Solids = 24/36 Baked 20 minutes at 300°F	

that inclusion of the multifunctional monomer in both types of coatings (air dry and bake types) reduced the permeability of the modified films to moisture vapor, leading, in turn, to the observed heightened resistance to blistering. But, whatever the mechanism, the results of TMPTA modification are, quite clearly, a substantial improvement in resin quality (Table 11).

CONCLUSION

It has been demonstrated that inclusion of 5%, by weight, of TMPTA in a variety of water-borne alkyd formulations will result in substantial improvements in the performance of coatings based upon these resins. Where improvement in coating performance is desired, the resin formulations and process conditions described in this paper may be considered as starting point formulations.

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- (1) Bailey, R.S. *Modern Paint & Coatings*, 68, No. 4, 44 (1978).
- (2) Levine, E. and Kuzma, E.J., "Polyacrylate-Modified Water-Borne Alkyds," *Journal of Coatings Technology*, 51, No. 657, 35 (1979).
- (3) Hansen, C.M. and Nielsen, K.B., "Behavior of Amines in Water-Dilutable Coatings and Printing Inks," *Journal of Coatings Technology*, 51, No. 659, 73 (1979).

Trademark and Product References

- TiO₂ OR-900 American Cyanamid Co.
- TiPure R-960 E. I. DuPont de Nemours & Co.
- Trimethylolpropane Triacrylate Celanese Chemical Co., Inc.
- Cymel® 301 American Cyanamid Co.



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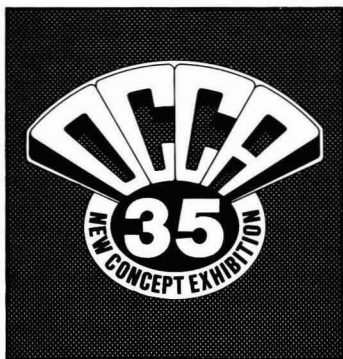
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Toxicology, the Law, and the Coatings Chemist

H. Everett Myer
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Toxicology, the science concerned with the setting of "no effect" levels, is basic to the scientific effort known as risk assessment. The judgment of risk goes one step further in that it involves value judgments as to what society considers an acceptable level of risk. Such judgments are reflected in the passage of health and safety regulations as well as in the decisions handed down in product liability cases. The coatings chemist must consider these concerns when planning work. Only in this way can the chemist best serve society and also hope to avoid delays and hassles as the work progresses.

Introduction

Since toxicology is closely related to administrative and tort law, the coatings chemist is well advised to consider both of these fields and how they relate to one's work. The purpose of this paper is three-fold:

- (1) To open a window into the world of toxicology,
- (2) To compare this world to that of hazard and risk assessment, sometimes called regulatory toxicology, and
- (3) To suggest ways that the field of toxicology relates to the work of the coatings chemist.

Figure 1 suggests some of the factors the coatings chemist must consider when planning work. Although toxicological considerations certainly are not the only factors to be considered, the coatings chemist cannot afford to ignore this important area.

Toxicology

HISTORY: Historically, the roots of the science of toxicology can be traced back as far as the Ebers Papyrus of 1500 B.C., which contains more than 800 recipes used in Egyptian medical practice.¹ Many of these contained poisons such as hemlock and lead. In 400 B.C., Hippocrates added some more poisons and wrote some instructions relating to absorption and prevention of overdosage of potentially poisonous medicines. In the early 1500's A.D., Philippus Aureolus Theophrastus Bombastus von Hohenheim-Paracelsus laid the groundwork for modern toxicology by emphasizing that toxic agents are chemical in nature and that whether a chemical is therapeutic or toxic depends largely on the dose administered. Orfila, a Spanish physician, is considered by some to be the founder of modern toxicology. Working in the early 1800's, he studied the effects of then-

known poisons by exposing and observing the responses of several thousand dogs. He was the first to advocate toxicology as a science in its own right and defined it as the study of poisons.¹

BASIC CONCEPTS: Today, there is a shift in emphasis. Usually, toxicology is now seen as the science concerned with the setting of "no effect" levels below which exposure is not likely to cause injury. Toxicity is now often defined as the capacity of a substance to produce injury. This is often further qualified by reference to a particular test protocol. For example, DDT is roughly thirty times as toxic as table salt when administered to rats in a single oral dose with the end point being death. The picture may change if much smaller doses are administered over the lifetime of the test animal or by a different route of exposure.

Toxicologists are also often concerned with the estimation of hazard, defined as the probability that injury will result from a particular use of a chemical under a given set of practical conditions. For example, lead may be quite toxic when inhaled as a fine dust, but may not be hazardous at all when handled as 20 lb. ingots. Safety, by this view, is the complement of hazard. That is, safety is the probability that injury will not result from use of a particular agent in a given practical situation. Absolute safety (zero hazard) is very rare indeed. But defined probabilistically, relative safety certainly is a useful concept. For example, even though it would be possible to drown in three inches of water, most people consider taking a bath a relatively safe

*Penn Lincoln Pkwy. West, Pittsburgh, PA 15205.

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Presented at the "Coatings and the Law" seminar sponsored by the Protective Coatings Div. of the Chemical Institute of Canada on April 27 and 28, 1983 in Toronto and Montreal, respectively.

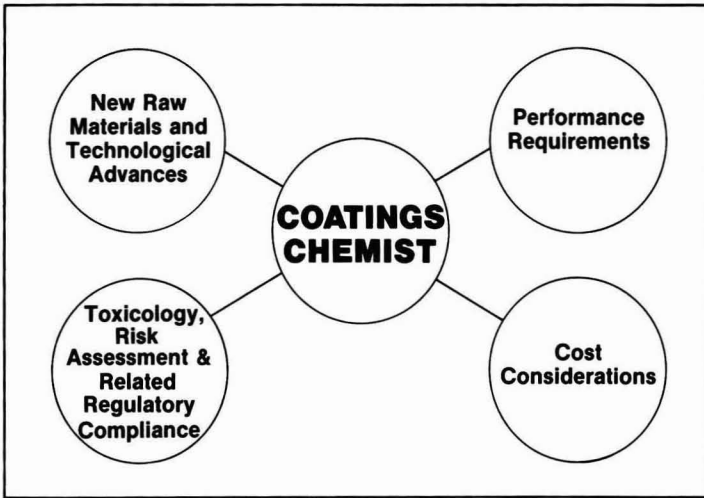


Figure 1—Factors the coatings chemist must consider in planning his or her work

activity since the probability of a healthy adult drowning in such a situation is quite low.

Another very important concept in toxicology is illustrated by the question, "Is table salt toxic to rats when taken orally in a single dose?" Paracelsus would have been likely to answer with another question, "How much table salt?" Writing in the third edition of "Patty's Industrial Hygiene and Toxicology," Dr. George Wright states that, "The weight of evi-

dence thus far overwhelmingly supports the conviction that all biological responses to nonliving agents are dose related."²

Figure 2 shows what is called a dose-response curve. As dosage (exposure) is increased, there is an increased probability of observing the end point in a given individual. This is evidenced in a test animal population by an increase in the proportion of the exposed group which exhibits the effect. The LD50 is the lethal

dose for 50% of the test population. In this example then, death is the end point being observed. So, is table salt toxic to rats when taken orally in a single dose? The answer is a qualified yes. At a dosage of three grams of NaCl per kg. of body weight, roughly 50 out of a group of 100 exposed rats will die. (That is, the LD50 is 3 gm/kg). Therefore, at a much lower dosage (perhaps 0.003 grams/kg body weight) most exposed rats will probably show no signs of any toxic effect. How-

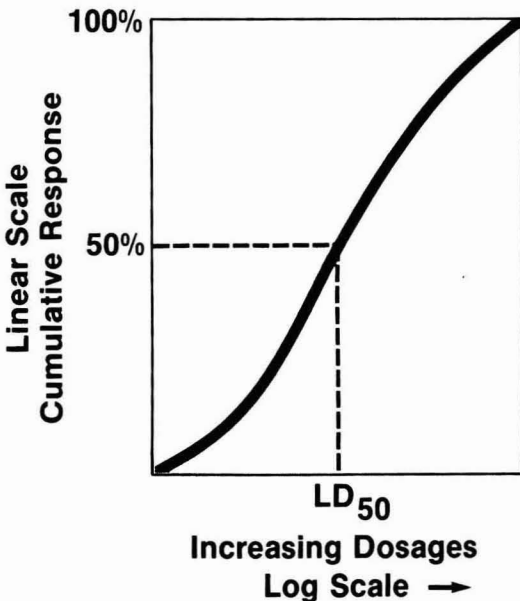


Figure 2—Dose-response curve

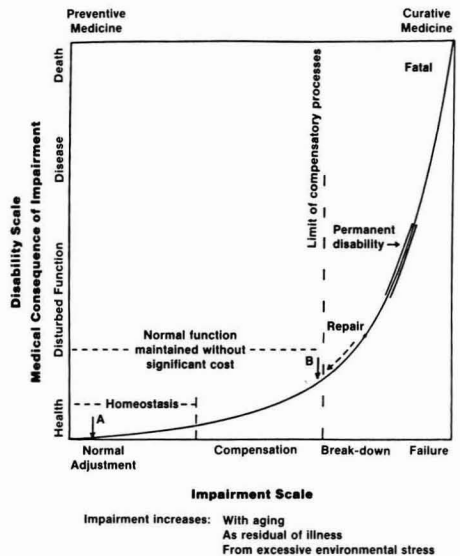


Figure 3—Impairment-disability curve³

ever, at an intermediate dosage (for example, 0.3 gm/kg) some of the rats may experience a sub-lethal effect, such as diarrhea. This example illustrates the concepts of impairment and disability as shown in *Figure 3*.

In 1962 Dr. Theodore Hatch proposed this way of looking at the sub-lethal effects of exposure to toxic agents. Applied to the example of rats being fed table salt, this means that if we assume all test animals were the same age and were all free of any complicating illness, then impairment will increase as the environmental stress increases (in this case the environmental stress is table salt in the diet). At a very low dosage, such as 0.003 gm/kg, most rats would probably be near point A on this curve. That is, the salt will be absorbed and the normal bodily functions will use what is needed and excrete the excess without any measurable evidence of ill health. At a higher but still sub-lethal dosage, perhaps 0.3 gm/kg, the rat may experience diarrhea resulting from a compensatory response. In this case the animal would be near B on this curve. There is evidence of ill health (disturbed function, i.e., diarrhea) but as long as the dose does not exceed that level, no permanent injury results. At a still higher dose, the rat may experience some permanent disability (e.g., loss of 30% of normal kidney function). We are now in the breakdown portion of the impairment scale. This loss is permanent, but not yet lethal. Lastly, in the 3-5 gm/kg dosage range the system breaks down completely (fails) and death results.

According to this model, the healthy, young organism is seen to have considerable resilience and resistance to disease. Over a fairly wide range of exposure levels, there is relatively little disability increase. However, beyond point B, disability increases more rapidly. Furthermore, an older person who may already have some disability may already be operating most of the time in the compensation range, and thus, any additional environmental stress (e.g., exposure to a toxic agent) will much more quickly result in permanent disability and death. The practical consequence is that when the question is asked, "Is table salt toxic?"... One needs to answer: "That depends."

The answer depends on: (1) dose; (2) route of exposure: oral, inhalation, skin contact; and (3) individual susceptibility: species, age, general health. In addition, the question, "Is table salt a hazardous material?," must also be answered "That depends." In this case the answer depends on the answers to questions such as:

- (1) In what physical form is the table salt? Block, powder, molten, etc.?
- (2) What materials handling procedures are being used? Automated

or manual, batch or continuous, open or closed vessels, etc.?

- (3) What ventilation is available?
- (4) What personal protective equipment will be worn?
- (5) To what conditions of temperature and pressure will the table salt be subjected?
- (6) What other chemical substances are likely to come into contact with the salt?

As you can see from this discussion, toxicity refers to more or less inherent properties of a material as revealed by the effects caused by the material in narrowly defined testing situations. In contrast, hazard refers to the characteristics of a given set of circumstances surrounding a particular use of a material.

RELEVANCE OF TOXICITY DATA: In one sense, all materials are toxic. That is, one can find some dose and some route of exposure which will cause some kind of adverse effect in some organism, no matter what the material is. The question one has to ask is, "Is this test relevant?" For example, pure distilled water, if injected intravenously, can cause serious electrolyte imbalance which can lead to death. Another example is a toxicity test which involved the effects of black pepper on mice. The pepper was extracted with alcohol and the extract was rubbed on the skin. Some cancer did ensue. It is, therefore, inadvisable to rub the alcohol extract of black pepper on the skin. This author does not expect that the product shown in *Figure 4* would make him rich were it to be put on the market. It is this author's opinion that an inappropriate route of exposure was used for this toxicity test.

In light of all this, it should be clear that to ask the question, "Is substance X toxic?," is really not meaningful. However, the question, "How toxic is substance X when administered by mouth in one large dose?," is quite meaningful. To gain some sense of perspective let us examine *Figure 5*.¹ Remember that an LD50 represents the dose that will result in mortality for about 50% of the exposed group. Thus, the higher the LD50, the less toxic the material since a larger dose is needed to produce the end point of this test, mortality. It can be seen that table salt is one of the least toxic of these agents (4,000 mg = 4 gm). At the other end of the scale are dioxin and Botulinus (or food poisoning) toxin. Even table sugar (sucrose) is toxic at 30,000 mg/kg, but of course, at normal dosages would cause no ill effects whatsoever. It would therefore be classified as practically nontoxic according to *Figure 6*. By comparison, strychnine sulfate, nicotine and botulinus toxin would all be considered supertoxic

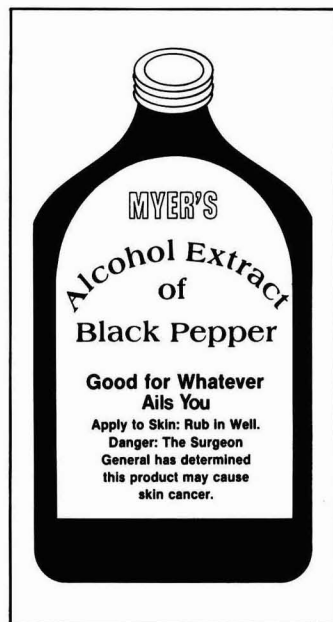


Figure 4—Recent toxicity test results would indicate that this product could not succeed commercially

by oral administration since less than seven drops would probably kill the average adult human. Table salt would be considered moderately toxic by this classification. That is, less than a pint, eaten all at once, would probably kill an adult human.

ACUTE AND CHRONIC TOXICITY: There are, of course, other measures of toxicity in addition to the oral LD50. *Figure 7* gives some idea of some other common measures. The third one is of special interest since it is our first mention of chronic toxicity. The examples used so far have involved an effect caused by rather massive one-time exposures to toxic agents. These are known as acute exposures, and the ill effects are often sudden and can lead quickly to serious illness or even death. Single oral LD50 values and four-hour LC50 values can give us some feel for the acute toxicity of materials. However, to extrapolate from these measures of acute toxicity in an attempt to predict effects of long-term, low level exposures to the same substance, is to ask for trouble. The living organism may behave very differently in the two situations. Some materials may have a fairly weak acute toxicity, but since they accumulate in the body, they may eventually cause serious illness. The appropriate animal test for chronic toxicity is

AGENT	LD50 (mg/kg)
Ethyl alcohol	10,000
Sodium chloride	4,000
Ferrous sulfate	1,500
Morphine sulfate	900
Phenobarbital sodium	150
DDT	100
Picrotoxin	5
Strychnine sulfate	2
Nicotine	1
d-Tubocurarine	0.5
Hemicholinium-3	0.2
Tetrodotoxin	0.10
Dioxin (TCDD)	0.001
Botulinus toxin	0.00001

Based on Loomis (1974).

Figure 5—Approximate acute LD 50's of a selected variety of chemical agents¹

obviously one which exposes the test animals to sub-lethal concentrations day after day for a period of weeks, months, or even several years. The end points may range all the way from slightly reduced body weight to early mortality due to cancer.

Risk Assessment

With this we leave the discussion of toxicology per se and begin to consider a broader arena—that of the policy maker. One way that toxicology is put to work is to use it as one of the tools in an effort known as risk assessment. Risk here can be seen as a composite of (1) the probability that an injury will occur (hazard), and (2) the degree of severity of the injury, should it occur. In tables such as the one in Figure 8, the degree of severity is held constant (mortality is the end point) so as

to compare the relative probabilities of injury. Another way of comparing risks is to list activities, all of which would result in roughly the same risk (Figure 9).

It is clear from these tables that we all have learned to live with some degree of risk. Often, individuals as well as society as a whole must make a decision as to how much safety we can afford. Insistence on zero risk in one area will almost certainly lead us to run a large risk in another area.⁴ In one sense, risk is part of the price we pay in order to enjoy some expected benefit.⁵ We all engage in informal risk benefit analyses every day. For example, most of us believe that the risk of driving an automobile is outweighed by the convenience and time savings which we enjoy as a result of this activity. There are, however, some ethical considerations involved in situations where one person bears the risk while

someone else enjoys the benefits. As Dr. Nicholas Ashford states in an article entitled, "The Chemist's Responsibility for Materials", ". . . if the society decides to use asbestos wherever it will save money, and a selected group of asbestos workers pay for it with their lives and health, there is a strong argument that the situation is not equitable, even if more lives are saved than lost. For example, by the use of asbestos brake linings, more lives may be saved for the public on the highways than are lost by workers in the plant. The non-random selection of those who bear the risk, however, deserves special attention."⁶ Howard Fawcett sums it up nicely when he writes, "To continue to achieve acceptable benefits from chemicals and other technology, we must control the risks by understanding them . . ."³ Thus, a risk benefit analysis consciously made is a first step toward

LDL₀	Lethal Dose Low
	Lowest dose reported to have caused death
LC₅₀	Lethal Concentration Fifty
	The airborne concentration expected to cause death in 50% of the animal group exposed
TDL₀	Toxic Dose Low
	Lowest dose of a substance ever reported to have caused any toxic, carcinogenic, teratogenic or other effect

Figure 7—Some common measures of toxicity

PROBABLE ORAL LETHAL DOSE FOR HUMANS		
TOXICITY RATING OR CLASS	DOSE	FOR AVERAGE ADULT
1. Practically nontoxic	> 15 g/kg	More than 1 quart
2. Slightly toxic	5-15 g/kg	Between pint and quart
3. Moderately toxic	0.5-5 g/kg	Between ounce and pint
4. Very toxic	50-500 mg/kg	Between teaspoonful and ounce
5. Extremely toxic	5-50 mg/kg	Between 7 drops and teaspoonful
6. Supertoxic	< 5 mg/kg	A taste (less than 7 drops)

Figure 6—Toxicity rating chart¹

RISK	ACTIVITY
1/400	Smoking (10 cigarettes/day)
1/2,000	All accidents
1/8,000	Traffic accidents
1/30,000	Work in industry
1/50,000	Natural disasters
1/1,000,000	Driving 80.5 kilometers†
1/1,000,000	Being struck by lightning

* From Flowers, B.D. (chairman) Royal Commission on the Environment, Sixth Report: Nuclear Power and the Environment. Her Majesty's Stationery Office, London, 1976.

† Risk is expressed as probability of death for an individual for a year of exposure and orders of magnitude only are given.

‡ This risk is conveniently expressed in the form indicated rather than in terms of a year of exposure.

Figure 8—Estimated risks for selected activities

Smoking 1.4 cigarettes
Living two months with a cigarette smoker
One x-ray (in a good hospital)
Eating 100 charcoal-broiled steaks
Eating 40 tablespoons of peanut butter
Drinking 10,000 24-ounce soft drinks from recently banned plastic bottles
Drinking 30 12-ounce cans of diet soda containing saccharin
Living 20 years near a polyvinyl chloride plant
Living 15 years within 30 miles of a nuclear-powered plant

* From Wilson, R.: A rational approach to reducing cancer risk. *New York Times*, July 7, 1978.

Figure 9—Exposures that increase the chance of death by one part in a million, or reduce life expectancy by eight minutes (From Wilson, R., "A Rational Approach to Reducing Cancer Risk." *New York Times*, July 7, 1978

achieving the goal of minimum risk for maximum benefit. Secondly, if we seriously think about the risks involved before beginning a new venture, it is more likely that we will consider who will bear the risks, and thus, we will be in a better position to make a good ethical decision.

ASSESSING RISKS OF USING NEW MIXTURES: Of course paint chemists have a special problem. Namely, it is to assess the risk of using a new mixture of numerous chemical substances. Logically there are three possible approaches. One is to have each and every formulation tested by several appropriate toxicological protocols. Practically, however, this approach must be rejected simply because of the sheer enormity of the task. A second approach is to have several representative formulations tested and then to use these results to judge the toxicity of similar formulations. This approach is called argument by analogy and is used extensively. A third approach is to judge the toxicity of the mixture by a consideration of the known toxicities of the ingredients. This approach is also used extensively. Theoretically, this can be referred to as joint toxicity.⁷

Three types of joint toxicity are:

- (1) Additive: Two or more chemicals act on the same target cells in the same manner. It is thus possible to calculate the average toxicity by taking a weighted average based on individual toxicities and the proportion of each ingredient in the mixture.
- (2) Antagonistic: Less than the additive effect.

- (3) Synergistic: Two or more chemicals produce more than an additive effect.

But, how does one know which model is operative without actually doing the testing? In the 1960's workers at the Chemical Hygiene Fellowship at Mellon Institute in Pittsburgh, PA decided to try to get some handle on this question, since they had often been called on to make estimates of the toxicities of mixtures when the only data available were the toxicities of individual ingredients.⁷ Over several years they tested all possible 50/50 combinations of 27 widely used industrial chemicals (350 mixtures). The oral LD50 values were obtained for all the pairs and compared to the theoretical mixture LD50 values arrived at by calculation based on the additive model (weighted averages calculated by Finney's method). Ninety percent of the tested mixtures followed the additive model, 7% showed a greater than additive result, while 3% showed a less than additive outcome. Dr. Henry Smythe concluded from these results that this offers "... some reassurance that estimates of the toxicity of mixtures, based on the assumption that the toxicities of their components are additive, will usually be sound."⁷ This estimated toxicity can then be factored into the overall risk assessment relating to a specific use situation.

Regulatory Toxicology

Having considered the topics of toxicology and risk assessment, we now move on to the public policy-setting arena, sometimes referred to as regulatory toxicology. Since the mid-1960's, there has been a tremendous increase in the number of U. S. Federal laws relating to toxicology and risk assessment (Figure 10). I

am sure that this is evidence of a legislative response to a perceived public outcry calling for a cleaner environment. The regulatory agencies were given the authority and responsibility to administer these laws. The assumption was that the public has the right to a cleaner environment. Dr. Nicholas Ashford, an attorney and Ph.D. chemist, writes that, "When it comes to safeguarding certain very important rights under the law, sometimes a 'scintilla of evidence' may justify legal sanctions, control, and even the establishment of liability. This pervasive principle in our system of jurisprudence is not fully understood by 'pure scientists' and, indeed, they sometimes view the law as 'unscientific'. The law attempts to make the best decisions on the information that exists."⁶

Is the law unscientific? W. W. Lowrance makes a distinction between assessment of risk and judgment of risk.⁸ He expects scientists to assess (measure) risks through such activities as carefully controlled toxicology testing. Public policy makers (regulators) then must make value judgments as to what an acceptable level of risk is, based on the best scientific data available as well as their best estimate of societal values and needs. In this sense, regulatory toxicology must go beyond what is commonly defined as a scientific endeavor into the area of value judgments. Of course, as Dr. Morton Corn points out in his chapter in "Casarett and Doull's Toxicology," "In certain cases where data are absolutely lacking, regulators must err on the side of prudence."¹¹ The limitation on this approach is, of course, that once compliance with a regulation is perceived as infeasible by the

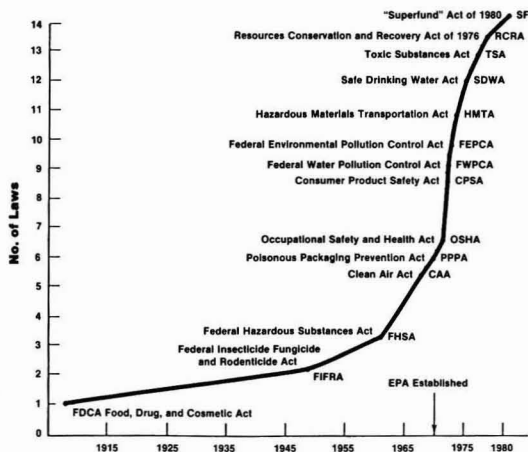


Figure 10—Chronology of major federal laws concerning chemicals⁵

public, the regulator's credibility is gone and enforcement becomes next to impossible. Therefore, regulators often try to determine "... what 'the traffic will bear' at a given point when action must be taken."¹¹

Another possible reason why environmental laws have proliferated in the U. S. is that the public no longer believes that market forces offer sufficient incentive for socially responsible behavior. In fact, the conscientious among us sometimes even appreciate the reasonable intervention of the government regulator because it tends to cut down on the unfair advantage enjoyed by the unscrupulous operator. It is sometimes easier to do the right thing if it is also legally required. In other words, the "game" is more fair when all are playing by the same rules.

There is, of course, a danger in government regulation which is too detailed and specific. In addition to the natural resentment aroused by such specification standards, there is also the danger of limiting technology development. The standard must be specific enough to be enforceable yet flexible enough to allow the regulated to develop the most effective and least expensive ways of reaching the overall goal.

Responses to Regulation

There are several possible responses that the regulated community can make to all this public policy setting activity. One is the "ignorance is bliss" approach. This is risky since as we all know, ignorance of the law generally is not accepted as an adequate defense.

Operations	Number of Observations	Mean and Range of Sums of Standardized Concentrations(a)	Principal Solvents (number of cases in which the solvent was found)
Charging solvents	33	mean = 2.0 0.2-16	Xylene (16), methylene (4), toluene (4), styrene (2), butanol (9), esters, and others
Pigment dispersion (grinding, roll-milling, etc.) + emptying of vessels	18	mean = 1.5 0.2-4.4	Xylene (13), butanol (4), and others
Tinting, thinning	14	mean = 0.9 0.1-20	Xylene (11), butanol (3), and others
Can filling, paints	39	mean = 1.3 0.02-6.6	Xylene (23), alkanes (4), butanol (7), benzene (4), toluene (6), and others
Can filling, thinners	14	mean = 1.8 0.1-7.4	Toluene (3), xylene (5), trichloroethylene (3), esters (2), acetone (1), and others
Manual cleaning of equipment with solvents	51	mean = 5.7 0.5-30	Xylene (33), butanol (8), toluene (13), methylene chloride (9), esters (7), and ketones (4)
Laboratory work cleaning with solvents, spraying paints, grinding, oven drying	22	mean = 0.9 0.06-3.0	Xylene (11), toluene (7), ethyl acetate (4), and others

(a) Standardized Concentration = $\frac{\text{Observed Concentration}}{\text{Health Standard}}$

Figure 13—Summary of solvent concentrations¹²

Secondly, we could take a "knowledge is power" stance. Many corporations take this approach. In 1981 there were 12,000 lawyers, 9,000 lobbyists, 42,000 trade association personnel, 8,000 public relations specialists, and 4,800 consultants who were based in Washington, DC and whose job it was to help corporations keep abreast of what congress and the regulators were doing. With this knowledge, corporate interests can then hope to influence new legislation and regulation in the early stages of their development. Once the regulation is in effect, knowledge again enables the company to comply as quickly and efficiently as possible with minor disruption in normal operations.

There is also evidence that, especially in the areas of toxicology and safety,

A. VEHICLE	
1) Non-Volatile Portion	2) Volatile Portion
- Resins	- True Solvents
- Oils	- Latent Solvents
- Plasticizers	- Diluents
- Driers	
- Other Additives	
B. PIGMENTS	

Figure 11—Paint

Operation	Paint mist (mg/m ³)
I. Mean time-weighted average concentrations of paint mist in continuous painting operations	
Powder coating small parts (electrostatic)	1.3
Wood furniture (airless and compressed air)	0.1 - 2.5
File cabinets and panels (compressed air)	4.2
Metal furniture (compressed air)	3.7 - 27.6
Appliances (compressed air/electrostatic)	21.7 - 39.2
II. Mean concentrations of paint mist during spraying of internal cavities	
Freezer liners (compressed air)	320.0
File cabinet interiors (airless)	2.9
Walk-in spraying of large vehicles (airless)	36.5
III. Mean concentrations of paint mist in intermittent painting operations	
Heavy equipment exteriors (airless electrostatic with heated paint)	2.0
Automotive refinishing (compressed air)	8.7
Light aircraft (compressed air)	23.3
Railroad freight cars (airless)	43.3

Figure 12—Summary of paint mist concentrations in selected finishing operations¹¹

compliance with regulations alone may not always result in our reaching the overall goal of protecting the health and safety of the public. In the U. S. A. today, there are over 58,000 commercially available chemical substances.⁹ Only about 500 of them have established Threshold Limit Values and less than 25 have detailed workplace comprehensive health standards. Dr. Bruce Karrh, of Du Pont's Medical Div., puts it well when he says, "Although there are many necessary and reasonable regulations safeguarding employee health, we should never rely on them alone to protect employee health. They are not crutches or substitutes for sound medical practices. They must be supplemented by the judgment of professional health experts, and such judgment may call for action that goes beyond the dictates of existing regulations."¹⁰

The Coatings Chemist

Now, how does all this relate to the coatings chemist? Let us begin by talking briefly about paint (Figure 11). Since the nonvolatile portion of the vehicle remains in the cured coating film, its contents are of somewhat limited toxicological concern. However, spray application can result in exposure by the inhalation route. Even during a nonspray application, workers could experience skin and eye contact with the nonvolatile vehicle portion. Other possibilities are ingestion of cured coating film chips by children (a fairly common historical cause of lead poisoning in children), inhalation of dust from grinding, powerbrushing or sandblasting of old cured coatings, and inhalation of thermal decomposition products during welding or high temperature cutting of coated surfaces. The same possible routes of exposure would apply to the pigment portion of the coating system.

The volatile vehicle portion, by contrast, is designed to be released to the atmosphere during curing. It is of major concern, therefore, from the viewpoint of inhalation toxicity, as well as fire and explosion hazard.

It is beyond the scope of this paper to attempt to describe in any detail the toxicological properties of all of the myriad of ingredients used in paint manufacture. However, two tables which summarize results of exposure evaluations in a number of paint manufacture and application settings will be discussed. Figure 12 is taken from a NIOSH Technical Report entitled *An Evaluation of Engineering Control Technology for Spray Painting*, by O'Brien and Hurley.¹¹ There is currently no U. S. TLV for paint spray mist, but we can see that these spray mist concentrations often exceed even the inert dust standard of 10 mg/m³. It is certainly clear that many spray paint applicators must be protected from inhalation of spray paint mist by wearing appropriate respiratory protection. Figure 13 shows airborne solvent concentration data collected by Ulfvarson in 10 paint factories in Sweden employing 40% of that country's paint industry workers. Notice the mean standardized concentrations. Any number over one means that the health standard was exceeded. Most of these samples were taken in the breathing zones of workers. Again, respiratory protection is needed unless engineering controls can be upgraded sufficiently to lower the airborne concentrations.

Summary

The American Chemical Society offers for sale a T-shirt showing a flask partially filled with a liquid. The inscription reads, "Chemists Have Solutions." This author shares this sentiment. Industrial hygienists rejoice when chemists discover new substances that are less toxic than the ones they replace. Dr. Henry Smythe called this activity planning molecules. An example in the field of coatings chemistry would be the development of an adduct of a reactive monomer where the adduct is still reactive but is less hazardous to use since it is less volatile. Other approaches are technological in nature, such as new applications technology, some examples may be airless electrostatic spraying, electrodeposition, powder

coating and high solids technology. In the opinion of this writer, there will be continued public and regulatory pressure to develop chemistry and technology which is compatible with the goals of a clean and healthy environment. Like the ACS T-shirts say, you have the solutions. Happy and healthy innovating.

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Society Meetings

BIRMINGHAM DEC.

"Color Measurements By Colorimeters"

A moment of silence was observed for Peter Churchley, formerly of Manders, who died recently.

R. W. English, of Mastermix Engineering, was presented a 25-Year Pin.

"COLOR MEASUREMENTS BY COLORIMETERS" was presented by D. A. Plant, Consulting Scientist.

Aided with slides, Dr. Plant illustrated additive and subtractive mixing. Systematic terminologies for color differences were described, as were machines for measuring these differences.

The application of color measurements to manufacturing control, shade matching, batch corrections, waste work-off and metamerism, and with the sometimes poor correlation between visual and machine acceptability of colors was discussed by Dr. Plant.

Q. How can one resolve problems of match prediction in semi-opaque films?

A. There is no solution, other than a second coat. The key to the problem is reproducibility of film, e.g., in printing, films are so closely controlled that lack of opacity is not a problem.

Q. What is the position of the P.R.S. wet/dry color control system?

A. It has been withdrawn, since both the degree and direction of color drift depends on the pigmentation system.

Q. Does one need to take account of the gloss level of the material being measured?

A. In modern systems, this is usually allowed for.

Q. What is the latest position regarding instrumental matching of metallic colors?

A. This is being done. Currently, it is still less accurate than non-metallic colors. Results are much improved on machines able to use more than one angle of measurement.

Q. Is comparability of calibration a problem?

A. There is some difference between values given by different machines, but these are of the same order as the variation in acceptance standards.



1983-84 Officers of the Baltimore Society are (left to right): Treasurer—Harry Poth; President—Joseph D. Giusto; Society Representative—James A. McCormick; Secretary—Frank Gerhardt; and Vice-President—Robert Hopkins

Q. What instrumental system would you recommend for the first-time purchaser whose control is now entirely visual?

A. If for quality control only, a tristimulus colorimeter is much cheaper than a match prediction system. It will not detect metamerism, however.

Q. Can the pigments currently in use allow no match within the acceptability of a match prediction system?

A. Yes, e.g., none of the current automotive pigments will produce fluorescent yellow like a tennis ball.

D.H. CLEMENT, *Secretary*

while dry hiding is noticed once the coating goes above the critical PVC, he said.

According to Mr. Stoy, extender pigments should have the following attributes: (1) fine particle size range; (2) large number of particles per pound; (3) efficient spacing of active pigments; (4) excellent dispersant ability; and (5) high optical activity.

It was stressed that only a few of the extenders available in the marketplace could be considered to be light scattering extenders.

ALFRED F. YOKUBONIS, *Secretary*

HOUSTON DEC.

"Light Scattering Extenders"

Bill Stoy, of Englehard Corp., spoke on "LIGHT SCATTERING EXTENDERS."

Mr. Stoy explained how it is possible to reduce the cost of a coating with light scattering extenders by keeping the VLC levels down. He pointed out that the relative cost of the pigments was approximately \$.15 per pound for the light scattering extenders vs \$.70 per pound for TiO₂ and \$.50 per pound for iron oxide.

Mr. Stoy stated that hiding extenders tend to increase the PVC. Milkiness in the coating is noticed at normal PVC,

NORTHWESTERN JAN.

"Rapid Wetting and Spreading On Polymeric Substrates"

It was announced that the Society's annual symposium will be held March 6 at the Marriott Hotel, Bloomington, MN. The theme for the symposium is "Pigments/Manufacturers' End Use."

Daniel B. Pendergrass, of 3M Co., spoke on "RAPID WETTING AND SPREADING ON POLYMERIC SUBSTRATES."

Comparison of literature values for drop spreading (≈ 10 CM Sec⁻¹) with the rate of web transport makes it apparent that additional factors are important in the coating process, said Mr. Pendergrass.

Current studies of drops of two different sizes on polyethylene terephthalate web simulating spray or curtain coating showed the effects of surface tension and rheology on the spreading rates, explained Mr. Pendergrass.

"WATER-EXTENDIBLE HIGH SOLIDS ENAMELS" was discussed by Rich Johnson, of Cargill, Inc.

Mr. Johnson covered a new approach for formulating low VOC enamels. In this approach, combinations of high hydroxyl value resins, water-miscible solvents, and standard crosslinkers are formulated to high solids enamels that are thinned to spray viscosity with water. Mr. Johnson said that film properties were good and better in some respects to conventional enamels.

ALFRED F. YOKUBONIS, *Secretary*

PHILADELPHIA DEC.

"Dispersion"

"DISPERSION FROM A PRACTICAL STANDPOINT" was presented by Leo Dombrowski, of Chicago Boiler Co.

Mr. Dombrowski discussed whether sand grinders really grind and if high speed dispersers really disperse. He pointed out that if you do not get the proper laminar flow in your mill, you will not achieve good grinds or dispersions.

Slides reviewed the many types of equipment available. Two roll mills provide very high shear stress while the high speed turbine produces very low shear stress, explained Mr. Dombrowski.

The Vortex, according to Mr. Dombrowski, is very important to insure obtaining satisfactory grinds. This is due to the fact that at any given time during grinding, only 1% of the mass is in contact with the blade.

Improper use of equipment results in poor grinding, high temperatures, unusual wear of parts and media, and erratic power draw, explained Mr. Dombrowski.

Q. Will improper use of equipment destroy polymer properties?

A. Improper use will not only affect resin properties, but other ingredients, such as pigments.

Q. What differences can be expected in using acicular or spherical pigments?

A. One has to watch load limits. Because of their shape, they pack differently which will affect your grind rate and cycle.

WILLIAM GEORGOV, *Secretary*

PIEDMONT DEC.

"Photography"

Environmental Committee Chairman, Ed West, announced that the following members have volunteered to serve on the committee: Sara Robinson, Inland-Leidy; Clayton Reid, Seaboard Chemical Co.; Don Williams, Prillaman Co.; and Teresa Tounge, Chemcentral, Inc.

Walter Dove, of Fisher Harrison Corp., spoke on **"PHOTOGRAPHY—THE HOBBY AND YOU."** A slide and tape show on 35mm cameras was shown, courtesy of Eastman Kodak.

MICHAEL S. DAVIS, *Secretary*

PITTSBURGH DEC.

"Superfund and Other Environmental Regulations"

Pat Dawson, Chairperson of the Educational Committee, announced that a five-day course on "Colloids" would be held at Carnegie-Mellon University in May. She also stated that the Committee is continuing its work in the development of a comprehensive presentation to be made available to high schools in the Western Pennsylvania area. Ms. Dawson said that she is looking for volunteers with experience, who would be willing to work in general discussion groups before high school students, explaining what takes place in the coatings field, and how best to prepare for it. She also mentioned that a slide program is a possibility that the committee is exploring.

"SUPERFUND AND OTHER ENVIRONMENTAL REGULATIONS" was discussed by Thomas Graves, of the National Paint and Coatings Association.

According to Mr. Graves, the paint and coatings industry is a heavily legislated one, with the bulk of the legislating coming under the direction of the EPA. Unfortunately, because we are coming into an election year, and because the Reagan administration has been accused of being too soft on industry, particularly those involved in the chemical areas, there could be problems for each of us in the immediate future.

The NPCA has spent much time and energy fighting both unfair and ineffective legislation which could and will affect each of us, both directly and indirectly, said Mr. Graves.

Approximately three years ago, the paint and coatings industry had an image of being a part of the much larger chemical industry, and we were regulated accordingly. An example of this is in the

area of water effluent from a producing plant, where the EPA proposed a zero discharge level when it came to certain waste products. Of course, just to show the confusion that takes place in government, while the EPA was establishing this zero discharge level, the Office of Solid Waste Management was stating that this was not necessary, explained Mr. Graves.

The NPCA went to work to prove that the rule was unfair, and to date, we are the only major industry in the chemical subcategory to have the discharge rule changed. At the same time, we are continuing to push for a waste reclamation via process changes, and we are hopeful to have success there. Now in order to do this, along with the technical appeals, there have also been law suits against the EPA, to get them to change their laws, and in some cases, their own technical people have backed up our position.

There is a great deal of politics present in the whole area of Environmental Protection, and while we feel the Reagan administration has not really turned the laws around, to favor industry, they have been painted with an image of an administration that does do this, said Mr. Graves.

Those of you who are not familiar with what is taking place concerning the cleanup of chemical dump sites around the country should acquaint yourselves either directly, or through your legal department with both court and EPA rulings regarding liability for cleanup of these dump sites. The NPCA does offer informational help in this area, and with over 300 identified sites currently in the United States, if you are a producer of any material that could find its way into one of these sites, it would behoove you to investigate the matter more closely, stressed Mr. Graves.

In particular, you should be aware of your liability in spite of the fact that you may be using approved haulers, and dump at state approved sites. Also, stated Mr. Graves, you should know how the government determines the pro rata share of cleanup costs. Recent rulings are indicating that courts feel that a company who may put very small numbers of drums of material into a site can be held equally liable for its total cleanup.

Part of the effort of the NPCA is an attempt to make the legislators aware of the impact of their actions on small and medium size companies who act in good faith, and still end up being dragged into some of the large, politically tainted suits.

Mr. Graves noted that many sites are being cleaned up, and cleaned up efficiently. Yet, there is an entirely new item being brought up on the horizon, and that has to do with individuals claiming the damages for chronic illnesses

related to these chemical dump sites. Congress is currently in the process of bringing through the legislative process, victim compensation bills. The possibility here is that the contributors are going to be held responsible not only for the damages, but also to determine who is susceptible, and who is not, to certain potential risks. This could bring about both state and federal class action suits. You can be quite certain that many firms in the chemical industry are concerned about being able to obtain adequate insurance, should these laws be enacted.

On top of all this, here in Pennsylvania, the Legislature has enacted a "Right to Know" law, where the workers are to be told completely about all the materials they are working with, and the potential hazards of each. At this point, it is still too soon to know the full impact of this law, because we are not certain what sort of law suit potential this is going to open for the workers and their employers, said Mr. Graves. It has however, made a great many firms apprehensive at this point.

Q. In your talk, Mr. Graves, you discussed the past hazardous waste practices, but what about the future?

A. Land fills have worked, but they are probably going to be phased out in the next few years. The same may be true for incineration as a method of treating hazardous waste, although that probably will stick around longer. Of course there are those who say that we can have no hazardous wastes at all, but our feeling is that some middle ground is going to have to be found. You simply cannot outlaw hazardous wastes, or you are going to have a wholesale breaking of the law, because in reality there will always be hazardous materials of some type. This is a concern of ours, that in some cases we get into Alice in Wonderland type thinking, and that can abound in a political atmosphere.

JOSEPH L. MASCIA, *Secretary*

PITTSBURGH JAN.

"Past Presidents' Night"

Seventeen past presidents attended this meeting in honor of the Society's past presidents. The eldest attending was Ralph Herr, President of the Society in 1935.

A 25-Year Pin was awarded to Past President Edward Neuwirth, of Watson Standard.

It was announced that the Educational Committee's work is progressing, and they are now in need of volunteers to both design a program for presentation to high schools on what takes place in the coatings industry, and to make the presentation.

The Technical Committee announced that it intends to present a five to 10 minute update at each meeting, telling what new and interesting developments are taking place in the computer field that relate to the coatings industry.

"MORE EFFICIENT PAINTING" was discussed by Carl Izzo, of Westinghouse Electric Corp.

A number of years ago, Robert T. Walsh, of the Environmental Protection Agency, warned that emissions from paints and coatings were going to have to be reduced, and there were some who heeded his remarks, but many who did not, said Mr. Izzo. However, with the coming of the 1977 Clean Air Act, and its subsequent implementation in 1982, everyone involved in coatings, both from a production and application standpoint, knew that some steps were going to have to be taken to reduce solvent emissions.

The California Rule 66 was a starting point, even though the EPA tests later showed that Rule 66 solvents, given enough time, would still cause the same amount of photochemical smog that standard solvents emitted, explained Mr. Izzo.

Other methods were also being explored to reduce solvent emission, and one of these was the establishment of VOC levels. At the same time, companies, including Westinghouse, began analyzing transfer efficiency of coatings as an additional key to reducing solvent emissions. In short, we began to evaluate how efficient our method painting was, and the evaluation was built around a program called RACT, or Reasonable Available Coating Technology. Not only was the application method evaluated, but also types of coating used. Of course, water-borne coatings were looked at most favorably, simply because they could reduce solvent emissions by anywhere between 60-90%, Mr. Izzo explained. From these sorts of evaluations, it was learned that not only can you reduce solvent emissions, but you can also reduce your in-plant costs enough to justify new equipment, and in some cases, coatings which cost more than what you are currently using.

In order to more accurately evaluate transfer efficiency, Mr. Izzo stressed that it should be remembered that from the time Binks and DeVilbus first perfected spray painting equipment, their transfer efficiencies have stayed in the 30-50% range. A quick comparison of transfer efficiencies shows the following:

Air atomization . 30-40% efficiency
Airless 50-60% efficiency
atomization
Air electro- 60-70% efficiency
static spray
Airless 70-80% efficiency
electrostatic spray
High speed 80-90% efficiency
electrostatic disc bells

It should also be pointed out that as pumps, heaters, discs, and bells are improved upon, these efficiencies can go even higher, said Mr. Izzo.

Out at the Westinghouse facility, upon doing a thorough study of their coating lines, and upgrading them, to take advantage of approved coatings and application equipment, they realized a \$200,000 savings in one year.

As a small object lesson, let us look at a hypothetical transformer that to be coated would require one gallon of 100% solids paint. If you reduce the solids level to 50%, you would now require two gallons of paint, and one gallon of solvent, and consequently, your transfer efficiency drops off 50%, explained Mr. Izzo. When you figure the additional coatings loss, solvent required, and other incidentals, the additional costs incurred with the lower solids paint becomes dramatic. Westinghouse feels that even if the Federal Government had not begun its push on solvent emission reductions, the economic factor alone would force customers to seek more efficient coatings. Increasing transfer efficiency is a job which required individuals and companies to examine all aspects of the coating operation.

Q. What criteria does Westinghouse use when and if they plan to renovate an existing paint line?

A. Return on investment is of course quite important, but the object to be painted is also of great importance. Our company would take these two points into consideration along with what the customer expected from the paint system on the product he was buying, and then determine the best way to paint it. From there we would attempt to see if the existing line could be modified to meet that criteria, and then attempt to arrive at a decision based on all factors involved.

Q. You stressed moving to high solids coatings as much as possible, to improve transfer efficiencies. But on some substrates, can't high absorbency present a problem with these high solids paints, and actually cause them to become inefficient?

A. Yes, this is true, because of some of the poor wetting characteristics of high solids.

Constituent Society Meetings and Secretaries

BALTIMORE (Third Thursday—Eudwood Gardens, Towson, MD; FRANK GERHARDT, Bruning Paint Co., 601 S. Haven St., Baltimore, MD 21224. Virginia Section—Fourth Wednesday, Ramada Inn-East, Williamsburg, VA).

BIRMINGHAM (First Thursday—Westbourne Suite, Botanical Gardens, Birmingham). D. H. CLEMENT, Holden Surface Ctg. Ltd., Bordesley Green Rd., Birmingham B9 4TQ England.

CHICAGO (First Monday—meeting sites in various suburban locations). MARTIN F. BALOW, United Coatings, Inc., 3050 N. Rockwell Ave., Chicago, IL 60618.

C-D-I-C (Second Monday—Sept., Jan., Apr., June in Columbus; Oct., Dec., Mar., May in Cincinnati; Nov., Feb., in Dayton). BILL M. HOLLIFIELD, Perry & Derrick Co., Inc., P.O. Box 12049, Cincinnati, OH 45212.

CLEVELAND (Third Tuesday—meeting sites vary). SCOTT E. RICKERT, Case Western Reserve University, Cleveland, OH 44106.

DALLAS (Thursday following second Wednesday—Executive Inn, near Lovefield Airport). VAN G. FALCONE, Koppers Co., 801 E. Lee St., Irving, TX 75060.

DETROIT (Fourth Tuesday—meeting sites vary). AL MOY, Glasurit America, Inc., P.O. Box 38009—Fenkell Station, Detroit, MI 48238.

GOLDEN GATE (Monday before third Wednesday—Alternate between Sabella's Restaurant on Fisherman's Wharf and Francesco's, Oakland, CA). SANDRA LUND, The O'Brien Corp., 450 E. Grand Ave., S. San Francisco, CA 94080.

HOUSTON (Second Wednesday—Sonny Look's, Houston, TX) ARTHUR McDERMOTT, Nalco Chemical Co. P.O. Box 87, Sugarland, TX 77478.

KANSAS CITY (Second Thursday—Cascone's Restaurant, Kansas City, MO). H. DENNIS MATHES, Olympic Stain Co., 1141 N.W. 50th, Seattle, WA 98107.

LOS ANGELES (Second Wednesday—Steven's Steak House, Commerce, CA). HENRY J. KIRSCH, Trans Western Chemicals, 7240 Crider Ave., Pico Rivera, CA 90660.

LOUISVILLE (Third Wednesday—Breckinridge Inn, Louisville, KY). JOYCE SPECHT, Porter Paint Co., 400 S. 13th St., Louisville, KY 40203.

MEXICO (Fourth Thursday—meeting sites vary). GEORGE CARRINGTON, Nuodex Mexicana, S.A., Av. de las Granjas 536, 02020 Mexico, D.F., Mexico.

MONTREAL (First Wednesday—Bill Wong's Restaurant). JEAN BRUNET, Van Waters & Rogers Ltd., 2700 Jean Baptist Deschamps, Lachine, Que., Can., H8T 1E1.

NEW ENGLAND (Third Thursday—Hillcrest Function Facilities, Waltham). MAUREEN M. LEIN, Raffi & Swanson, Inc., 100 Eames St., Wilmington, MA 01887.

NEW YORK (Second Tuesday—Landmark II, East Rutherford, NJ). RAYMOND P. GANGI, Woolsey Marine, 183 Lorraine St., Brooklyn, NY 11231.

NORTHWESTERN (Tuesday after first Monday—Tax Cafe, Minneapolis, MN). ALFRED F. YOKUBONIS, Celanese Specialty Resins, 5008 W. 99th St., Bloomington, MN 55437.

PACIFIC NORTHWEST (Portland Section—Tuesday following second Wednesday; Seattle Section—the day after Portland; British Columbia Section—the day after Seattle). GERALD MCKNIGHT, Rodda Paint Co., 6932 S.W. Macadam Ave., Portland, OR 97219.

PHILADELPHIA (Second Thursday—Dugan's Restaurant). ROBERT L. TOZER, Delkote, Div. of Lilly Ind. Coatings, Inc., 76 S. Virginia Ave., Penns Grove, NJ 08069.

PIEDMONT (Third Wednesday—Howard Johnson's, Brentwood exit of I-85, High Point, NC.) MICHAEL DAVIS, Paint Products Co., Inc., P.O. Box 648, Walkertown, NC 27051.

PITTSBURGH (First Monday—Skibo Hall, Carnegie Mellon Univ.). JOSEPH MASCIA, Campbell Chemical Co., P.O. Box 11182, Pittsburgh, PA 15237.

ROCKY MOUNTAIN (Monday following first Wednesday—Bernard's, Arvada, CO). CARWIN BEARDALL, Howells, Inc., 4285 S. State St., Salt Lake City, UT 84107.

ST. LOUIS (Third Tuesday—Salad Bowl Restaurant). CHARLES L. GRUBBS, Rockford Coatings Corp., 1825 Ave. H, St. Louis, MO 63125.

SOUTHERN (Gulf Coast Section—Various Dates; Central Florida Section—Third Thursday after first Monday; Atlanta Section—Third Thursday; Memphis Section—Second Tuesday; Miami Section—Tuesday prior to Central Florida Section). S.G. SANFILIPPO, Reichhold Chemicals, Inc., Technical Services Lab., P.O. Box 1610, Tuscaloosa, LA 35401.

TORONTO (Second Monday—Cambridge Motor Hotel). GORDON MAJOR, Mactac Canada Ltd., 100 Kennedy Rd., S., Brampton, Ont., Can., L6W 3E8.

WESTERN NEW YORK (Third Tuesday—The Red Mill, Clarence, NY). CHARLES C. TABBI, Spencer-Kellogg Div., Textron, Inc., P.O. Box 210, Buffalo, NY 14225.

Q. You mentioned that four different Westinghouse plants were using four different application coating systems. Why is this?

A. Each plant has its own specific set of conditions and requirements and consequently, the choice of coating and application systems was mainly controlled by each plant's particular situation.

JOSEPH L. MASCIA, *Secretary*

WESTERN NEW YORK . . . DEC.

"Dispersion of Carbon Black"

James Joudrey, of Columbian Pigments, discussed "DISPERSION OF CARBON BLACK IN COATINGS SYSTEMS."

The parameters of particle size, surface area, structure (clusters of chains), physical form, and their effect on tinting strength, masstone or blackness, system viscosity, cost, dispersion, time, and energy (shear) requirements were discussed.

Mr. Joudrey noted that carbon blacks are classified into low, medium, and high color categories. Low color blacks are coarse particles, 44-70 manometers NM, used for low cost coatings where blackness is not a major factor. Medium color blacks, 23-43 NM, are utilized in general purpose maintenance and utility finishes, explained Mr. Joudrey. High color carbon blacks, 13-22 NM, are used for high quality automotive and appliance coatings, where blackness and gloss are the main requirements.

The need for the right dispersion equipment when using a particular particle size was stressed. For instance, beaded black is best dispersed in a steel ball mill, while powdered black disperses best in a sandmill. Mr. Joudrey explained that for any type mill, a proper viscosity is required. This viscosity varies depending on the equipment used.

Mr. Joudrey explained that dispersion is more than getting a 7-8 Hegmann. It is determined by the stability of the final paint. Dispersion can be further evaluated using particle size analysis, sedimentation behavior, flow characteristic changes, optical properties, and even, dielectric properties.

Wetting agents to aid dispersion were discussed. Specific ones for H₂O and solvent systems were mentioned.

Mr. Joudrey explained the importance for the coatings chemist to select the right carbon black based on blackness, desired tint levels, available dispersion equipment, and vehicle compatibility.

CHARLES TABBI, *Secretary*

Future Society Meetings

Baltimore

(Apr. 19)—TECHNICAL STEERING COMMITTEE PROGRAM.

(May 17)—ANNUAL BUSINESS MEETING AND ELECTION OF OFFICERS.

(June)—JOINT OUTING WITH BPCA.

Birmingham

(Apr. 5)—"SATURATED POLYESTER DEVELOPMENTS FOR THE INDUSTRIAL PAINT INDUSTRY"—B. Langdon, Dynomit U.K. Ltd.

(May 3)—"Trends in Automotive Finishes"—R. Hurn, Ford Motor Co. Ltd.

C-D-I-C

(Apr. 9)—"COATINGS DEFECTS—CAUSES AND ANALYSIS"—Dr. Clifford Schoff, PPG Industries, Inc.

Chicago

(Apr. 2)—"COLLOIDAL SILICA—A UNIQUE PIGMENT"—R. Thornton, Nalco Chemical Co. "ROLE OF ADDITIVES IN THE '80's"—E. Antonucci, Drew Chemical Co.

(Apr. 27)—AWARDS NIGHT.

Cleveland

(Apr. 16)—"WATER-BORNE MAINTENANCE COATINGS"—Speaker from Spencer-Kellogg Div., Textron, Inc.

(May 21)—Annual Meeting/Spouses' Night. "PAINT EXAMINATION TECHNIQUES UTILIZED IN THE FBI LABORATORY"—James E. Corby, Federal Bureau of Investigation.

Detroit

(May 15)—Joint Meeting with DPCA.

Golden Gate

(Apr. 18)—"DISPERSION OF TiO₂"—V.R. Pedersen, Tioxide Canada, Inc.

(May 16)—"THE PROPER SOFTWARE FOR YOU"—L.S. Feldman, Sinclair Paint Co.

Houston

(Apr. 12-14)—Southwestern Paint Convention.

(May 9)—"CONTROL FOR THE MODERN PAINT PLANT"—James T. DeGroff, Applied Color Systems, Inc.

Kansas City

(Apr. 12)—"DISPOSAL OF HAZARDOUS COMBUSTIBLE WASTE"—Melvin C. Eifert and Joseph J. Durczynski, Systech Corp.

(June 8-9)—Joint Meeting of the Kansas City and St. Louis Societies.

Los Angeles

(Apr. 11)—MANUFACTURING SEMINAR/BOSSES' NIGHT. "DISPERSION OF TiO₂"—V.R. Pedersen, Tioxide Canada, Inc.

(May 9)—AWARDS NIGHT. "THE PROPER SOFTWARE FOR YOU"—L.S. Feldman, Sinclair Paint Co.

(June 13)—ANNUAL MEETING/ELECTION OF OFFICERS. TECHNICAL COMMITTEE PROGRAM.

Montreal

(Apr. 4)—"A PRACTICAL APPROACH TO UNDERSTANDING EMULSIONS"—P.J. McDonald, Reichhold Chemicals, Inc.

(May 2)—MANUFACTURING COMMITTEE'S PRESENTATION.

New York

(Apr. 10)—Subject to be announced.
(May 8)—PAVAC NIGHT.

Pacific Northwest

(Apr. 19)—"DISPERSION OF TiO₂"—V.R. Pedersen, Tioxide Canada, Inc.

(May 17)—"THE PROPER SOFTWARE FOR YOU"—L.S. Feldman, Sinclair Paint Co.

Philadelphia

(Apr. 6)—AWARDS NIGHT.

(May 10)—Speaker from Cargill, Inc.

Piedmont

(Apr. 18)—"CURRENT USE AND TRENDS—ACCELERATED WEATHERING TESTS IN THE UNITED STATES"—R. Metsinger, Atlas Electric Devices Co.

(May 16)—"INERTING FOR SAFETY IN COATINGS PLANTS"—Kevin Donahue, Neutronics, Inc.

(June 20)—"COMPOSITE VS. SINGLE DISPERSANT IN COLORANTS AND COATINGS"—Elio Cohen, Daniel Products Co.

Pittsburgh

(Apr. 2)—"EFFECT OF SURFACE TENSION AND VISCOSITY ON SURFACE DEFECTS IN COATINGS"—Cliff Schoff, PPG Industries, Inc.

(May 7)—"INS AND OUTS OF TiO₂"—Richard Ensminger, NL Industries.

Rocky Mountain

(Apr. 11)—"DISPERSION OF TiO₂"—V.R. Pedersen, Tioxide Canada, Inc.

(May 9)—"THE PROPER SOFTWARE FOR YOU"—L.S. Feldman, Sinclair Paint Co.

St. Louis

(Apr. 17)—TEACHERS' NIGHT.

(May 15)—MANUFACTURING NIGHT.

**Seminar
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Producing Paint Efficiently,
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Helpful information on all aspects of paint production will be featured at this 1-1/2 day event. Included will be discussions of efficient, time-tested methodology, as well as insights into newer, innovative practices.

The manufacturing segment is probably the most fertile area for a paint company to effect cost savings and increase profitability. Coatings manufacture differs from many industries in that its raw materials generally account for 50% or more of the selling price of the finished product. It is, therefore, most important to use these materials efficiently in the production process.

Increasing productivity, saving time, and reducing waste will enable the manufacturer to offer his customers a better quality product. And better quality leads to increased sales!

Presentations will range from Production Planning, through Raw Materials Inventory Management, to Pigment Dispersion, Color Matching, Packaging and Shipping, Waste Management, Health and Safety, and Employee Selection and Motivation. The speakers will be experienced and knowledgeable coatings industry personnel who will offer practical, down-to-earth information on these and other elements of the paint manufacturing process.

Manufacturing executives, plant managers, production superintendents, foremen, warehouse and shipping personnel—as well as top company management—can benefit from participating in this update on paint production.

Registration fee is \$125 for FSCT members; \$155 for non-members. After May 1, registration fee is \$165 for everyone. The fee includes complete set of papers presented, continental breakfast, luncheon, coffee breaks, and bus transportation to the airport at conclusion of the Seminar.

Complete program information and registration/housing forms available on request.

Federation of Societies for Coatings Technology
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Elections

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GUNN, DAVID J.—Carr's Paints Ltd., Birmingham, England.

C-D-I-C

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ANDERSON, JON E.—Ashland Chemical Co., Columbus, OH.
AVERY, JOHN C.—Foy-Johnston, Inc., Cincinnati, OH.
BAUER, CHARLES P.—Ashland Petroleum Co., Ashland, KY.
FITZGERALD, LAWRENCE—PPG Industries, Inc., Delaware OH.
KRATZER, SAM—D&L Paint Co., Liberty, IN.
LU, ROGER C.—Foy-Johnston Inc., Cincinnati.
MONTAGUE, ROBERT A.—PPG Industries, Inc., Delaware.
OSER, STEVE L.—Fischer Industrial Coatings, Cincinnati.
PODLEWSKI, RAYMOND—D&L Paint Co., Liberty.
STADTFELD JR., JOSEPH R.—Hanna Chemical Coatings Co., Columbus.
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WALLACE, DAVID R.—PPG Industries, Inc., Delaware.
WHITLOCK, W.E.—Ashland Chemical Co., Columbus.
WOOCK, KEVIN LAWRENCE—Hanna Chemical Coatings Co., Columbus.
YOUNG, JR., CHARLES L.—PPG Industries, Inc., Delaware.

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ELLIGOTT, WILLIAM M.—Schabel Products, Medina, OH.
FRATTURELLI, ROBERT—NL Chemicals, Columbus, OH.
MORRIS, JACK P.—Reichhold Chemicals, West Chester, OH.
VAN DE RYT, JAMES R.—Chemcentral/Cincinnati, Cincinnati, OH.

Educator/Student

GHOSH, SUBRATA—Wright State University, Celina, OH.

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BENNETT, HAL—Atech Chemical Coatings, Toledo.
BROCKMILLER VERNE—Wyandotte Paint Products, Inc., Detroit.
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MAKSYMUK, STEPHEN—Wyandotte Paint Products, Inc., Troy.
MERRITT, WILLIAM—Wyandotte Paint Products, Inc., Troy.
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DECARY, RENE—SICO Inc., Outremont.
HAWRYSZCZUK, JOHN—International Lacquer Products, Ville D'Anjou, Que., Can.
HSU, W. ERNEST—Noranda Research Center, Pointe-Claire, Que., Can.
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RAFALSKI, DONNA—Ferox Coatings, Inc., Ville D'Anjou.
VEILLEUX, RENALD—Houlesmasse Inc., St. Hubert, Que., Can.

Associate

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Chicago Society to Sponsor Manufacturing Seminar, March 27-28

The Manufacturing Committee of the Chicago Society for Coatings Technology will sponsor its first seminar entitled, "84 Seminar on Manufacturing and Waste Management," March 27-28 at Carson Inn—Nordic Hills Conference Center, Itasca, IL.

Topics and speakers for the seminar include:

Tuesday, "Dispersing and Mixing"

"Theory of Attrition Milling"—Roy Nelson, Epworth Manufacturing Co.

"Theory and Practices of High Speed Dispersion"—James White, Myers Engineering.

"Theory and Application of Mixing"—Tom Walters, Mixing Equipment Co.

"Theory and Application of Color Matching"—Don Parker, Macbeth, Div. Kollmorgen Corp.

"Theory and Application of Straining"—Anthony Shucosky, Filter Rite Corp.

"Theory and Application of Filling"—Terrence P. Robert, Paxall-Thiele Equipment.

Los Angeles Society Announces Theme Of Manufacturing Seminar

The Manufacturing Committee of the Los Angeles Society for Coatings Technology has selected the theme, "How to Automate Your Plant—A Little at a Time," for its seminar to be held April 11, at Steven's Restaurant, Commerce, CA.

The program for the seminar is centered around the concept that paint manufacturing, a batch-type operation, cannot be fully automated, but specific operations within the total process can be automated. Seven speakers are scheduled to present talks on topics ranging from the broad overall concept to existing implementable-today technology.

Registration fee is \$30. On-site registration is \$40. Luncheon is included in these fees.

Additional information can be obtained from Chairperson Anne M. Probizanski, AMPRO Technologies, 3888 Commerce St., Riverside, CA 92507.

Wednesday, "Waste Management"

"Landfill and Transportation"—Mary Bauer, CECOS, International.

"Incineration"—Jerry Piper, Services Corp. of America.

"Secondary Fuel"—Robert P. Miner, Stauffer Chemical Co.

"Solvent Reclamation"—Anthony Bellavia, The Pfadler Co.

"Update and Overview of Regulations"—Robert Kuykendall, Illinois Environmental Protection Agency.

Fee for the seminar is \$100; fee for March 27 only, is \$80.

Members of the Manufacturing Committee include: Chairman—Marvin J. Tomberg, United States Gypsum Co.; Secretary—Phillip H. Goldblatt, PRA Laboratories, Inc.; M.S. Fujimoto, The Sherwin-Williams Co.; Sabi A. Samara, Rust-Oleum Corp.; Robert Ericsson, Rust-Oleum Corp.; and Audrey LeNoble, Carl Lechner, Inc.

For information, or to register, contact Audrey LeNoble, Carl Lechner, Inc., 601 Skokie Blvd., Northbrook, IL 60062. (312) 498-9766.

West Coast Finishing Conference To Be Held by AFP/SME

The Association for Finishing Processes (AFP/SME) of the Society of Manufacturing Engineers will sponsor the first Conference and Exposition for finishing and coating technologies on the West Coast, November 28-30. The Conference will be held at the Anaheim Marriott with the Exposition taking place at the nearby Anaheim Convention Center.

Called "FINSTRAT '84—Finishing Strategies for the Eighties," the event will focus on new improvement technologies critical to the finishing and coating industries of the West.

The Conference program will feature group discussions of advanced finishing technologies led by experts and industrial specialists. Recent breakthroughs in key finishing and coating areas with new generation techniques will be explored by

end users and manufacturers. This event will provide firms with advice from leading experts directed to specific needs.

The Exposition will feature demonstrations of new equipment and technology for surface preparation, cleaning, coating applications, curing, coating materials, materials handling, safety, pre-coated materials, quality control, and testing.

For further information on FINSTRAT '84, contact Donna Thiesen, Administrator, Association for Finishing Processes, One SME Dr., P.O. Box 930, Dearborn, MI, 48121.

New York Society Co-Sponsors Spring Coatings Course

The New York Society for Coatings Technology, in cooperation with the NYPCA, has sponsored "Rheology of Coatings" course this spring at Fairleigh Dickinson University, Rutherford, NJ.

The new, advanced course was designed for those who desire a better understanding of the physical principles and rheological behavior of coatings. It covers the topics of viscosity and viscometers, brushing, leveling, sagging and settling, dispersion of pigments, dispersion equipment, mill base letdown, flooding, floating, orange peel and foaming, and paint flow relationships.

Chicago Society To Sponsor 'Symco '84'

The Chicago Society for Coatings Technology will hold its 14th Annual Chicago Area Coatings Symposium, "Symco '84," on April 17-18 at Knickers Restaurant, Des Plaines, IL. Entitled, "Dawn of a New Beginning," the symposium will be devoted to trade sales and industrial coatings.

For additional information, contact Chairman Bob Becker, D.R. Fitzgerald Co., 4001 W. Devon, Suite 510, Chicago, IL 60646.

WPTG to Sponsor 24th Annual Symposium in D.C.

The Washington Paint Technical Group will hold its 24th annual symposium at the Marriott Twin Bridges Motel, in Washington, D.C., April 2 and 3.

Featured as Keynote Speaker will be Dr. Marco Wismer, Vice-President, R&D, PPG Industries, Inc., who will speak on "Coatings Technology—A Look at the Future."

The program will also feature the following topics and speakers:

"Hydrocarbon Emission Control Program"—Elaine Sloan, Nalco Chemical Co.

"Non-Cellulosic Thickeners"—Charles Glancy, Union Carbide Corp.

"Corrosion Inhibiting Pigments"—Rolf Odenthal, Mobay Chemical Co.

"Elastomer Modified Epoxy Coatings"—Ralph Drake, B.F. Goodrich.

"Polymer Beads as Pigment in Naval Coatings"—Charles Hegedus, Naval Air Development Center.

"Propylene Based Glycol Ethers and Acetates"—Mark Adamchuk, ARCO Chemical Co.

"Spin Coating and Other Coating Technologies"—Basil Washo, IBM Corp.

"Basic Chemistry and Process of Group Transfer Polymerization"—Carol A. Seneker, E.I. DuPont de Nemours & Co., Inc.

"Naval Coatings Programs"—Jean A. Montemarano, D.W. Taylor Naval Ship R&D Center.

A reception and banquet will be held April 2.

For further information, please contact the WPTG, P.O. Box 12025, Washington, D.C. 20005; or call, Hing Dear at (301)229-8300, or Ken Zacharias at (202) 462-6272.

CIC to Hold Protective Coatings Seminar

The Protective Coatings Division of the Chemical Institute of Canada (CIC) will hold its annual symposium on April 25, at Le Pavillon Hotel, in Montreal, and on April 26, at the Constellation Hotel, in Toronto.

"Curing in Coatings" will feature the following topics and speakers:

"An Overview of Cure Kinetics Methodology for the Characterization of Coatings"—Dr. T. Provder, Glidden Coatings and Resins Div., SCM Corp.

"Cross-Linking Reactions of Phenolics"—Dr. A. Rudin, University of Waterloo.

"Vitrification During Curing of Thermoset Resins"—Dr. I. Goldfarb, Wright-Patterson Air Force Base.

"Use of Organophosphate Co-Reactant Catalysts in High Solids Automotive Coatings"—Dr. M. Chattha, Ford Motor Co.

"Chemical Aspects of Cross-Linking Stoving Urethanes"—Dr. V. Mirgel, Bayer A.G., Leverkusen, West Germany.

Advance registration fee for CIC members is \$40; for non-members, \$45. On-site registration is \$50 for all participants.

Further information can be obtained by contacting: (For Montreal) Art Hagopian, C-I-L Paints, Inc., 6930 Clanranald Ave., Montreal, Que., H3X 2V1; (For Toronto) Al Green, Glidden Co., 351 Wallace Ave., Toronto, Ont., M6P 3N9.

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CALL FOR PAPERS

Fourth World Congress
On

"Coatings Systems for Bridges and Steel Structures"
November 7-8
St. Louis, MO

The University of Missouri-Rolla announces a call for papers for the Fourth World Congress on "Coatings Systems for Bridges and Steel Structures" to be held November 7-8, at the Breckenridge Concourse Hotel, St. Louis, MO.

The Congress will focus on methods, materials, and techniques for protection of exposed structural steel. In addition, a session is planned on the administrative aspects of a coatings program.

Papers are invited on the following topics: surface preparation, advances in coatings systems, coatings evaluations, application techniques, inspections, failure analysis, administering a coatings program, contracts and specifications, inspection, and the roles and interaction of members of a coatings program team. Related papers, not specified above, are welcome.

Abstracts of papers should be submitted to Dr. Lloyd Smith, Program Chairman, Materials Technology and Chemistry Div., HNR-40, Federal Highway Administration, 6300 Georgetown Pike, McLean, VA 22101. Authors of selected papers will be required to submit a complete manuscript by August 1.

For further information on the conference, contact Cynthia Sonewald, Congress Coordinator, Dept. of Chemistry, UMR, Rolla, MO 65401.

Bruning Paint Co., Baltimore, MD, has announced the appointment of **W. Thomas Cochran** to the position of Vice-President. He will continue with his present duties as General Manager of Southern Operations. Mr. Cochran joined Bruning in 1970 and most recently served as Technical Director. He is a past President of the Baltimore Society and was the recipient of the Society's Herman Shuger Award.



W.T. Cochran

Day-Glo Color Corp., Cleveland, OH, has announced the appointment of **Edward L. Kimmel** to Vice-President, Western Operations, with full responsibility for all activities of its subsidiary, Pacific Dispersions, Inc., Cudahy, CA. In addition, Mr. Kimmel will be responsible for all Day-Glo operations in the Western region. He previously served as Vice-President, Research & Development.

Robert DeLeon has been appointed General Manager of Trail Chemical Corp., El Monte, CA. Prior to his promotion, Mr. DeLeon served as Laboratory Manager. He is a Los Angeles Society member.

Commercial Coatings Corp., Miami, FL, has announced the promotion of **Jack E. Benham** to Vice-President. Mr. Benham joined Commercial Coatings in 1982 as Technical Director. He is a Past President of the Miami Section of the Southern Society for Coatings Technology, the FPCA, the Florida Institute of Chemists, and is Past National President of the National Association of Chemical Distributors.

Skeist Laboratories, Inc., Livingston, NJ, has announced the promotion of **Dr. Jerry Miron** to President and **Arnold Brief** to Vice-President. **Dr. Irving Skeist**, who founded the company in 1955, will continue as Chairman. Dr. Miron is a member of the New York Society.

Douglas Miller has retired from his position at The O'Brien Corp. as Vice-President of Fuller-O'Brien Paints trade sales for the Midwestern Region. He is presently working with the company as a consultant. In Mr. Miller's 30 years with O'Brien, he has served in many capacities, including field sales representative, sales promotion manager, and corporate director.



E.L. Kimmel

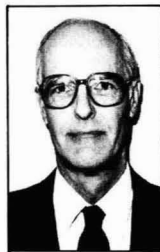
James C. Hunter has joined Hempel Technology Inc., Houston, TX, as a Senior Development Associate. Mr. Hunter, a 30-year veteran of the paint industry, was most recently associated with Napko Fuller-O'Brien Corp. He is a native of Edinburgh, Scotland and attended the University of Edinburgh and the University of Houston. Mr. Hunter is a Past-President of the Houston Society and has served in other capacities for the Society.

Jamestown Paint and Varnish Co., Jamestown, PA, has appointed **Andrew N. Figoli** as Technical Service Manager. Mr. Figoli was most recently associated with Continental Products Co. He is a member of the Cleveland Society.

Angus Chemical Co., Northbrook, IL, has promoted **Edward R. Kendall** to Worldwide Business Manager for basic nitroparaffins. Previously, Mr. Kendall served the firm as Market Manager for Solvents. He is a member of the Chicago Society.

Also announced by Angus was the promotion of **C. Joseph Fette** to Northern District Sales Manager. Mr. Fette was formerly associated with International Minerals & Chemical Corp., the former parent company of Angus, as Product Group Manager.

United Technologies' Inmont Corp., Clifton, NJ, has appointed **Leonard L. DeSantis** to the position of President and Chief Operating Officer. Mr. DeSantis joined Inmont from another UTC company, Pratt & Whitney, where he served as Senior Vice-President, Customer Requirements and Support of the Government Products Div.



J.C. Hunter



C.W. Fuller

Reichard-Coulston, Inc., Bethlehem, PA, has appointed **Carl W. Fuller** as Director of Technical Services. Mr. Fuller is a Past-President of the Philadelphia Society and currently serves as Society Representative and Federation Board Member. He is also involved in the American Society for Testing Materials and the Steel Structures Painting Council.

Witco Chemical Corp. has appointed **Kenneth N. Taylor** as Manager of R&D Services for its corporate technical center in Oakland, NJ. Mr. Taylor succeeds **Dr. Bernard R. Bluestein** who has been named Vice-President for R&D at Witco's Allied-Kelite Div.

J. Robert Desjardins has been named President of Devoe and Reynolds Co., a division of Grow Group, Inc. Mr. Desjardins joined Devoe and Reynolds, located in Louisville, KY, in 1980 as Executive Vice-President of the Trade Sales Group. He is Chairman of the Trade Sales Steering Committee of the National Paint and Coatings Association and is Vice-President and a Director of the LPCA.

A. Marshall Jones III has joined the sales staff of Van Horn, Metz & Co., Inc., Conshohocken, PA. He will be responsible for sales in eastern Pennsylvania and southern New Jersey.

James D. Long has been appointed to the position of Technical Sales Representative for the Industrial Coatings Div. of H.B. Fuller Co., St. Paul, MN. In this position, Mr. Long is responsible for sales and customer service for the firm's coatings in the upper Midwest. Mr. Long was previously associated with Nissen/Universal Corp., Cedar Rapids, IA.



Elias Singer (center) accepts congratulations from Frank Borrelle on his 50th anniversary in the coatings industry, while John Oates, a Troy colleague, looks on

Elias Singer, Founder and Chief Executive for 28 years of Troy Chemical Corp., Newark, NJ, was honored recently on occasion of his Fiftieth Anniversary of service to the paint and coatings industry.

Hosted by Troy, the testimonial dinner was attended by 125 of Mr. Singer's industry friends and colleagues, and featured a tribute by Troy's President, **Scott Gonge**.

Three of Mr. Singer's long term associates, **Bill Singer**, **Milt Nowak**, and **John Oates**, conducted a program termed, "This is Your Life, Elias Singer," which detailed his career using reminiscences by many of the guests in attendance.

Among those paying tribute were **Sid Lauren**, Executive Director of Coatings Research Group, Inc., who spoke of Mr. Singer's active involvement in industry education; **Frank Borrelle**, Executive Vice-President of the FSCT, who praised him for his long time support of the Paint Industries' Show, the New York Society, and the Federation; and **Ed Rabon**, of Charles Wagner Co., who spoke on behalf of Troy's manufacturers' representative organization.

Mr. Singer was presented with both a gift from his many Troy colleagues and a bound copy of photographs and letters of congratulations and tribute from his friends.

Joseph A. Budash, former Vice-President of Research and Development for Scott Paint Corp., Sarasota, FL, has joined Anvil Paint and Coatings, Inc., Largo, FL. A veteran in the coatings industry for more than 20 years, Mr. Budash is a member of the Southern Society and has served as Section Chairman and Technical Committee Chairman.

Sidney B. Levinson, Chairman and CEO of D/L Laboratories, Inc., New York City, has retired, effective January. He will remain active in the industry, however, and has formed a consulting organization, SIDLEV Associates. He will also assist D/L Laboratories on a part-time basis.



Mr. Levinson, a graduate chemist and chemical engineer, started his career in the paint and coating industry 50 years ago. Before his association with D/L Laboratories, he spent 10 years as a consulting chemist, six years as Vice-President and Technical Director of a resin manufacturing plant, and four years as Technical Director and Plant Engineer of a paint manufacturing plant. Over 30 years ago, he became Technical Director of D. H. Litter Co., sales agents to the industry. A year later, its consulting division, David Litter Laboratories, was formed. Mr. Levinson became its Technical Director and subsequently its President. About five years ago the name was changed to D/L Laboratories.

During his many years of service, Mr. Levinson has been active in all phases of paint and coatings technology. His services have included industry and market surveys, formulation, supervision of testing, and evaluation of all types of paints and coatings, including certification of specification products. He also has prepared manuals and specifications, trained personnel, and provided legal assistance. Some of his most interesting experiences have been the investigation of coating failures in locations such as water tunnels, power plants, LNG ships, over-water highway bridges, and waste treatment plants.

One result of his experience has been the presentation of over 60 talks, over 30 articles, chapters in five books, and a major manual used by the Army, Navy, and Air Force.

Mr. Levinson has been active in many industry associations. He is a member of ACS, ASTM, NACE, SSPC, the New York Society, and FSCT. In ASIM, he has chaired three subcommittees and served as a Committee Chairman for the maximum permissible time of six years. In the New York Society, he chaired seven committees, including its Technical Committee, and has held every office including the Presidency. In the Federation, he has acted as delegate to the Society of Plastics Engineers, the Scientific Committee of NPCA, and the Steel Structures Painting Council. As a result of these activities, Mr. Levinson has received the PaVaC award from the New York Paint Society, and Honorary Mem-

bership in both ASTM and its Committee D-1 on Paints and Related Coatings and Materials. For over 20 years, he also has been an active member of the Scientific Committee of the National Paint and Coatings Association.

Mr. Levinson is a Corrosion Specialist certified by NACE and is a Professional Engineer in Corrosion.

SIDLEV Associates is located at P.O. Box 507, Cranbury, NJ, 08512, telephone 609/655-4695.

Ruediger J. Erckel has been appointed Divisional Vice-President Research, Specialty Products Group, for American Hoechst Corp., Somerville, NJ. He succeeds **Dr. Willi R. Steckelberg**, who has returned to West Germany as head of research for Cassella AG, one of the Hoechst Group companies. Dr. Erckel had been serving Hoechst AG Central Staff department, in charge of corporate research coordination.

Also announced by American Hoechst was the appointment of **William E. Bartlett** as District Manager—Pigments, Midwest territory. Mr. Bartlett is based in Chicago, IL.

Obituary

William A. Weckback, Technical Director of Brod-Dugan Co., St. Louis, MO, died January 23. He was 68.

Mr. Weckback began his career with Phelan-Faust Paint Manufacturing Co. in 1934, upon graduation from high school. In 1977, he left Phelan, which was then a part of The Valspar Corp., to assume the duties of Technical Director of Brod-Dugan.

Garland (G.B.) Keith, 66, founder of MiniFIBERS, Inc., Weber City, VA, died November 29.

Mr. Keith, a registered professional engineer, began his career in 1946 with Tennessee Eastman Co. as a design engineer. He left TEC in 1967 to establish MiniFIBERS, a supplier of specialty cut fibers. MiniFIBERS' operations were established in Weber City and in Harri-man, TN.

Mr. Keith was a member of the Tennessee Society of Professional Engineers, the Technical Association of Pulp and Paper Industry, and the National Paint and Coatings Association.

Carbon Black Dispersions

Information on a series of flushed carbon black dispersions is available. The carbon blacks known as Beit 900 and Beit 950 are discussed as are their characteristics of high tint strength, high carbon content, and low viscosity. Advantages to producers of coatings for decorative, automotive, and industrial finishes are highlighted. Write Capricorn Chemicals Corp., Harmon Cove Towers, Secaucus, NJ 07094 for additional information.

Resins Systems

Resins systems, which allow formulators of epoxy coatings, primers, adhesives, and floorings to eliminate problems associated with the manufacture of curing agents, are the subject of new literature. Typical problems avoided with the use of these resins systems are featured as are cost advantages. For information, write Henkel Corp., 7900 W. 78th St., Minneapolis, MN 55435.

GPC/SEC Column

Information is available detailing a gel permeation chromatography/size exclusion chromatography (GPC/SEC) column for molecular weight analysis. Features and applications uses of the column are described. For information, contact IBM Instruments, Inc., Dept. 25, P.O. Box 3020, Wallingford, CT 06492.

Emulsion

The first water-based emulsion to achieve high values in peel adhesion, tack, and shear resistance is featured in a recent publication. Described is a vinyl acetate copolymer designed specifically for high-performance, pressure-sensitive applications. For information, contact Air Products and Chemicals, Inc., Box 538, Allentown, PA, 18105.

Explosion-Proof Forklifts

Forklifts for use in industrial areas where flammable or explosive concentration of fumes or dust may exist are featured in new literature. Design and construction highlights are listed as are use applications and advantages. For information, contact Gregory, Inc., P.O. Box 906, 457 River Rd., Clifton, NJ 07014.

On-Line Color Control

The capabilities and use advantages of an on-line color measurement and control system developed for textiles, papers, plastics, and other continuous production processes are discussed in a new 12-page brochure. The four-color brochure describes and illustrates the use of the system to analyze and respond to changing color conditions without disrupting production operations. Listed benefits for users include: increased color accuracy and consistency, reduced correction time and rework, greater throughput and production efficiency, and availability of a meaningful color communications tool for operators. Also discussed are alternative installation designs which depend upon the type of process, and standard software packages. Copies of the literature are available from Macbeth, P.O. Box 950, Newburgh, NY 12550.

Coatings

A guide to a line of coatings for corrosion protection is now available. The brochure describes coatings that protect fasteners against corrosion, oxidation, thermal shock, high temperature, and dissimilar metal and lubricity problems. Copies of the guide can be obtained from Sermatech Materials Div., 155 S. Limerick Rd., Limerick, PA 19486.

Thickness Gauge

Information is available on a portable, digital electronic thickness gauge which provides rapid measurements of all non-magnetic coatings on steel. Operational techniques, features, and accuracy data of the thickness gauge are discussed. For literature, write Elektro-Physik Inc., 1129 Independence Blvd., Virginia Beach, VA 23455.

Mills

Literature is available featuring mills which are specially-designed to produce extremely high quality pigment dispersions for paints, coatings, and inks. Discussed are how these mills produce uniformly-narrow pigment particle size distribution, which greatly improve transparency, jetness (for black), gloss, and color strength. For additional information, write Netzsch Inc., 119 Pickering Way, Exton, PA 19341.

Dimer and Polybasic Acids

A new 20-page booklet on Empol^R dimer and higher polybasic acids has been published. The literature is intended to serve as a guide to the selection of Empol dimer and higher polybasic acids from among the nine currently being produced. Described are these acids, their properties, and applications. Also included are comparison data and analytical procedures. Contact Emery Industries, 1300 Carew Tower, Cincinnati, OH 45202 for additional information.

High Solids Alkyd

A high solid short oil alkyd resin for use by coatings manufacturers in formulating VOC-compliant industrial finishes is covered in a recently issued bulletin. Described is Beckosol^R synthetic resin solution 12-607, which exhibits the good hardness, mar resistance, adhesion, flexibility, and exterior durability normally associated with standard short oil alkyds. Included in the literature are specifications, typical reduction curves and a bar graph showing the effects of solvents on viscosity and stability of Beckosol 12-607-based vehicles. The bulletin is available from Reichhold Chemicals, Inc., 525 N. Broadway, White Plains, NY 10603.

Production/Inventory Control System

An automated processing and record-keeping system for paints, pigments, dyes, coatings, and other made-by-formula products has been introduced in recently published literature. The production/inventory control system, which is an on-line, real-time, mini-computer-based software package that automates the manufacture of all made-by formula products, is detailed as are its use advantages. For literature, contact Parallax Computer Corp., 3490 Rt. 1 Bldg. 19-1, Princeton, NJ 08540.

Viscometers and Rheometers

A new 24-page, full-color catalog is available detailing a line of viscometers, consistometers, and related rheological instrumentation for industrial, commercial, scientific, and academic applications. Contact Fann Instruments, Dresser Industries, Inc., Box 42111, Houston, TX 77242.

Thickness Gauge

A new concept for measuring anodic or organic coatings on aluminum or copper is the subject of recent literature. A thickness gauge which can be customized for any specific substrate metal, is simple to operate, and does not require calibration is featured. Design features and application uses of the gauge are detailed. For information, contact KTA-Tator, Inc., 115 Technology Dr., Pittsburg, PA 15275.

Surface Profile Projector

Literature is available introducing a new surface profile projector that attaches to D-series and S-series stereo microscopes for use in obtaining fast, easy, and precise measurements of surface topographies and textures. Application uses and advantages of the surface profile projector are highlighted. For information, contact Carl Zeiss, Inc., Scientific Instruments Div., One Zeiss Dr., Thornwood, NY 10594.

Coatings

A new full-color brochure is available which catalogs a complete line of coatings designed specifically for the business machine industry. Entitled, "Finish Ahead of the Rest," the brochure details a variety of finishing options for metal and plastic computer cabinetry and ancillary systems which include polyurethanes, water-reducibles, high solids enamels, and electronic shielding material. Quality and performance features of the coatings are also specified. For a copy of the literature, contact G.L. Holmberg, Chemical Coatings Div., The Sherwin-Williams Co., 11541 S. Champlain Ave., Chicago, IL 60628.

Water-Soluble Propellant

Dimethyl ether (DME), a cost-effective alternate to hydrocarbon propellants used by the aerosol industry, is featured in recent literature. Described is how DME, a water-soluble propellant, provides numerous benefits such as good vapor pressure, excellent solubility, and improved safety. Application uses of DME for paints, industrial products, and automotive products are listed. For additional information, write Air Products and Chemicals, Inc., Box 538, Allentown, PA 18105.

Agents

Two epoxy-based flexibilizing agents, developed specifically for UV-curable epoxy coatings, have been introduced in new literature. Use of the new flexibilizers with cycloaliphatic epoxide resins is discussed. Applications and recommended uses are listed. Further information can be obtained from Union Carbide Corp., Specialty Polymers and Composites Div., Dept. M1553, Danbury, CT 06817.

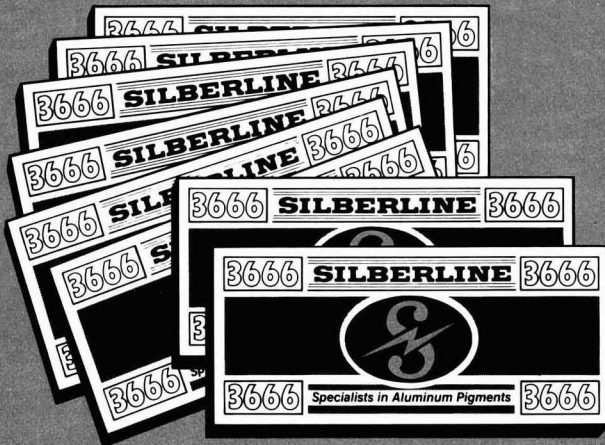
Water-Reducible Coatings Resins

Water-reducible resins and emulsions for industrial primers and enamels are featured in a new bulletin. Brief descriptions of the applications for 14 different water-reducible coatings resins are included. The literature is available from Reichhold Chemicals, Inc., 525 N. Broadway, White Plains, NY 10603.

Iridescent Pigments

Hi-lite iridescent pigments which provide color-play along with pearly luster are introduced in new literature. Application uses of the pigments for surface coatings, inks, and plastics are listed. Additional information is available from The Mearl Corp., 41 E. 42nd St., New York, NY 10017.

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Coming Events

FEDERATION MEETINGS

(May 15-18)—Federation "Spring Week." Manufacturing Seminar on 15th and 16th; Society Officers on 17th; and Board of Directors on 18th. Galt House, Louisville, KY. (FSCT, 1315 Walnut St., Philadelphia, PA 19107).

(Oct. 24-26)—62nd Annual Meeting and 49th Paint Industries' Show. Conrad Hilton Hotel, Chicago, IL. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, PA 19107).

1985

(May 14-17)—Federation "Spring Week." Seminar on 14th and 15th; Society Officers on 16th; and Board of Directors on 17th. Hilton Hotel, Baltimore, MD. (FSCT, 1315 Walnut St., Philadelphia, PA. 19107).

(Oct. 7-9)—63rd Annual Meeting and 50th Paint Industries' Show. Convention Center, St. Louis, MO. (FSCT, 1315 Walnut St., Philadelphia, PA 19107).

SPECIAL SOCIETY MEETINGS

(Apr. 10)—Annual FOCUS Symposium on "Dynamics of Automotive Color." Sponsored by Detroit Society, Detroit Color Council, and Inter-Society Color Council, Michigan Inn, Southfield, MI. (Dr. R.A. Rodrigues, E.I. Du Pont de Nemours & Co., Inc., 945 Stephenson Hwy., P.O. Box 2802, Troy, MI 48007).

(Apr. 11)—Los Angeles Society for Coatings Technology Manufacturing Committee's Seminar, "How to Automate Your Plant—A Little at a Time." Steven's Restaurant, Commerce, CA. (Chairperson Anne M. Probizanski, AMPRO Technologies, 3888 Commerce St., Riverside, CA 92507).

(Apr. 12-14)—Southwestern Paint Convention of Dallas and Houston Societies. Shamrock Hilton Hotel, Houston, TX. (John Pennington, Cron Chemical Corp., P.O. Box 14042, Houston, TX 77021).

(Apr. 17-18)—Chicago Society for Coatings Technology's 14th Annual Chicago Area Coatings Symposium, Symco '84, "Dawn of a New Beginning." Knickers Restaurant, Des Plaines, IL. (Chairman Bob Becker, D.R. Fitzgerald Co., 4001 W. Devon, Suite 510, Chicago, IL 60646).

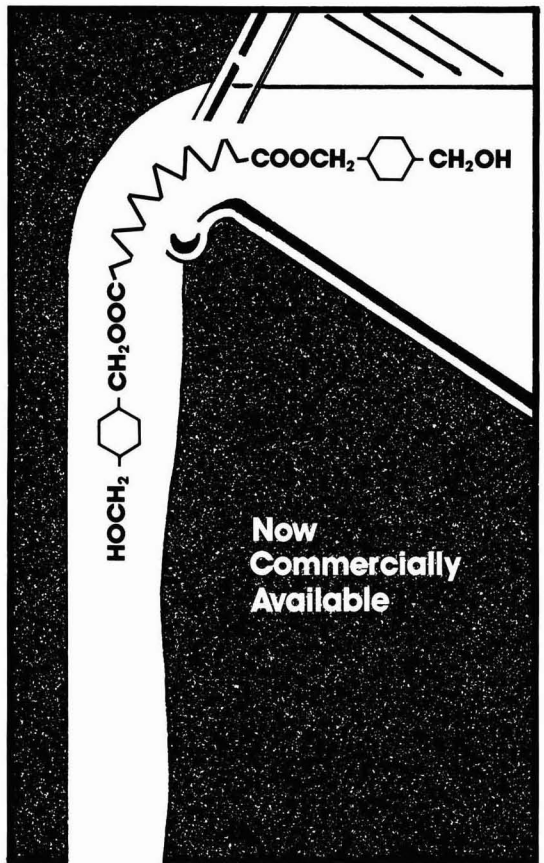
(Apr. 18)—"The Environment: Where We Are, And Where We're Going," Seminar sponsored by the Louisville Society for Coatings Technology and the LPCA. Marriott Inn, Clarksville, IN. (Joyce Specht, Porter Paint Co., Coatings Div., 400 S. 13th St., Louisville, KY 40203).

(May 3-5)—Pacific Northwest Society for Coatings Technology Symposium. Holiday Inn Crowne Plaza, Seattle, WA. (Robert Hogg, Preservative Paint Co., 5410 Airport Way S., Seattle, WA 98108).

(May 14)—Philadelphia Society for Coatings Technology's Seminar on "Anti-Corrosive Coatings." Airport Hilton Hotel, Philadelphia, PA.

(May 15-16)—Cleveland Society for Coatings Technology 27th Annual Technical Conference, "Advances in Coatings Technology." (Richard Eley, Glidden Coatings & Resins Div. SCM Corp., 16651 Sprague Rd., Strongsville, OH 44136).

(May 16-17)—"Coatings Tech Expo '84." 3rd Biennial Convention & Exposition sponsored by New England Society for Coatings Technology. Sheraton Inn & Conference Center, Boxborough, MA. (Dame Associates, Inc., 51 Church St., Boston, MA 02116).



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(June 8-9)—Joint Meeting of St. Louis and Kansas City Societies for Coatings Technology. Kansas City, MO.

(June 18)—Golden Gate Society for Coatings Technology's Manufacturing Committee Symposium on "Safety and Robotics." Sabella's, San Francisco, CA. (Louie Sanguinetti, Jasco Chemical Co., P.O. Drawer J. Mountain View, CA 94042).

1985

(Feb. 26-Mar. 1)—Western Coatings Societies Symposium and Show. Disneyland Hotel, Anaheim, CA.

(Apr. 25-27)—Pacific Northwest Society for Coatings Technology Symposium. Empress Hotel, Victoria, B.C. (Ottwin Schmidt, Helzer Canada Ltd., 8531 Cullen Crescent, Richmond, B.C., V6Y 2W9 Canada).

OTHER ORGANIZATIONS

(Apr. 2-3)—24th Annual Symposium of the Washington Paint Technical Group. Marriott Twin Bridges Hotel, Washington, DC. (WPTG, P.O. Box 12025, Washington, DC 20005).

(Apr. 2-5)—CORROSION 84, NACE Materials Performance and Corrosion Show. Rivergate Exposition Center, New Orleans, LA. (National Association of Corrosion Engineers, P.O. Box 218340, Houston, TX 77218).

(Apr. 2-6)—"Introduction to Paint Formulation" Short Course. University of Missouri-Rolla, Rolla, MO. (Cindy Sonewald, Dept. of Chemistry, UMR, Rolla, MO 65401).

(Apr. 4-11)—"Surface Treatment Exhibition" at the 1984 Hannover Fair, Hannover, West Germany. (Hannover Fairs Information Center, P.O. Box 338, Rt. 22 E., Whitehouse, NJ 08888).

(Apr. 8-10)—Inter-Society Color Council Annual Meeting. Michigan Inn, Southfield, MI. (Fred W. Billmeyer, Dept. of Chemistry, Rensselaer Polytechnic Institute, Troy, NY 12181).

(Apr. 9-10)—"Advanced Paint Formulation—Trade Sales" Short Course. University of Missouri-Rolla, Rolla, MO. (Cindy Sonewald, Dept. of Chemistry, UMR, Rolla, MO 65401).

(Apr. 12-13)—"Electrochemical Test Methods of the Protecting Properties of Metals Coatings" Meeting. Genoa University, Genoa, Italy. (Prof. P.L. Bonora, Istituto di Chimica, Fac. Ingegneria—Fiera del Mare Pad. D1 16129 Genoa, Italy).

(Apr. 12-15)—"FARBE 84". Munich Trade Fair Centre, Munich, West Germany. (Kallman Associates, Five Maple Court, Ridgewood, NJ 07450).

(Apr. 24-25)—Electrocoat/84 Conference, sponsored by *Products Finishing Magazine*. Drawbridge Inn, Cincinnati, OH. (Anne Porter, Products Finishing, 6600 Clough Pike, Cincinnati, OH 45244).

(Apr. 25-26)—Protective Coatings Div. of Chemical Institute of Canada Symposium on "Curing in Coatings." 25th in Montreal; 26th in Toronto. (Dr. K.G. Rutherford, University of Windsor, Windsor, Ont. N9B 3P4).

(Apr. 29-May 2)—"Opportunities in the Automotive Market" meeting sponsored by the National Coil Coaters Association. Rancho Las Palmas, Rancho Mirage, CA. (NCCA, 1900 Arch St., Philadelphia, PA 19103).

(Apr. 29-May 3)—75th Annual Meeting of the American Oil Chemists' Society, Fairmont Hotel, Dallas, TX. (AOCS, 508 S. Sixth St., Champaign, IL 61820).

(May 1-3)—Oil & Colour Chemists' Association's 35th Annual Exhibition. London, England. (R.H. Hamblin, OCCA, Priory House, 967 Harrow Rd., Wembley, Middlesex, HA0 2SF).

(May 1-4)—Painting and Decorating Contractors of America. 100th Anniversary Meeting. New York, NY.

(May 2-4)—"Vinylidene Chloride: A Monomer for the '80's" Symposium. Breckenridge Concourse Hotel, St. Louis, MO. (Cindy Sonewald, Chemistry Dept., University of Missouri-Rolla, Rolla, MO 65401).

(May 7-11)—Short Course on "Dispersion of Pigments and Resins in Fluid Media." Kent State University, Kent, OH. (Dr. Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, OH 44242).

(May 7-11)—Spray Painting Seminar. Binks Manufacturing Co., Franklin Park, IL. (Binks Manufacturing Co., Training Div., 9201 W. Belmont Ave., Franklin Park, IL 60131).

(May 16-18)—"Appearance Science Workshop." HunterLab, Reston, VA. (Ms. V. Baca, HunterLab, 11495 Sunset Hills Rd., Reston, VA 22090).

(May 20-23)—ASTM Annual Meeting. Queen Elizabeth Hotel, Montreal, Que., Canada. (ASTM, 1916 Race St., Philadelphia, PA. 19103)

(May 20-23)—ASTM Committee D-1 on Paint and Related Coatings & Materials. Montreal, Que., Canada. (ASTM, 1916 Race St., Philadelphia, PA 19103).

(May 21-25)—Short Course on "Adhesion Principles and Practice for Coatings and Polymer Scientists." Kent State University, Kent, OH. (Dr. Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, OH 44242).

(May 21-25)—Short Course on "Corrosion and Its Control by Protective Coatings." Lehigh University, Bethlehem, PA. (Prof. Henry Leidheiser, Jr., Sinclair Laboratory #7, Lehigh University, Bethlehem, PA 18015).

(May 22-24)—Chemical Coaters Association. "Surface Coating '84." Bloomington, MN. (Matt Huertz, Chemical Coaters Assn., Box 241, Wheaton, IL 60187).

(May 23)—ASTM Symposium on "Review and Evaluation of Appearance: Methods and Techniques" sponsored by Committee E-12. Queen Elizabeth Hotel, Montreal, Canada. (Symposium Chairman, J.J. Rennilson, Retro-Tech, P.O. Box 3103, La Mesa, CA 92041).

(June 4-8)—Short Course on "Advances in Emulsion Polymerization and Latex Technology." Lehigh University, Bethlehem, PA. (Dr. M.S. El-Aasser, Dept. of Chemical Engineering, Sinclair Lab #7, Lehigh University, Bethlehem, PA 18015).

(June 4-8)—Short Course on "Thermal and Rheological Characterization of Coatings and Polymers." Kent State University, Kent, OH. (Dr. Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, OH 44242).

(June 6-7)—"Color Technology for Management" course. Rochester Institute of Technology, Rochester, NY. (Brenda Reimherr, T&E Center Seminar Coordinator, Rochester Institute of Technology, One Lomb Memorial Dr., P.O. Box 9887, Rochester, NY 14623).

(June 10-13)—"58th Colloid and Surface Science Symposium." Carnegie-Mellon University, Pittsburgh, PA. (G.D. Parfitt, Chemical Engineering Dept., Carnegie-Mellon University, Pittsburgh, PA 15213).

(June 11-15)—"Principles of Color Technology" course. Rochester Institute of Technology, Rochester, NY. (Brenda Reimherr, T&E Center Seminar Coordinator, Rochester Institute of Technology, One Lomb Memorial Dr., P.O. Box 9887, Rochester, NY 14623).

(June 17-20)—Dry Color Manufacturers' Association's Annual Meeting. The Greenbrier, White Sulphur Springs, WV. (P.J. Lehr, DCMA, Suite 202, 206 N. Washington St., Alexandria, VA 22314).

(June 18-22)—"Principles of Color Technology" course. Rochester Institute of Technology, Rochester, NY. (Brenda Reimherr, T&E Center Seminar Coordinator, Rochester Institute of Technology, One Lomb Memorial Dr., P.O. Box 9887, Rochester, NY 14623).

(June 25-29)—"Advances in Color Technology" course. Rochester Institute of Technology, Rochester, NY. (Brenda Reimherr, T&E Center Seminar Coordinator, Rochester Institute of Technology, One Lomb Memorial Dr., P.O. Box 9887, Rochester, NY 14623).

(July 9-13)—10th International Conference on "Organic Coatings Science & Technology." Athens, Greece. (Prof. Angelos V. Patsis, Director, Materials Research Lab., CSB 209, State University of New York, New Paltz, NY 12561).

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(July 31-Aug. 2)—"International Symposium on the Analysis and Identification of Polymers." Forensic Science Research and Training Center, Quantico, VA. (K.W. Nimnich, Symposium Coordinator, Forensic Science Research and Training Center, Bldg. 12, Rm. 212, FBI Academy, Quantico, VA 22135).

(Aug. 13-17)—Short Course on "Physics and Chemistry of Printing Inks." Davos, Switzerland. (Dr. M.S. El-Aasser, Dept. of Chemical Engineering, Sinclair Lab #7, Lehigh University, Bethlehem, PA 18015).

(Sept.)—"Maintenance Painting of Industrial Plants" Symposium sponsored by the Steel Structures Painting Council. Pittsburgh, PA. (SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213).

(Sept. 13-15)—Oil and Colour Chemists Association Australia. 26th Convention. Mandurah, Western Australia. (Grant McManus, P.O. Box 490, Cloverdale, Western Australia 6015).

(Sept. 22-25)—Canadian Paint and Coatings Association. Annual Convention. Westin Hotel, Winnipeg, Man., Canada. (CPCA, 515 St. Catherine St. W., Montreal, Que. H3B 1B4, Canada).

(Sept. 23-26)—American Oil Chemists' Society Short Course on Fatty Acids. Kings Island, OH. (AOCS, 508 S. Sixth St., Champaign, IL 61820).

(Sept. 23-28)—XVIIth Congress of FATIPEC (Federation of Associations of Technicians in the Paint, Varnish, Lacquer and Printing Ink Industries of Continental Europe). Lugano, Switzerland. (C. Bourgery, Secretary General, FATIPEC, Maison de la Chimie, 28 Rue St.-Dominique, 75 Paris (7), France).

(Oct. 8-12)—Spray Painting Seminar. Binks Manufacturing Co., Atlanta, GA. (Binks Manufacturing Co., Training Div., 9201 W. Belmont Ave., Franklin Park, IL 60131).

(Oct. 22-24)—National Paint & Coatings Association 97th Annual Meeting. Palmer House, Chicago, IL. (Karen Bradley, NPCA, 1500 Rhode Island Ave., N.W., Washington, DC 20005).

(Oct. 23-26)—Fall Technical Meeting of the National Coil Coaters Association. Hyatt Regency O'Hare Hotel, Chicago, IL. (NCCA, 1900 Arch St., Philadelphia, PA 19103).

(Nov. 7-8)—4th World Congress on "Coatings Systems for Bridges and Steel Structures." Breckenridge Concourse Hotel, St. Louis, MO. (Cindy Sonewald, University of Missouri-Rolla, Dept. of Chemistry, Rolla, MO 65401).

(Nov. 16-17)—37th National Decorating Products Show. McCormick Place, Chicago, IL. (NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132).

(Nov. 28-30)—FINSTRAT '84, Conference and Exposition on Finishing Strategies for the 80's. Marriott Hotel and Anaheim Convention Center, Anaheim, CA. (Association for Finishing Processes of SME, One SME Dr., P.O. Box 930, Dearborn, MI 48128).

(Dec. 3-7)—Spray Painting Seminar. Binks Manufacturing Co., Franklin Park, IL. (Binks Manufacturing Co., Training Div., 9201 W. Belmont Ave., Franklin Park, IL 60131).

(Dec. 16-21)—1984 International Chemical Congress of Pacific Basin Societies. Honolulu, Hawaii. (PAC CHEM '84, Meetings and Divisional Activities, American Chemical Society, 1155 Sixteenth St., N.W., Washington, DC 20036).

1985

(Mar. 25-27)—"Electrochemical Techniques for Corrosion" Symposium to be held during CORROSION/85, sponsored by the National Association of Corrosion Engineers. Boston, MA. (Symposium Chairman, Robert Baboian, Texas Instruments, Inc., Mail Station 10-13, Attleboro, MA 02703).

(June 26-29)—Oil & Colour Chemists' Association's Biennial Conference. Edinburgh, Scotland. (R.H. Hamblin, OCCA, Priory House, 967 Harrow Rd., Wembley, Middlesex, HA0 2SF).

(Sept. 2-4)—Federation of Scandinavian Paint and Varnish Technologists. 11th Congress. SAS Hotel Scandinavia, Oslo, Norway. (Paal Ivan, Nodest Industries A/S, Boks 500, N-3001 Drammen, Norway).

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'Humbug' from Hillman

This month's "Humbug" features items sent in by Mike Malaga, Maureen Lein, and Joe Vasta. Keep 'em coming. Contributions to the column should be sent to me at Humbug's Nest, Box 135, Whitingham, VT 05361.

My rotten filing system occasionally comes up with lost but not forgotten gems. Mike Malaga, our past Federation President, sent me the following some time ago. It came to light as I was searching through my "R" file. In my file—that's absolutely logical. Even though Mike did not send me a denial of personal involvement in the letter, I have to assume it came from some remote source.

Dear Son:

Just a few lines to let you know that I'm still alive. I'm writing this letter slowly because I know that you cannot read fast. You won't know the house when you come home . . . we've moved.

About your father . . . he has a lovely new job. He has 500 men under him. He is cutting the grass at the cemetery.

There was a washing machine in the new house when we moved in, but it isn't working too good. Last week I put 14 shirts into it, pulled the chain, and I haven't seen the shirts since.

Your sister Mary had a baby this morning. I haven't found out whether it is a boy or girl, so I don't know whether you're an aunt or uncle.

Your Uncle Dick drowned last week in a vat of whiskey in Dublin Brewery. Some of his workmates dived in to save him, but he fought them off bravely. We cremated his body, and it took three days to put out the fire.

Your father didn't have much to drink at Christmas. I put a bottle of castorol in his pint of beer. It kept him going until New Year's Day. I went to the doctor on Thursday and your father came with me. The doctor put a small tube into my mouth and told me not to open it for ten minutes. Your father offered to buy it from him.

It only rained twice last week. First for 3 days, and then for 4 days. Monday it was so windy that one of our chickens laid the same egg four times.

We had a letter yesterday from the undertaker. He said if the last installment wasn't paid on your grandmother within 7 days, up she comes.

Your Loving mother,

P.S. I was going to send you \$10.00 but I had already sealed the envelope.

• • •

Maureen Lein sends us some little known but vital laws still on the books around the U.S.

This very important data comes from the *Farmers Almanac*—If you live in the area mentioned—be careful, friends, you don't know who's watching.

An old Riverside, California health ordinance does not allow two people to kiss each other on the lips until the two parties first clean their lips with carbolated rose water.

Indiana law does not allow a man to wear a mustache if he "habitually kisses human beings." (If you don't want to break the law, you have two options, I guess.)

An all but forgotten law in Owensboro, Kentucky states that if a woman wants to buy a new hat, her husband must try it on first. (That should cut down on hat sales alright.)

Orange County, New York has a law that forbids a man's looking at a girl "that way."

It's against the law in Abilene, Texas to whistle at a girl, and tickling a girl with a feather duster is illegal in Portland, Maine.

In Lebanon, Tennessee, a husband may not legally shove his wife out of bed, even if her feet are cold. On the other hand, the same law allows a wife to shove her husband out of bed at any time without a reason.

• • •

And sneaked to us via secret microfilm via Joe Vasta from spy Robert J. Truvela, of Gilbert Associates, we have the following document prepared for "F" troop by the Standards Approval Committee.

1. All pipe is to be made of a long hole, surrounded by metal centered around the hole.
2. All pipe is to be hollow throughout it's entire length.
3. All pipe is to be supplied with nothing in the hole so that water, steam or other stuff can be put in at a later date.
4. O. D. of all pipe must exceed the I. D., otherwise the hole will be on the outside.
5. Flanges must be used on some pipe. Flanges must have holes for bolts quite separate from the big hole in the middle.
6. If flanges are to be blank or blind, the big hole in the middle must be filled with metal.
7. All pipe is to be of very best quality, perfectly tubular or pipular.
8. All acid-proof pipe is to be made of acid-proof metal.
9. All pipe is to be supplied without rust, as this can be more readily applied at the jobsite.
10. All pipe is to be cleaned free of any covering such as mud, tar, barnacles or any form of manure before putting up, otherwise it will make lumps under the paint.
11. All pipe over 500 feet long must have the words "LONG PIPE" clearly painted on each end so the fitters will know that it is long pipe.
12. Pipe over two miles long must also have these words painted in the middle so the fitters will not have to walk the full length of the pipe to determine if it is long pipe or not.
13. All pipe over six inches in diameter is to have the words "LARGE PIPE" painted on it so the fitters will not use it for small pipe.
14. All pipe closers are to be open on one end.
15. All pipe fittings are to be made of the same stuff as the pipe.
16. No elbows are to be put on pipe unless specified. If you do, straight pipe becomes crooked pipe.
17. Elbows come in all sorts of shapes and sizes. Be sure to specify the direction you are going when ordering.

—Herb Hillman

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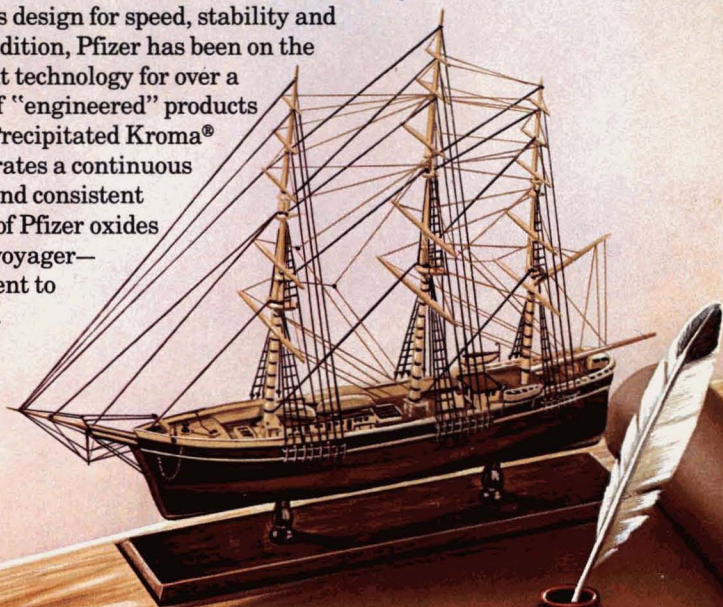
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