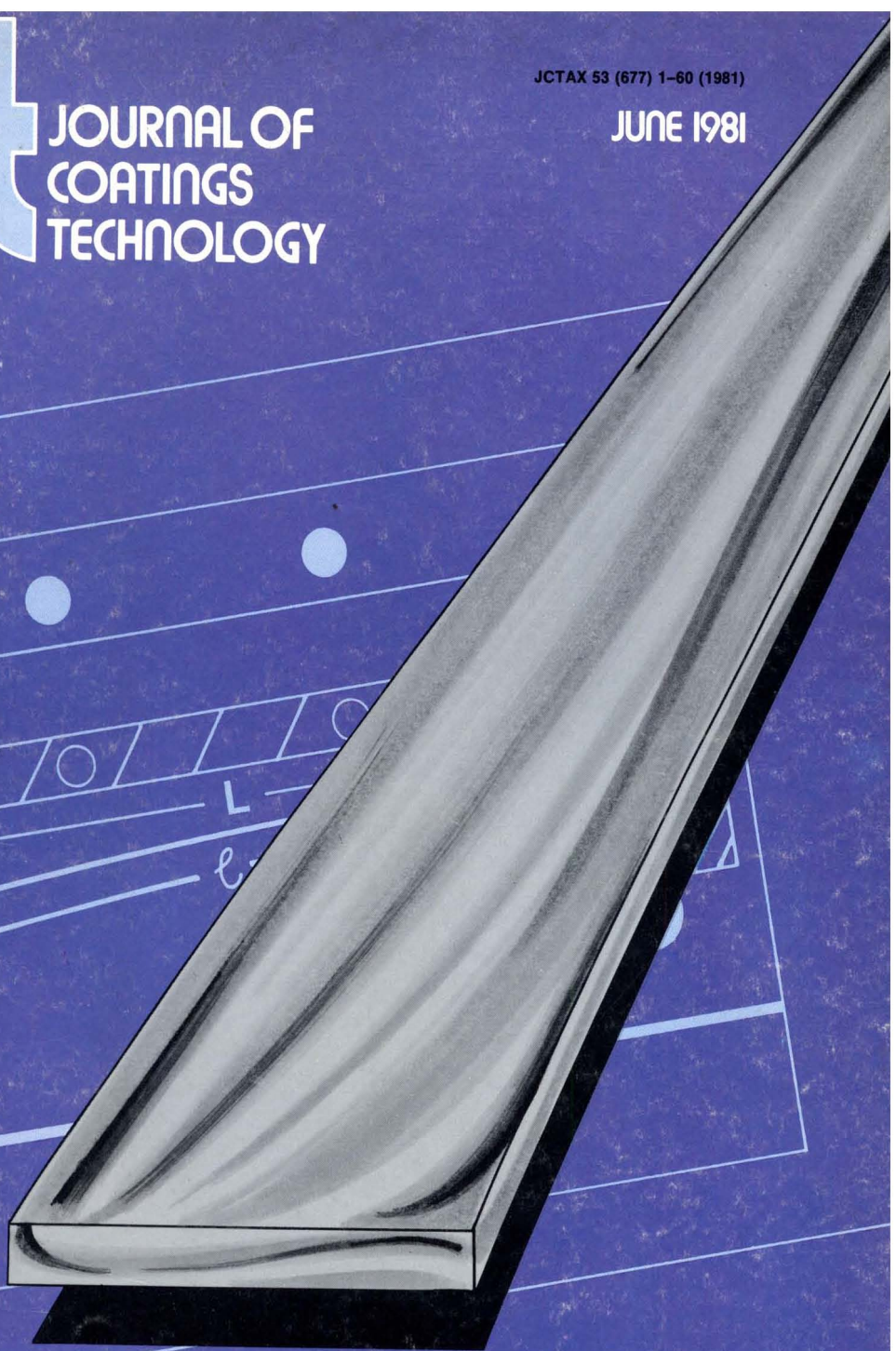


JCTAX 53 (677) 1-60 (1981)

JUNE 1981

jct

JOURNAL OF
COATINGS
TECHNOLOGY



**Cantilever (Beam)
Method Measuring
Internal Stress in
Organic Coatings**

Introducing Geon® 138 vinyl for faster line speed, lower energy needs.

New Geon® 138 dispersion resin for carpet backings, coated fabrics, and chip guard for automotive coatings, offers a number of processing advantages.

The primary benefit of this copolymer is reduced energy requirements. In many cases, a faster line speed, or a lower temperature may be used during processing. (Where 350 - 360°F was previously required, 310°F may now be adequate.) This is particularly beneficial when the resin is used in conjunction with a synthetic substrate which cannot endure higher temperatures.

Geon® 138 provides greater compounding and processing latitude. Starting with low viscosity, good air release, and very fine particle size. Formulating for optimum end properties is easier, and so

is processing. In addition, this copolymer tolerates adverse mixing, plastisol storage, and processing conditions, including elevated temperatures, as well as typical homopolymer resins.

Other important qualities of Geon® 138 resin include high gloss, fast gelation and good clarity. It also meets FDA requirements for adhesives and dry food contact applications.

For more information, write to The BFGoodrich Company, Chemical Group, Dept. JP-37, 6100 Oak Tree Boulevard, Cleveland, Ohio 44131.

BFGoodrich
Chemical Group

©BFGoodrich

©1981 BFGoodrich



We're the Chemical Group of BFGoodrich.

New ideas for a changing industry.

For High-Solids, High Performance

LOW-VOC

BAKING ENAMELS

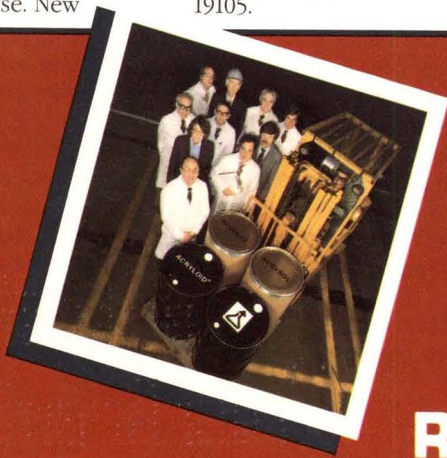
Acryloid® AT-400, Acryloid AT-410

If High Solids is your route to Low-VOC, ACRYLOID AT-400 and ACRYLOID AT-410 thermosetting acrylic resins will launch you on the right course. With these attractively-priced vehicles, you can give your general-product-finishing enamels the high performance you need—the performance you don't always get from polyester resins. Or you can upgrade the performance of a polyester by blending with one of these acrylics.

The performance of ACRYLOID AT-400 has been proved by several years of commercial use. New

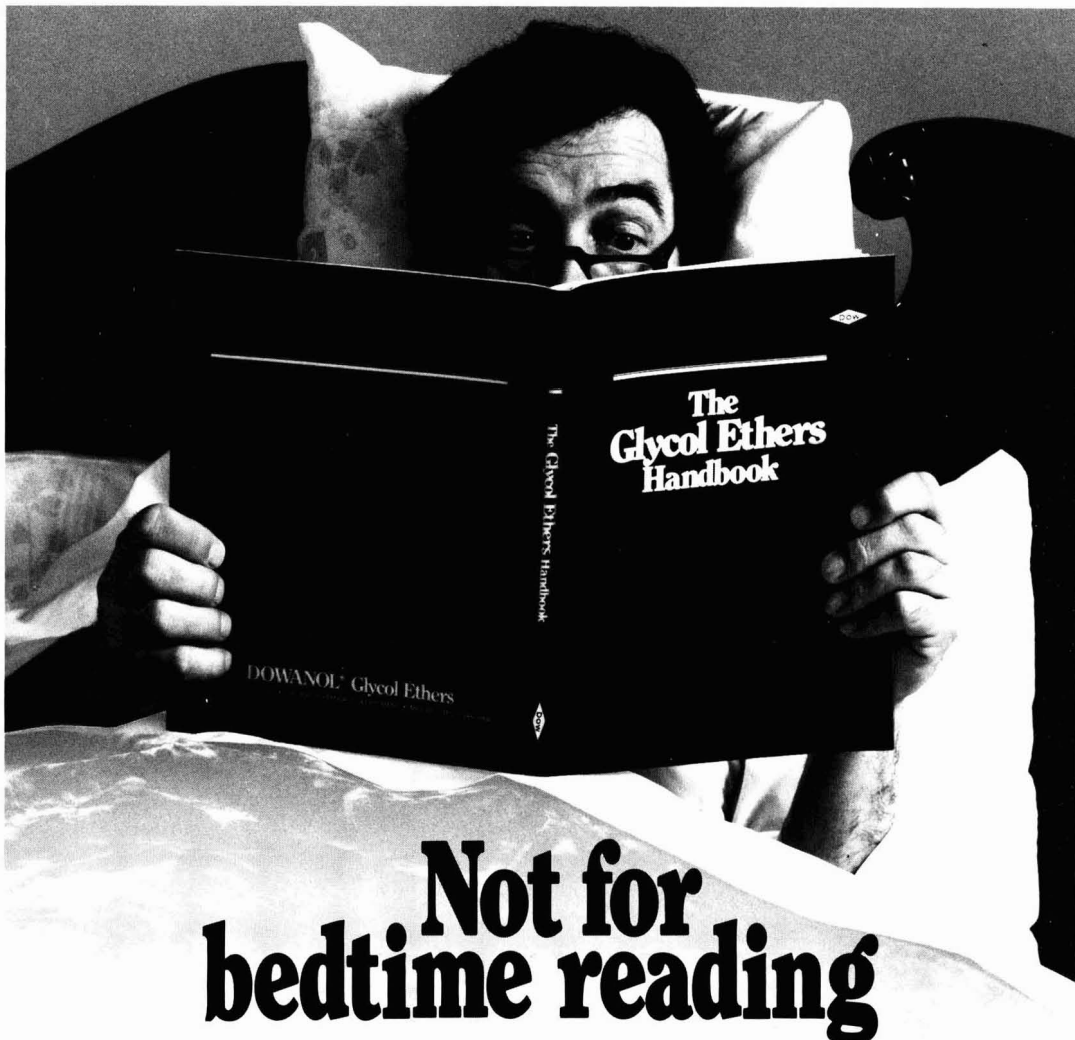
ACRYLOID AT-410 offers a different balance of properties—with hardness, stain resistance, and solvent resistance in the spotlight. Both cure at a low, energy-saving 250°F and exhibit exceptional sag-resistance and broad compatibility with other resins. They also show excellent gloss and color retention plus many other desirable acrylic qualities.

For complete information, contact one of our field representatives...or our Marketing Services Dept., Independence Mall West, Philadelphia, PA 19105.



Ask us.
We've got the answers.

ROHM
AND
HAAS 



Not for bedtime reading

... unless you've been staying up late looking for answers to questions about glycol ethers. If so, *The Glycol Ethers Handbook* is just what you've been looking for.

This newly published manual from The Dow Chemical Company is the most complete reference source on glycol ethers. With over 60 pages of pertinent data on glycol ether physical properties, applications, toxicity and formulation. Thoroughly compiled and organized for maximum value to formulating chemists.

The *Handbook* also contains the latest information on propylene-based

DOWANOL* glycol ethers. Tests in a variety of products prove that DOWANOL P-Series products offer significant advantages in terms of performance, availability and formulation cost reduction.

The Glycol Ethers Handbook is available at no charge from your Dow distributor. Call him or contact the Organic Chemicals Department, Dow Chemical U.S.A., Midland, Michigan 48640. Phone toll-free 1-800-248-9160 (in Michigan 1-517-636-6251).

After all, you deserve a good night's sleep.



DOW CHEMICAL U.S.A.
Organic Chemicals Department
9008 Building, P.O. Box 1706
Midland, Michigan 48640

*Trademark of The Dow Chemical Company

JUNE 1981

Journal of Coatings Technology
jct

**JOURNAL OF
COATINGS
TECHNOLOGY**

Volume 53 Number 677

Features

- 33** FILM FORMATION MECHANISM OF ALKYL SILICATE ZINC-RICH COATINGS—T. Ginsberg
- 33** MISCIBILITY AND VISCOSITY CONSIDERATIONS IN ORGANIC COSOLVENT SELECTION FOR WATER-BORNE COATINGS—P.M. Grant
- 39** CONSIDERATIONS ON A CANTILEVER (BEAM) METHOD FOR MEASURING THE INTERNAL STRESS IN ORGANIC COATINGS—D.Y. Perera and D. Vanden Eynde.
- 45** MOLECULAR WEIGHT AND MOLECULAR DISTRIBUTION OF POLY(METHYL METHACRYLATE) IN EMULSION POLYMERIZATION—R. Mertens

Federation Activities

- 14** EXHIBIT SPACE SETS RECORD FOR 1981 PAINT INDUSTRIES' SHOW
- 16** 1981 PAINT SHOW EXHIBITORS

Departments

- | | | |
|--------------------------------------|---|---------------------------------|
| 7 Comment | 51 Elections | 56 Obituary |
| 12 Abstract | 52 Technical Articles
In Other Publications | 57 Literature |
| 20 Government and
Industry | 53 Meetings/Education | 57 Letters to the Editor |
| 49 Society Meetings | 54 People | 58 Coming Events |
| | | 60 Humbug from Hillman |

THE JOURNAL OF COATINGS TECHNOLOGY (ISSN 0361-8773) is published monthly by the Federation of Societies for Coatings Technology, 1315 Locust St., Philadelphia, Pa. 19107. Phone (215) 545-1507. Second class postage paid at Philadelphia, Pa. and at additional mailing offices. POSTMASTER: Send address changes to JOURNAL OF COATINGS TECHNOLOGY, 1315 Locust St., Philadelphia, Pa. 19107. Subscriptions U.S. and Canada—1 year, \$20; 2 years, \$37; 3 years, \$52. Outside (Air Mail)—1 year, \$33; 2 years, \$53; 3 years, \$91. Other countries—1 year, \$28; 2 years, \$53; 3 years, \$76.



กรมส่งเสริมการค้าระหว่างประเทศ
-2.ก.ย.2524

PAINT CHEMIST OF THE YEAR



I'D LIKE TO THANK MY MOTHER, MY CHEMISTRY PROFESSOR AND, OF COURSE, UCAR ACRYLICS.

I wouldn't be here without you.

In fact, my boss, the paint manufacturer, wouldn't be, either. You see, two years ago we were faced with a terrible choice. Either sacrifice the quality of our paint. Or sacrifice ourselves.

Then I discovered UCAR Acrylics. I was able to formulate paints with the same exterior durability as with conventional acrylics. And the boss was able to save as much as 25¢ on every gallon.

What's more, with UCAR Acrylics I can get other performance characteristics such as gloss retention, pigment binding and resistance to

both chalking and dirt pickup. And the boss is still making more than he was with conventional acrylics.

My advice to every paint chemist out there is to call your local Union Carbide Sales Representative and ask for more information about UCAR Acrylics. Or write to Union Carbide, Dept. K3442, Danbury, CT 06817.

And when your boss offers you a testimonial dinner as a reward, listen to your mother. Mine told me to ask for a raise.



Coatings Materials

JOURNAL OF COATINGS TECHNOLOGY

1315 Walnut St., Phila., Pa. 19107

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

Annual dues for members of the Federation of Societies for Coatings Technology, \$15.00, includes a subscription to this publication. Membership in the Federation is obtained through prior affiliation with, and payment of dues to, one of its 26 Constituent Societies. Non-member subscription rates are:

	U.S. and Canada	Europe (Air Mail)	Other Countries
1 Year	\$20.00	\$33.00	\$28.00
2 Years	\$37.00	\$63.00	\$53.00
3 Years	\$52.00	\$91.00	\$76.00

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

Staff

FRANK J. BORRELLE	PUBLISHER
ROBERT F. ZIEGLER	EDITOR
THOMAS J. MIRANDA	TECHNICAL EDITOR
THOMAS A. KOCIS	CONTRIBUTING EDITOR
LORRAINE LEDFORD	ASSOCIATE EDITOR
JANE MARIE PALUDA	ASSISTANT EDITOR
RICHARD D. GROSS	ART DIRECTOR

Publications Committee

THOMAS J. MIRANDA, Chairman	
PAUL R. GUEVIN, JR., Vice-Chairman	
FRANK J. BORRELLE	THOMAS A. KOCIS
JOHN A. GORDON, JR.	SIDNEY LAUREN
HERBERT E. HILLMAN	PERCY E. PIERCE
RUTH JOHNSTON-FELLER	ROBERT F. ZIEGLER

Editorial Review Board

THOMAS J. MIRANDA, Chairman		
D. BREZINSKI	L.W. HILL	M.J. McDOWELL
R. DOWBENKO	H.E. HILLMAN	I.H. McEWAN
F.L. FLOYD	R. JOHNSTON-FELLER	A. MERCURIO
J.L. GARDON	J.V. KOLESKA	P.E. PIERCE
J.A. GORDON, JR.	L. KUTIK	J.H. SAMPLE
P.R. GUEVIN, JR.	S.S. LABANA	H. SKOWRONSKA
H.E. HILL	S. LAUREN	

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

A Guide for Authors is published in each January issue.

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

The Federation of Societies for Coatings Technology assumes no responsibility for the opinions expressed by authors in this publication.

Copyright 1981 by the Federation of Societies for Coatings Technology. All rights reserved. No portion of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage or retrieval system without permission in writing from the publisher.

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY BOARD OF DIRECTORS

PRESIDENT

*WILLIAM H. ELLIS
Chevron Research Co.
P.O. Box 97
El Segundo, CA 90246

HUGH W. LOWREY
Perry & Derrick Co., Inc.
Cincinnati, OH 45212

HARRY B. MAJCHER
Standard Detroit Paint Co.
Detroit, MI 48238

PRESIDENT-ELECT

*HOWARD JEROME
Spatz Paint Industries, Inc.
1601 N. Broadway
St. Louis, MO 63102

GARY MARSHALL
Paint Products Co., Inc.
Walkertown, NC 27051

TREASURER

*A. CLARKE BOYCE
Nacan Products Ltd.
371 Wallace Ave.
Toronto, Ont. M6P 3P1, Can.

*WILLIAM MIRICK
Battelle Memorial Institute
Columbus, OH 43201

BOBBY D. MOORE
Interstate Paint Corp.
Brunswick, GA 31520

ANTONIO PINA ARCE
Mexicana de Pinturas Intl.
Ixtapalapa, Mexico

JOHN J. OATES
Troy Chemical Corp.
Newark, NJ 07105

CHARLES ARONSON
Beacon Paint Works
Jamaica Plain, MA 02130

DERYK R. PAWSEY
Rohm and Haas Co.
Vancouver, B.C. V6J 3P7, Can.

*JOSEPH A. BAUER
Porter Paint Co.
Louisville, KY 40201

COLIN D. PENNY
Hampton Paint Mfg. Co.
Hampton, VA 23669

WILLY C.P. BUSCH
PPG Industries, Inc.
Houston, TX 77001

JAMES E. PETERSON
Peterson Paints
Pueblo, CO 81002

ALEX CHASAN
General Services Administration
Washington, D.C. 20406

HORACE S. PHILIPP
Sherwin-Williams Co.
Montreal, Que. H3C 2T4, Can.

S. LEONARD DAVIDSON
N L Industries, Inc.
Hightstown, NJ 08520

A. GORDON ROOK
The O'Brien Corp.
S. San Francisco, CA 94080

CARLOS DORRIS
Jones-Blair Co.
Dallas, TX 75235

*FRED G. SCHWAB
Coatings Research Group, Inc.
Cleveland, OH 44114

MILTON A. GLASER
Consultant
Glencoe, IL 60022

JOHN A. STIGILE
du Pont Co.
Wilmington, DE 19898

WILLIAM F. HOLMES
DeSoto, Inc.
Garland, TX 75040

JOHN T. VANDEBERG
DeSoto Inc.
Des Plaines, IL 60018

TERRY F. JOHNSON
Cook Paint & Varnish Co.
Kansas City, MO 64141

EDWARD VANDEVORT
PPG Industries, Inc.
Allison Park, PA 15101

RUTH JOHNSTON-FELLER
Consultant, Carnegie-Mellon Univ.
Mellon Institute of Research
Pittsburgh, PA 15213

KURT F. WEITZ
Indusmin Ltd.
Don Mills, Ont. M6E 1N7 Can.

HERMAN LANSON
LanChem Corp.
E. St. Louis, IL 62205

GERALD L. WEST
Devco & Raynolds Co.
Riverside, CA 92507

*ELDER C. LARSON
Shell Development Co.
Houston, TX 77001

LOWELL WOOD
Frost Paint & Oil Corp.
Minneapolis, MN 55413

EUGENE LeVEA
Pratt & Lambert, Inc.
Buffalo, NY 14240

* Executive Committee Members

EXECUTIVE VICE-PRESIDENT

DAVID LOVEGROVE
Carrs Paints Ltd.
Birmingham, B31 3PG, England

FRANK J. BORRELLE
FSCT Headquarters Office
1315 Walnut St.
Philadelphia, PA 19107

Neither Rain, Nor Snow, etc.

From a number of our readers has come the question, "Why in the world am I getting my January issue in the middle of February?," or less subtle words to that effect. Well, unless you regularly receive your copy of the JCT while scaling the west ridge of Annapurna, this June issue should reach you in the beginning of *June*.

There are a number of reasons for this change. First, you deserve to receive the Journal as quickly as possible. Meeting notices, stories of coming events, and regulatory information mean so much more if read before they occur rather than three days after the fact.

Second, the advertisers who have supported the JCT and the Federation so well will be able to inform you of their products and services as expeditiously as possible. There is nothing more aggravating than buying Brand X in May and seeing the "improved" Brand X advertised in the May issue you received in June.

Third, we feel that it is simply more professional to have you receive the Journal during the same month shown on the front cover.

All of this, however, will require a small favor from those who submit stories. Since the Post Office (you really didn't expect us to finish this without mentioning our friends at the USPS, did you?) seems to need plenty of lead time to deliver the JCT, the deadline for submitting editorial matter must be moved up.

Therefore, if a story is to appear in, say, the September issue, it must be received here by July 1, and so on, and so on, for all subsequent issues. The technical terminology is: The first of the month two months prior to the month of issue.

We do expect a few problems in the beginning. But with your help the JCT will arrive on time. At least until it's expedited into the Twilight Zone via a nine-digit zip code.—RFZ

Second generation epoxies for

ECN 1299 resin improves chemical and solvent resistance.

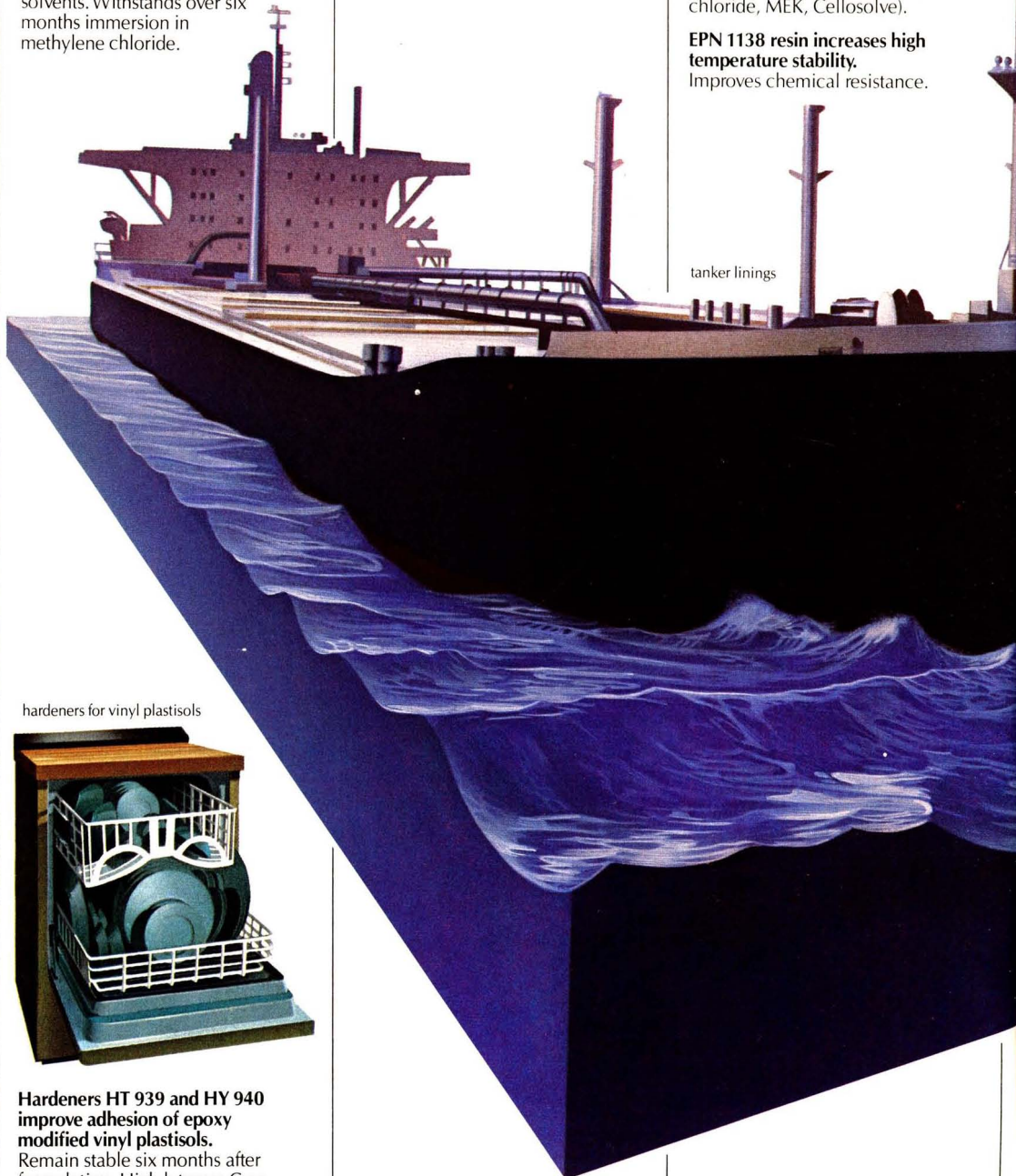
Can be formulated into coatings with very high HDT. In combination with o-cresol novolac, produces coatings with excellent resistance to aggressive solvents. Withstands over six months immersion in methylene chloride.

0500 resin increases heat tolerance.

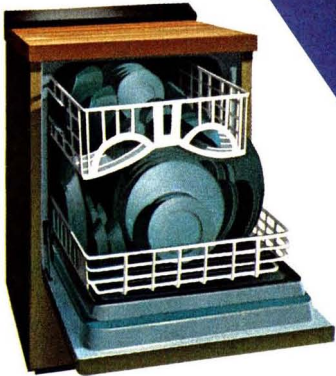
Due to low viscosity, allows formulation of solvent-free, room temperature cured coatings with outstanding resistance to aggressive solvents (methylene chloride, MEK, Cellosolve).

EPN 1138 resin increases high temperature stability.

Improves chemical resistance.



hardeners for vinyl plastisols



Hardeners HT 939 and HY 940 improve adhesion of epoxy modified vinyl plastisols.

Remain stable six months after formulating. High latency. Cure rapidly—five minutes at 100°C.

high-performance coatings.

EPN 1139 provides for excellent solvent and chemical resistance. It can be formulated in high solids coatings recommended for hot crude oil storage tanks.

Araldite® PT 810 resin crosslinks acrylic and polyester powders. Exhibits excellent weatherability (i.e., gloss retention and color stability).



exterior coatings

For years, these special CIBA-GEIGY epoxy resins have been used in the electronics and electrical industries.

Recently we built new, larger manufacturing facilities and can now make these special epoxies available to the coatings industry.

Their outstanding properties make them ideal for new high-performance coatings or upgrading existing coatings systems. We believe the applications illustrated suggest only a few of their many possible uses, especially in energy related fields.

For our free product information kit, please fill out the coupon below.

Please send me your free product information kit

CIBA-GEIGY Corporation
Resins Department
Ardsley, N.Y. 10502
Phone (800) 431-1874
In New York (914) 478-3131

Name _____

Title _____

Address _____

City _____

State _____ Zip _____

CIBA-GEIGY

BLACK PEARLS® 1300

the better carbon black for lacquers & enamels

More and more manufacturers are turning to Cabot's Black Pearls® 1300 (or the fluffy Monarch® 1300) for their black coating formulations.

Why? Simply because it is the *optimum* high-color carbon black. It provides a sharp gloss, excellent blue tone, and a jetness equal or superior to that of the channel blacks it replaced. It disperses easily, permitting fast, economical processing. What's more, it is available at a very modest price.

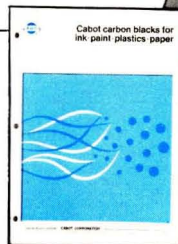
In short, you can't find a better all-round black for high-color lacquers, enamels and other coatings than Black Pearls® 1300.

For other applications, of course, there are other fine Cabot black grades. For example:

**For MEDIUM COLOR...
Black Pearls® 800 is the logical choice.**

**For TINTING...
Sterling® R is in a class by itself.**

For detailed information on the characteristics of Black Pearls® 1300 and Monarch® 1300, send for Technical Service Report S-23A. For typical properties of Cabot's complete family of special blacks, request "Cabot Carbon Blacks for Ink, Paint, Plastics, Paper."



125 High Street, Boston, Massachusetts 02110, U.S.A.
Tel: (617) 423-6000

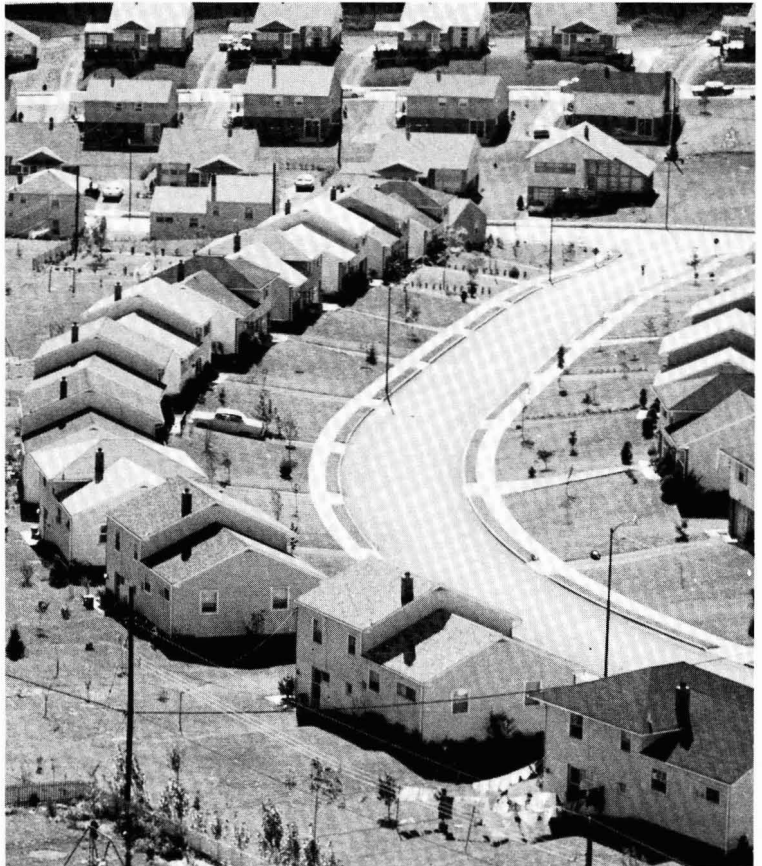
In 20 years we've sold enough Fungitrol-11[®] fungicide to protect 6,700,000 American homes.

Since 1958, Tenneco Chemicals has sold enough Fungitrol-11 non-metallic powdered fungicide for all non-aqueous paints and coatings, to make more than 66 million gallons of paint – or enough paint to give 6.7 million American homes a full exterior coat.

Why have we sold so much? Because no other non-metallic fungicide protects so completely against mildew at so reasonable a cost.

So, when you need mildew protection for your solvent house paint and stains, think about Fungitrol-11 fungicide, the winner in the war against mildew. No other fungicide of its type is so widely used, so performance-proven.

For more information, phone or write today to, Tenneco Chemicals Inc. Coatings & Colorants P.O. Box 365, Piscataway, N.J. 08854. (201) 981-5000.



Tenneco Chemicals Coatings and Colorants

A Tenneco Company

® Trademark of Tenneco Chemicals, Inc. ® * Reg. U.S. Trademark, Tenneco Inc.



Abstracts of Papers in This Issue

FILM FORMATION MECHANISM OF ALKYL SILICATE ZINC-RICH COATINGS—T. Ginsberg

Journal of Coatings Technology, 53, No. 677, 23 (June 1981)

Experimental difficulties in measuring relevant properties have been an obstacle to a better understanding of the mode of action of alkyl silicate zinc-rich coatings. This is due partly to the peculiar nature of alkyl silicates and of the resulting films. There are therefore considerable misconceptions regarding their mechanism of film formation.

Three instrumental techniques not widely used in conventional coatings technology were utilized to study specific aspects of alkyl silicate zinc-rich coatings behavior: Thermogravimetry, Densitometry, and Dynamic Mechanical Analysis. The results are incorporated into a model of an alkyl silicate zinc-rich coating, which conforms to the observed behavior, and is useful in understanding their mode of action.

MISCIBILITY AND VISCOSITY CONSIDERATIONS IN ORGANIC COSOLVENT SELECTION FOR WATER-BORNE COATINGS—P.M. Grant

Journal of Coatings Technology, 53, No. 677, 33 (June 1981)

Water-borne coatings utilize organic cosolvents to improve the solubility and rheological characteristics of a neutralized resin in water. To provide high-gloss coatings with desirable physical properties, cosolvents should ensure miscibility while the coating solvents evaporate during film formation. Such continuous miscibility depends on the coupling efficiency of the organic cosolvent. Coupling efficiency serves as a measure of the ability of a cosolvent to make a water-immiscible material miscible with water. Coupling efficiency is affected by temperature and depends on the distribution of the cosolvent between the organic and aqueous phases of the system. Miscibility diagrams of glycol ether/water-containing systems illustrate the effect of organic cosolvent on miscibility at elevated temperature and show that phase separation can occur on heating if the choice of cosolvent is incorrect for the resin, amine, and degree of neutralization. The choice of cosolvent also affects the viscosity of the coating system, as shown by the viscosity curves

obtained on diluting cosolvent solutions of neutralized resin with water.

These concepts and the data given in this paper contribute to an understanding of water-borne coatings and to the selection of a cosolvent or cosolvent blend that will give desired application and coatings properties.

CONSIDERATIONS ON A CANTILEVER (BEAM) METHOD FOR MEASURING THE INTERNAL STRESS IN ORGANIC COATINGS—D.Y. Perera and D. Vanden Eynde

Journal of Coatings Technology, 53, No. 677, 39 (June 1981)

The conditions necessary to obtain valid results with a cantilever (beam) method for measuring the internal stress in organic coatings are discussed. The method consists of measuring the deflection of a cantilever substrate coated on one side and vertically clamped at one end to a support. A significant error can be introduced if the effect of clamping is disregarded and the cantilever substrate is not carefully chosen. The maximum internal stress of two coatings investigated (a thermoplastic and a thermosetting varnish) appears to be independent of coating and cantilever substrate thicknesses. Erroneous conclusions can be drawn if an inadequate mathematical equation is used to calculate the internal stress.

MOLECULAR WEIGHT AND MOLECULAR WEIGHT DISTRIBUTION OF POLY(METHYL METHACRYLATE) IN EMULSION POLYMERIZATION—R. Mertens

Journal of Coatings Technology, 53, No. 677, 45 (June 1981)

Molecular weight and molecular weight distribution of emulsion polymerized methyl methacrylate was investigated in the presence of an anionic emulsifier (Sipon LS 100, sodium lauryl sulfate), a cationic emulsifier (Bacfor BL 80, lauryldimethylbenzyl ammonium bromide) and a blend of the anionic emulsifier with a nonionic emulsifier (Sinnopal OP 8, octyl phenol polyethoxyethanol). In all cases, the ratio M_w/M_n was in the range typical of the most probable molecular weight distribution. However, the absolute molecular weight produced with the cationic emulsifier was significantly higher than with the other two emulsifier systems.

NL introduces the antisetling agent that pours.



For raw material savings of up to 30% in non-aqueous industrial systems, we introduce liquid **M-P-A 2000X** antisetling agent.

With **M-P-A 2000X** additive doing the pigment suspension work, you can save batch preparation time. It's pourable, and it's pumpable. Measurement is precise. Dispersion is easy.

And all the while, the chemistry of the new **M-P-A 2000X** additive offers higher efficiency — you get the same outstanding antisetling properties, but at use levels 10-30% below those of conventional paste antisetling agents.

For samples and literature, just fill out the coupon and send to:
NL Chemicals/NL Industries, Inc., Box 700, Hightstown, NJ 08520.
Or telephone 609/443-2230.

NL Chemicals

Please send a sample and literature on **M-P-A 2000X**,
the antisetling agent that pours.
 Please have your representative contact me.
Name _____
Title _____
Company _____
Address _____
City _____ State _____
Zip _____

Exhibit Space to Set Record At 1981 Paint Show in Detroit

Over 37,000 sq. ft. of exhibit space will be available to registrants at the 46th Annual Paint Industries' Show of the Federation of Societies for Coatings Technology at Cobo Hall, Detroit, October 28-30. To be held in conjunction with the 1981 Annual Meeting of the Federation, this largest Paint Show ever will feature the exhibits of 159 supplier firms.

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

Show hours will be 12:00 p.m. to 5:30 p.m. on Wednesday, October 28; 9:30 a.m. to 5:00 p.m. on Thursday, October 29; and 9:30 a.m. to 4:00 p.m. on Friday, October 30.

Annual Meeting

The 59th Annual Meeting program will be open Wednesday, October 28, at Cobo Hall in Detroit.

Program Chairman Thomas J. Miranda, of Whirlpool Corp., Benton Harbor, Mich., has announced the theme of "Challenge, Change, and Opportunity," and he and his Program Steering Committee are developing a schedule of presentations around this topic.

Werner J. Blank, of American Cyanamid Co., will present the 1981 Mattiello Lecture, "Amino Resins in High Solids Coatings," on October 30 [see May issue—Ed.].

Featured presentations tentatively scheduled include:

- Keynote Address
- Paint Research Institute Seminar

• Manufacturing and Educational Seminars

Concurrent sessions will be held throughout the three-day meeting, but papers will be scheduled so as to avoid conflicting presentations.

Headquarters Hotel

The Detroit Plaza will be headquarters hotel, and the Detroit Cadillac will be co-headquarters. Blocks of rooms have also been reserved at other downtown hotels convenient to Cobo Hall.

Room Reservations

All requests for rooms and suites must be on the official housing form furnished by the Federation. Housing will be processed by the Detroit Convention & Visitors Bureau, who will accept only those reservations which are on the official form.

Housing forms have been mailed to all Federation members, and a form is included in this issue (see pages 17-19). Additional forms are available from the Federation headquarters office.

NPCA Meets Same Week

The National Paint and Coatings Association will hold its Annual Meeting on October 26-28 at the Detroit Plaza Hotel.

The back-to-back scheduling of Association and Federation events provides coatings industry personnel with a full week of programming.

Registration Fees

Regular "on-site" registration fees will be \$45 for Federation members and \$60 for non-members. Advance registration will be available for \$40 for members \$55

for non-members. Fee for spouses' activities will be \$30 on-site and \$25 in advance.

Once again there will be a special registration fee of \$20 each for retired members and their spouses.

Registration forms will be included in future issues of the JOURNAL OF COATINGS TECHNOLOGY, and will also be mailed to all members of the Federation in August.

Program Committee

Assisting Chairman Miranda on the Program Steering Committee are: John C. Ballard (Vice-Chairman), of Kurfess Coatings, Inc., Louisville, Ky.; Darlene Brezinski, of DeSoto, Inc., Des Plaines, Ill.; Percy E. Pierce, of PPG Industries, Inc., Allison Park, Pa.; Peter Hiscocks, of Canadian Industries Ltd., Toronto, Canada; Theodore Provder, of Glidden Coatings & Resins Div., SCM Corp., Strongsville, Ohio; and Walter Stuecken, of Grow Group, Inc., Troy, Mich.

Meetings Committee

Members of the Detroit Society are serving on the Meetings Committee under General Chairman Jose G. Benavides, of Ford Motor Co. Chairing the various subcommittees are: Information Services—Bohdan (Dan) Melnyk, of Chrysler Corp.; Program Operations—Taki Anagnostou, of Wyandotte Paint Products, Inc.; Publicity—Jack Dentler, of Pfizer, Inc., MPM Div.; Luncheon—Fred F. Boehle, of Boehle Chemicals, Inc.; Society President—Walter Stuecken, of Grow Group, Inc.

Co-chairing the Spouses' Activities Committee are Mrs. Fred (Rosemary) Boehle, Mrs. Walter (Lorraine) Stuecken, and Mrs. Jose (Lorraine) Benavides.

Paint Show Hours

Wednesday, Oct. 28
12:00 p.m. to 5:30 p.m.

Thursday, Oct. 29
9:30 a.m. to 5:00 p.m.

Friday, Oct. 30
9:30 a.m. to 4:00 p.m.



Cobo Hall (left foreground), site of the 1981 Paint Show

Bare wood never had it so good

...Stains based on RHOPLEX® acrylic emulsions.

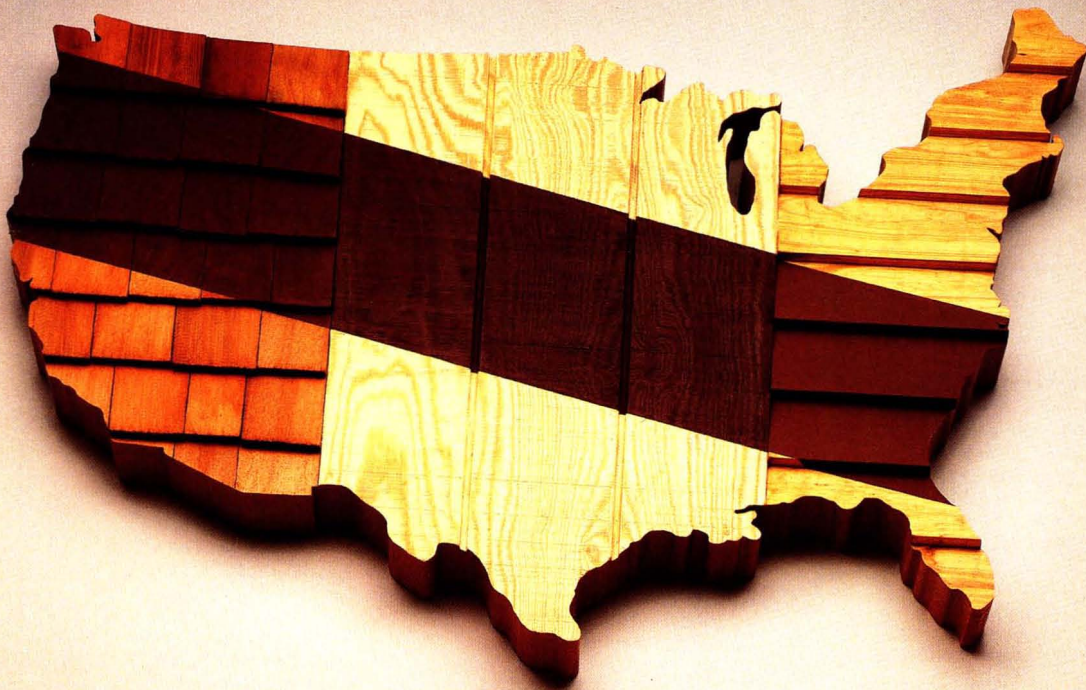
RHOPLEX acrylics give stains the adhesion, durability, and tint retention needed for tough bare-wood applications.

□ Stains are applied over bare wood. Outstanding adhesion is necessary. □ Stains are frequently applied in just one coat. Only vehicles of superior durability should be used. □ Stains are usually supplied in dark colors. Tint retention is especially important.

That's why RHOPLEX 100%-acrylic emulsions, with

adhesion, durability, and tint retention proved by years of outdoor testing and use, are the best vehicles for formulating opaque latex stains – coast to coast.

For additional information on Rhoplex acrylic emulsions for stains, contact one of our field representatives...or our Marketing Services Dept., Philadelphia, PA 19105.



**ROHM
AND
HAAS** 

1981 Paint Show Exhibitors to Date

- Aceto Chemical Co., Inc.
Air Products and Chemicals, Inc.
Aluminum Co. of America
C.M. Ambrose
American Hoechst Corp.
Applied Color Systems, Inc.
Armstrong Containers, Inc.
Ashland Chemical Co.
Atlas Electric Devices Co.
- B.A.G. Corp.
BASF Wyandotte Corp.
Beltron Corp.
Bennett's "Colorant Div."
Blackmer Pump Div., Dover Corp.
Brinkmann Instruments, Inc.
Brookfield Engineering Labs., Inc.
Buckman Laboratories, Inc.
Byk-Mallinckrodt Chem. Prod. GmbH
- Cabot Corp.
Capricorn Chemical Corp.
Cargill, Inc.
CDI Dispersions
CECOS International, Inc.
Celanese Chemical Co., Inc.
Celanese Plastics & Specialties Co.
CEM Corp.
Chemical & Engineering News (ACS)
Chicago Boiler Co.
Clawson Tank Co.
Color Corp. of America
Columbian Chemicals Co.
Commercial Filters Div., Kennecott Corp.
Continental Fibre Drum Co.
Cosan Chemical Corp.
Custom Chemical Co.
- Daniel Products Co.
Degussa Corp.
Desert Mineral Products, Inc.
Diamond Shamrock Corp., Proc. Chems. Div.
D/L Laboratories
Dominion Colour
Dow Chemical USA
Draiswerke, Inc.
Drew Chemical
DSET Laboratories, Inc.
- Eastman Chemical Products, Inc.
Ebonex Corp.
Eiger Engineering Ltd.
Elcometer, Inc.
Elektro-Physik, Inc.
Encapsulair, Inc.
Engelhard Minerals & Chemicals Div.
Epworth Mfg. Co., Inc.
- Fawcett Co., Inc.
Federated Metals Corp.
Fed. of Societies for Coatings Tech.
Filter Specialists, Inc.
- Freeport Kaolin (Message Center)
Fricke McCormick Engineering
- Gardner Lab. Div., Pacific Sci. Co.
General Electric Co., Silicones
Georgia Kaolin Co.
Goodyear Tire & Rubber Co.
W.R. Grace & Co., Davison Chem. Div.
Graco, Inc.
- Halox Pigments
Harshaw Chemical Co.
Henkel Corp.
Hercules Incorporated
Hilton-Davis Chemical Co. Div.
Hockmeyer Equipment Corp.
Hooker Chemical Corp.
J.M. Huber Corp.
Hunter Associates Lab., Inc.
- Ideal Manufacturing & Sales Corp.
International Minerals & Chem. Corp.
Interstab Chemicals, Inc.
ISC Alloys, Ltd.
- Johns-Manville
- Kenrich Petrochemicals, Inc.
KTA-Tator Associates, Inc.
- Labelette Co.
The Leneta Co.
Letica Corp.
Liquid Controls Corp.
Lorcon Chemicals, Inc.
- 3M Co.
Macbeth, Div. Kollmorgen Corp.
Manchem Incorporated
Matter Mixers, Inc.
McWhorter Resins, Div. of Valspar
Meadowbrook Corp.
The Mearl Corp.
Merck & Co., Inc.
MGI International, Inc.
Mineral Pigments Corp.
Mini Fibers, Inc.
Mobay Chemical Corp.
Modern Paint and Coatings
Morehouse Industries, Inc.
Myers Engineering
- Nalco Chemical Co.
National Assn. of Corrosion Engineers
National Paint and Coatings Assn.
Netzsch Incorporated
Neville Chemical Co.
New Way Packaging Machinery, Inc.
NL Chemicals/NL Industries
NYCO, Div. of PMI
- Omya, Inc.
Ottawa Silica Co.
- Paint Research Institute
- Penn Color, Inc.
Pennsylvania Glass Sand Corp.
The Pfaudler Co.
Pfizer, Inc., MPM Div.
Photomarker Corp.
Polyvinyl Chemical Industries
PPG Industries, Inc.
Premier Mill Corp.
- Q-Panel Co.
- Reichard-Coulston, Inc.
Reichhold Chemicals, Inc.
Rohm and Haas Co.
Roper Plastics, Inc.
Russell Finex, Inc.
- Sandoz, Inc.
SCA Chemical Services, Inc.
Semi-Bulk Systems, Inc.
Sewell Plastics, Inc.
Shamrock Chemicals, Corp.
Shell Chemical Co.
Sherwin-Williams Co., Chems. Div.
Silberline Manufacturing Co., Inc.
Southern Clay Products
South Florida Test Service
Spencer Kellogg, Div. Textron, Inc.
Standard Container Co.
Steel Structures Painting Council
Sun Chemical Corp., Pigments Div.
SWECO, Inc.
- Tenneco Chemicals, Inc.
Thibault & Walker Co.
Thiele Engineering Co.
Tokheim Meter Div.
Troy Chemical Corp.
- Union Camp Corp.
Union Carbide Corp.
Union Chemicals Div.
Union Process, Inc.
Uniroyal Chemical Co.
United Catalysts, Inc.
Universal Color Dispersions
University of Detroit
University, Kent State
University of Missouri-Rolla
University, North Dakota State
University of Southern Mississippi
U.S. Movidyn Corp.
- R.T. Vanderbilt Co., Inc.
Vorti-Siv Div., M&M Machine
- Wacker Chemical Co.
Warren Rupp Co.
Waukesha Div., Abex Corp.
Weathering Research Service Co.
Wellco Products Div., Itasco Ind.
Wilden Pump & Engineering Co.
Witco Chemical Corp.
- Zorelco Limited



Controlling high blood pressure on the job is good business.

Illnesses from uncontrolled high blood pressure cost about 26 million lost workdays and billions of dollars in lost earnings each year.

About 20% of your workforce has it, and many don't even know it. Proper treatment, every day, can prevent heart failure, stroke, or kidney disease caused by high blood pressure.

High blood pressure can be easily detected and controlled so a person can

lead a normal, healthy and active life. On the job, and off. To learn how your company can start a high blood pressure control program, write:

Ms. Judie LaRosa
Worksetting Programs Coordinator
National High Blood Pressure Education Program
Bethesda, MD 20205

**High blood pressure.
Treat it and live.**



Nitric acid production



Nitrating area

Why Hercules is source for

After a two-year, multimillion-dollar investment at our Parlin, N.J., facility (above), Hercules is now ready with a major addition to world nitrocellulose supplies. Our capacity has been increased 50% to 40,000 MTY, giving us the ability to serve present and future needs of coatings and ink manufacturers *everywhere in the*

world. Now you can count on the following benefits:

A supply commitment backed by the resources of Hercules, a worldwide, multi-national chemical company.

Consistently high-quality product from our modern, continuous-process plant.

Assistance on safety, formulations and

USA

Hercules Incorporated
910 Market Street
Wilmington, DE 19899
Attn: International
Telex: 835479

South America

Hercules Incorporated
255 Alhambra Circle
P.O. Box 340549, Suite 560
Coral Gables, FL, USA 33134
Telex: 51-5014

Australia

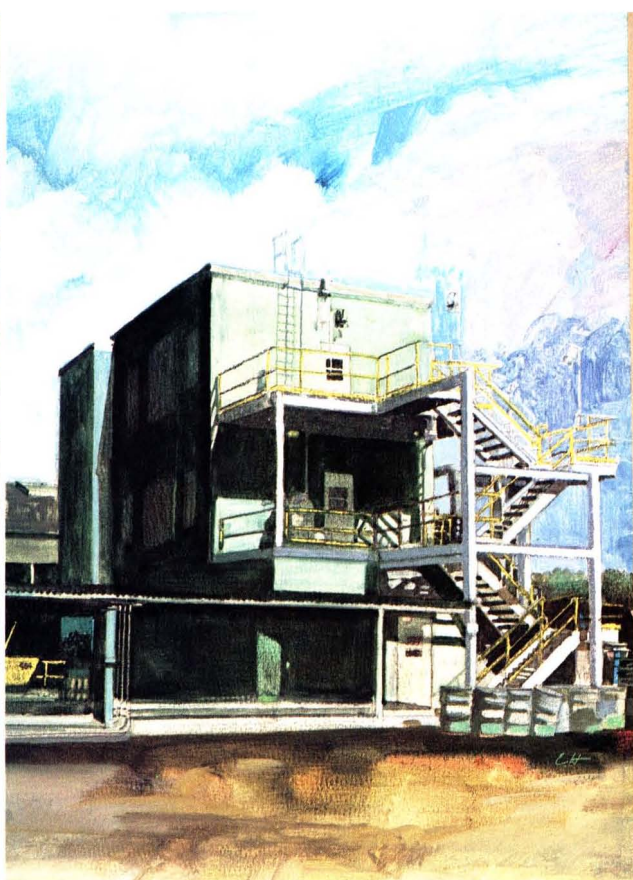
A. C. Hatrick Chemicals
Pty. Ltd.
49-61 Stephen Road
P.O. Box 59
Botany, N.S.W. 2019
Telex: 20390

Canada

Hercules Canada Limited
1245 Sherbrooke West
P.O. Box 610, Station H
Montreal, Quebec H3G 2L8
Telex: 05-268772



Alcohol distillation



Dehydrating area

the world's best nitrocellulose.

new technologies available around the world, backed by our Coatings Service Laboratory in the USA.

Convenient service from your established local Hercules Distributor.

Prompt shipments facilitated by our global network of Regional Offices and order-processing centers.

We look forward to a long-term relationship in servicing your needs. First step, Telex or write the nearest office below for information on Hercules® Nitrocellulose.



Europe

Hercules Powder Company Limited
20 Red Lion Street
London WC1R 4PB, England
Telex: 25803

Far East

Hercules Far East Limited
Pola Aoyama Building—5th Floor
5-17 Minami Aoyama 2-Chome
Minato-ku, Tokyo, Japan
Telex: J22309

Mexico

Quimica Hercules, S.A. de C.V.
Melchor Ocampo 469-601
Mexico (5) D.F.
Telex: 001-771306

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
1981 ANNUAL MEETING AND PAINT INDUSTRIES' SHOW
COBO HALL, DETROIT, MICHIGAN
OCTOBER 28, 29, 30

THE ANNUAL MEETING

The Federation's Annual Meeting consists of three days of technical program sessions and three days of exhibits—running concurrently on Wednesday, Thursday, and Friday. These combined events were last held in Detroit in 1971.

"CHALLENGE, CHANGE, AND OPPORTUNITY"

The theme of the technical program—"Challenge, Change, and Opportunity"—reflects a positive viewpoint of the coatings industry future in the decade of the 80's. Program sessions will focus on such topics as innovations in research, meeting the changes of regulatory compliance and hazardous waste disposal, and analyzing and responding to causes of industrial and trade sales coatings failures (particularly, coatings, failures on steel and wood substrates).

PAINT INDUSTRIES' SHOW

The "Paint Show," as it is popularly known, is the only national exhibit of raw materials and equipment used in the formulation, testing, and manufacture of paints and related coatings. More than 150 well-known supplier companies to the coatings industry will participate in the Show—which will be the largest in Federation history.

Purpose of the show is to enable registrants to learn of the latest developments in raw materials and equipment and also provide the opportunity to discuss these developments with the top technical representatives of the exhibitor companies.

SPOUSES' ACTIVITIES

Included in the spouses' registration fee will be: a get-acquainted social on Wednesday afternoon; continental breakfast on Thursday and Friday; and a tour of Meadowbrook Estate, the home of Matilda Dodge Wilson, and lunch on Thursday. Spouses headquarters will be located in both the Detroit Plaza and Book Cadillac Hotels.

FEDERATION LUNCHEON

The Annual Federation Luncheon will be held on Friday. This event will feature a well-known personality as a speaker and a brief presentation of Federation Awards.

HOTELS AND RESERVATIONS

Eleven hotels in Detroit and Windsor, Canada have reserved blocks of rooms for the Federation 1981 Annual Meeting and Paint Show. The room and suite rates and a map showing the location of the hotels is included in this brochure. The Detroit Plaza and the Book Cadillac will serve as co-headquarters hotels.

All housing reservations must be processed through the Detroit Convention and Visitors Bureau using the form provided in this brochure. The Housing Bureau will send you an acknowledgment which will state the hotel to which you have been assigned. The confirmation of your reservation will come to you directly from the hotel, to whom you must direct all of your inquiries.

IMPORTANT: Reservations for the Detroit Plaza will be accepted for arrival beginning Wednesday, October 28, only. Any requests for Plaza accommodations prior to Wednesday will be assigned to another hotel.

NPCA CONVENTION

The National Paint and Coatings Association will hold its Annual Meeting also at the Detroit Plaza on Monday, Tuesday, and Wednesday, October 26-28. NPCA registration badges will be honored for admission to the Federation Annual Meeting and the Paint Show on Wednesday, October 28 (only).

PROGRAM COMMITTEE

Following are the members of the Federation's 1981 Program Committee: Chairman—Thomas J. Miranda, of Whirlpool Corp., Benton Harbor, MI; Vice-Chairman—John C. Ballard, of Kurpees Coatings, Inc., Louisville, KY; Darlene Brezinski, of DeSoto, Inc., Des Plaines, IL; Peter Hiscocks, of C-I-L Paint Research Laboratory, Toronto, Ont., Canada; Percy E. Pierce, of PPG Industries, Inc., Allison Park, PA; Theodore Provder, of Glidden Coatings & Resins Div., SCM Corp., Strongsville, OH; and Walter Stuecken, of Grow Group, Inc., Troy, MI.

HOST COMMITTEE

The Detroit Society for Coatings Technology will serve as host organization. The members of the Host Committee are: Chairman—Jose Benavides, of Ford Motor Co., Mt. Clemens, MI; Bohdan Melnyk, of Chrysler Corp., Highland Park, MI; Taki Anagnostou, of Wyandotte Paint Products, Inc., Troy, MI; Jack Dentler, of Pfizer, Inc., Hoffman Estates, IL; Fred Boehle, of Boehle Chemicals, Inc., Southfield, MI; Walter Stuecken, of Grow Group, Inc., Troy, MI; Mrs. Fred F. Boehle; Mrs. Walter Stuecken; and Mrs. Jose Benavides.

Federation of Societies for Coatings Technology

DETROIT

HOUSING FORM

CHALLENGE

CHANGE

OPPORTUNITY

**ANNUAL MEETING
PAINT INDUSTRIES' SHOW
OCTOBER 28, 29, 30, 1981**

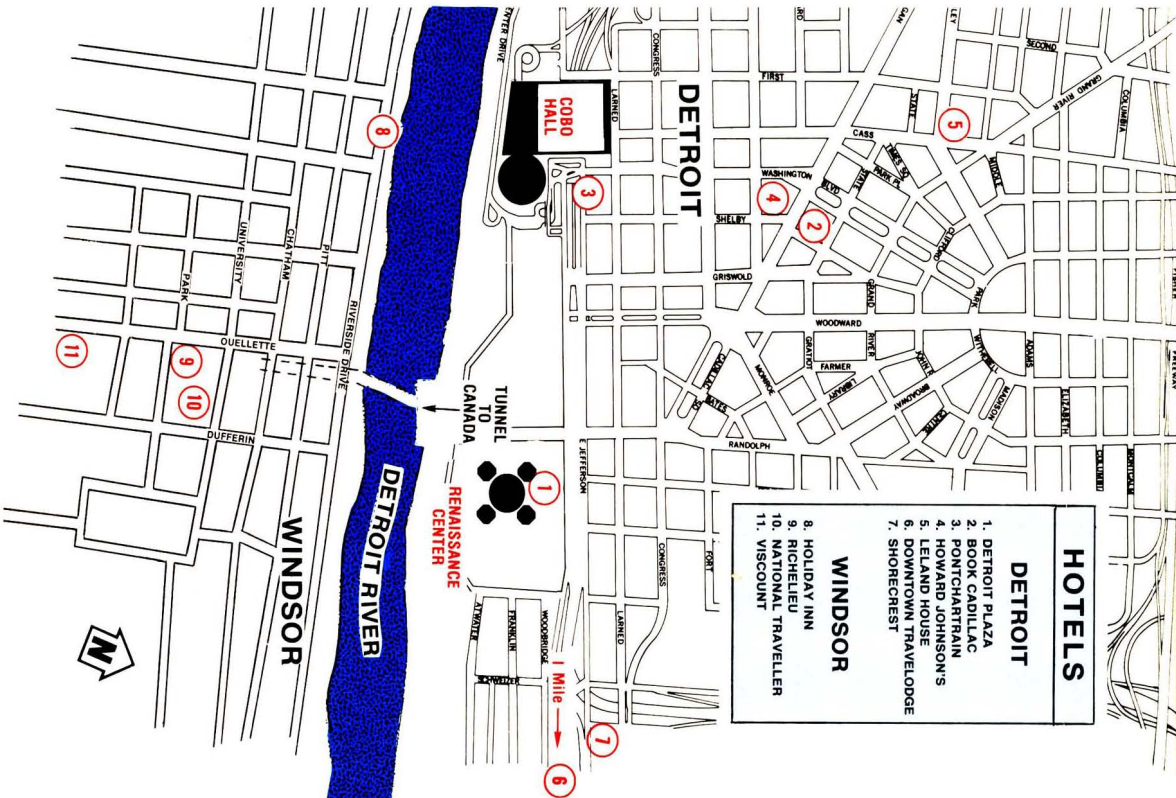
OCTOBER 26-30: COATINGS INDUSTRY WEEK IN DETROIT

HOTEL INFORMATION AND RATES

All room rates in Detroit are subject to an additional 4% charge—a Detroit tax. There is no hotel tax in Windsor.

Hotel	Singles	Doubles (D) Twins (T)	Parlor & 1 Bedroom	Parlor & 2 Bedrooms
Hotels in Detroit				
BOOK CADILLAC*	\$50	\$58 (D) 70 (T) (DD)	\$175/250	\$225/300
DETROIT PLAZA	59/69/79	71/81/91	170/190/280	240/270/365
DOWNTOWN TRAVELODGE	38	40 (D) 42 (T)	—	—
HOWARD JOHNSON'S	40	52 (DD) 50 (T)	—	—
LELAND HOUSE*	30 to 45	35 to 55 (D) 40 to 55 (T)	45 to 65	65 to 85
PONTCHARTRAIN	64/69/74/79	79/84/89/94	140 to 225	200 to 285
SHORECREST	25 to 34	27 to 38 (D) 33 to 44 (T) 50 (DD)	65 to 90	—
Hotels in Windsor, Ontario, Canada (All Rates in Canadian Dollars)				
HOLIDAY INN	49	59 (D) 63.50 (T)	—	—
NATIONAL TRAVELLER	36	41 (D)	—	—
RICHELIEU	46 to 52	52 to 60 (D)	—	—
VISCOUNT*	40/42	42/44 (D) 46/48 (T) 50 to 62 (DD)	—	—

* These hotels require a one night's room deposit.



**FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
 1981 ANNUAL MEETING AND PAINT INDUSTRIES' SHOW
 COBO HALL, DETROIT, MICHIGAN
 OCTOBER 28, 29, 30
 (Wednesday, Thursday, Friday)**

MAIL TO:	Coatings Federation Housing Bureau 100 Renaissance Center, Suite 1950 Detroit, MI 48243
-----------------	--

APPLICATION FOR ACCOMMODATIONS

Please indicate below the type of accommodations requested and your choice of hotels. Room reservations cannot be guaranteed unless this form is received by October 1. All reservation requests must be in writing and processed through the Housing Bureau. Phone requests will not be accepted.

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

CHOICE OF HOTELS:
(see below)
1st
2nd
3rd
4th

Hotel assignments will be made in the order received, and in accordance with availability. The Housing Bureau will send you an acknowledgment which will state the hotel to which you have been assigned. The confirmation of your reservation will come to you directly from the hotel, to whom you must direct all of your inquiries.

Note: Reservations for the Detroit Plaza will be accepted for arrival beginning Wednesday, October 28, only. Any requests for Plaza accommodations prior to Wednesday will be assigned to another hotel.

Please fill in the names and addresses of all occupants of the rooms you have reserved. (Bracket those rooming together.) Incomplete information will delay assignment of rooms. Type additional names on reverse side of this sheet. Please give accurate arrival and departure dates.

Type of Room	Name	Address	Dates of	
			Arrival	Departure

SEND CONFIRMATION FOR ALL RESERVATIONS TO:

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

TELEPHONE _____

(For Convention Bureau use only) RESERVATION FOLLOW-THRU	DATE & INITIAL
	Received at Housing Bureau
	Processed to Hotel/Motel
	Received at Hotel/Motel
	Confirmed to Guest
Returned to Housing Bureau	

Coatings Industry Targeted for HMIS

A Hazardous Materials Identification System (HMIS), designed to inform production workers what hazards they encounter with the 1500 substances used in making paints and coatings, is available for use throughout the coatings industry, nationwide.

The system, which uses simple combinations of colors, numbers, and symbols, was developed jointly by the National Paint and Coatings Association's Occupational Health Task Force and the Canadian Paint and Coatings Association. HMIS is being introduced in Canada through CPCA. (For information on the use of HMIS in Canada, contact CPCA headquarters in Montreal, Quebec.)

NPCA states that member companies will receive HMIS starter kits and that a series of seminars, scheduled for May and June in cities across the U.S., will provide practical information on how to install HMIS.

As designed, the systems will inform employees of the hazard associated with substances in the areas of health, flammability, and reactivity by a numerical severity index from 0-4. In addition, a personal protection index is given which codes the type of protective equipment necessary for the safe handling of the material.

Information for assigning the codes is

obtained from the raw material supplier. Coded labels are attached to material containers and the appropriate hazard and necessary personal protection may be determined at a glance. Employees will be provided with wallet cards explaining the codes and wall charts detailing the ratings will be placed throughout the plant.

A training program is available from

NPCA for instructing employees in the use of HMIS. The program includes a slide/tape audio-visual segment and a 12-page booklet, "Forewarned is Forearmed!," which details the entire program and tests the employee on comprehension.

For information, contact NPCA, 1500 Rhode Island Ave., N. W., Washington, D.C. 20005.

HEALTH HAZARD RATING CHART	
0 MINIMAL HAZARD	no significant risk to health
1 SLIGHT HAZARD	irritation or minor reversible injury possible
2 MODERATE HAZARD	temporary or minor injury may occur
3 SERIOUS HAZARD	major injury likely unless prompt action is taken and medical treatment is given
4 SEVERE HAZARD	life threatening major or permanent damage may result from single or repeated exposures

FLAMMABILITY HAZARD RATING CHART	
0 MINIMAL HAZARD	materials which are normally stable and will not burn unless heated
1 SLIGHT HAZARD	materials that must be preheated before ignition will occur. Flammable liquids in this category will have flash points (the lowest temperature at which ignition will occur) at or above 200°F (NFPA Class II and Class IIA)
2 MODERATE HAZARD	material which must be moderately heated before ignition will occur, including flammable liquids with flash points at or above 100°F and below 200°F. (NFPA Class II and Class IIA)
3 SERIOUS HAZARD	materials capable of ignition under almost all normal temperature conditions, including flammable liquids with flash points below 73°F and boiling points above 100°F as well as liquids with flash points between 73°F (NFPA Classes IB and IC)
4 SEVERE HAZARD	very flammable gases or very volatile flammable liquids with flash points below 73°F and boiling points below 100°F (NFPA Class IA)

Hazardous Materials Identification System

HAZARD INDEX	
4 Severe Hazard	1 Slight Hazard
3 Serious Hazard	0 Minimal Hazard
2 Moderate Hazard	

PERSONAL PROTECTION INDEX	
A	
B	
C	
D	
E	
F	

NPC hms-C1

G	
H	
I	
J	
K	
X Ask your supervisor for specialized handling directions	

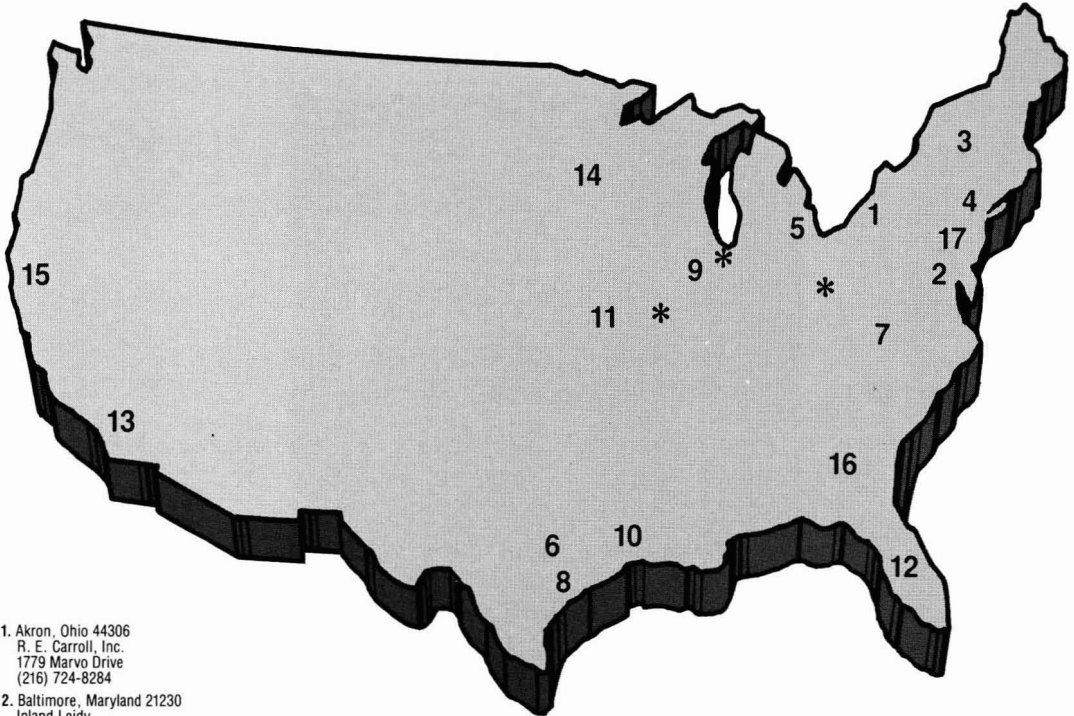
 <small>Safety Glasses</small>	 <small>Splash Goggles</small>	 <small>Face Shield</small>	 <small>Airline Hood or Mask</small>	 <small>Gloves</small>
 <small>Synthetic Apron</small>	 <small>Dust Respirator</small>	 <small>Vapor Respirator</small>	 <small>Combination Dust & Vapor Respirator</small>	
 <small>Full Protective Suit</small>	 <small>Boots</small>			

REACTIVITY HAZARD RATING CHART	
0 MINIMAL HAZARD	materials which are normally stable, even under fire conditions, and which will not react with water.
1 SLIGHT HAZARD	materials which are normally stable, but can become unstable at high temperatures and pressures. These materials may react with water, but will not release energy violently.
2 MODERATE HAZARD	materials which in themselves are normally stable and will readily undergo violent chemical change, but will not detonate. These materials may also react violently with water.
3 SERIOUS HAZARD	materials which are capable of detonation or explosive reaction, but require a strong initiating source, or must be heated under confinement before initiation, or materials which react explosively with water.
4 SEVERE HAZARD	these materials are readily capable of detonation or explosive decomposition at normal temperatures and pressures.

Asarco covers America with Zinc Oxide

To provide you with extra fast service on zinc oxide, Asarco has set up a nationwide network of stocking distributors. They all carry Asarco's American and French Process zinc oxides...in many grades...in large, medium and fine particles...either nodular or acicular.

Our distributors also have the technical know-how to help you use zinc oxide most advantageously. When you need zinc oxide in a hurry, or have a zinc oxide problem, contact the Asarco distributor nearest you or ASARCO Incorporated, P.O. Box 327, Columbus, OH 43216.



1. Akron, Ohio 44306
R. E. Carroll, Inc.
1779 Marvo Drive
(216) 724-8284

2. Baltimore, Maryland 21230
Inland Leidy
900 South Eutaw Street
(301) 685-2200

3. Braintree, Massachusetts 02184
C. K. Mullin, Inc.
222 Forbes Road
(617) 848-1680

4. Brooklyn, New York 11229
Nortman Associates, Inc.
1707 Kings Highway
(212) 645-1167

5. Detroit, Michigan 48212
Baker & Collinson, Inc.
12000 Mt. Elliott
(313) 366-2100

6. Garland, Texas 75040
Ribelin Sales, Inc.
3857 Miller Park Drive
P.O. Box 401673
(214) 272-1594

7. High Point, North Carolina 27260
Deeks & Co., Inc.
1159 Blandwood Circle
Box 1492
(919) 885-8185

8. Houston, Texas 77055
Ribelin Sales, Inc.
7786 Blankenship
(713) 688-7722

9. Itasca, Illinois 60143
Jensen-Souders Associates Inc.
725 North Baker Drive
(312) 773-1830

10. Jefferson, Louisiana 70121
Ribelin Sales, Inc.
4761 River Road
(504) 733-1112

11. Kansas City, Kansas 66110
Morton-Myers Company, Inc.
59 Ewing Street
P.O. Box 2448
(913) 621-2301

12. Largo, Florida 33540
Gulf Coast Chemical Corp.
1185 Baskins Road
(813) 584-7121

13. Long Beach, California 90810
Federated Metals Corporation
2751 East El Presidio Street
(213) 638-9333

14. Minneapolis, Minnesota 55409
Chemquip Corporation
4325 Nicollet Avenue South
(612) 827-5951

15. San Francisco, California 94119
Federated Metals Corporation
1901 Army Street
P.O. Box 3612
(415) 282-3340

16. Stone Mountain, Georgia 30083
Deeks & Co., Inc.
4748 Lewis Road
(404) 938-3100

17. Trenton, New Jersey 08601
R. E. Carroll, Inc.
1570 North Olden Avenue
P.O. Box 139
(609) 695-6211

Asarco Sales Offices

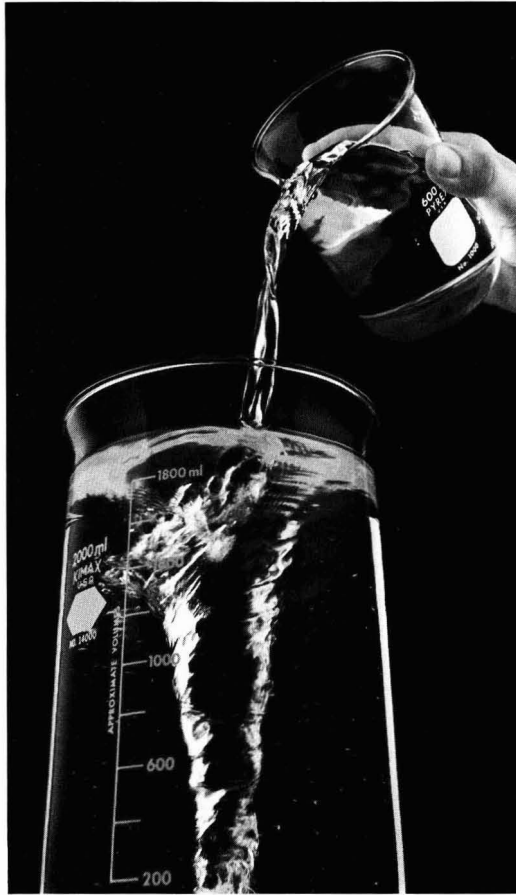
* Columbus, Ohio 43216
P.O. Box 327
(614) 294-5566

* St. Louis, Missouri 63101
611 Olive Street
Suite 1755
(314) 231-9490

* Whiting, Indiana 46394
P.O. Box 471
(312) 375-5100

ASARCO

Now with Carstab® 702 you can pour more ultraviolet light stability into your coatings.



Protecting a coating from the damaging effects of sunlight can be a tough job. But now, you can make it much easier by pouring in protection with Carstab 702.

Carstab 702 is a liquid ultraviolet light stabilizer that can retard color development and loss of physical properties in coatings due to deterioration caused by sunlight.

And because Carstab 702 is a liquid, it's much easier to use than conventional solid stabilizers. There are no dust problems. Carstab 702 is highly soluble in a wide range of resins and solvents. Handling costs are lower with the liquid. Low viscosity makes it

easy to pump and accurately meter Carstab 702. It also exhibits low volatility and low toxicity.

In short, Carstab 702 ultraviolet light stabilizer is a very cost efficient,

easy way to pour more value into a coating.

For more information about Carstab 702, call or write us. We'll also send along a sample you can test yourself.

Carstab Corporation, Cincinnati, Ohio 45215.
Phone 513-733-2100. In Canada, contact

Thiokol Canada Ltd., Carstab Division. Phone 416-259-1141.

In Europe, contact Carstab Corporation, B-3680 Maaseik, Belgium. Telex 846-39915 CARSTAB.

Thiokol
CARSTAB CORPORATION

© 1981 Thiokol Corporation • Carstab® is a registered trademark of Carstab Corporation.

Film Formation Mechanism Of Alkyl Silicate Zinc-Rich Coatings

Thomas Ginsberg
Union Carbide Corporation*

Experimental difficulties in measuring relevant properties have been an obstacle to a better understanding of the mode of action of alkyl silicate zinc-rich coatings. This is due partly to the peculiar nature of alkyl silicates and of the resulting films. There are therefore considerable misconceptions regarding their mechanism of film formation.

Three instrumental techniques not widely used in conventional coatings technology were utilized to study specific aspects of alkyl silicate zinc-rich coatings behavior: Thermogravimetry, Densitometry, and Dynamic Mechanical Analysis. The results are incorporated into a model of an alkyl silicate zinc-rich coating, which conforms to the observed behavior, and is useful in understanding their mode of action.

INTRODUCTION

Economics and conservation are the two most important factors determining the ever-growing need for improving the quality of protection of steel against corrosion. The excellent performance of zinc-rich coatings, together with their attractive nontoxic features, have propelled them to the forefront of anticorrosive technology. The many patents, review articles, and technical meetings dedicated to zinc-rich coatings are clear indications of the important role that they play in today's technical scene.

Although the anticorrosive effect is obviously credited to the zinc, many of the properties of a zinc-rich system are largely determined by the nature of the binder. While

true of virtually any coating, it is especially critical in the case of zinc-rich coatings because the binder's concentration in the resulting film must be low to allow the zinc particle-to-particle contact needed to carry on its electrochemical function. Thus, adhesion, cohesion, resistance to zinc by-products, water, and other environmental factors hinge on the quality of a component that may be present to a level of only 10% by weight of the total dry film.

The combination of mechanical and chemical resistance requirements has narrowed the choice of useful materials to a handful of high-performance binders. Binders derived from alkyl silicates have the advantages of inertness to chemical attack and complete solvent insensitivity. In addition, they do not freeze until at extremely low temperatures, nor leave any water-sensitive residue in the dry film, and they develop resistance to water wash-off almost instantly.

CHARACTERISTICS OF ALKYL SILICATE ZINC-RICH COATINGS

Alkyl silicates are peculiar compounds to which many conventional paint technology techniques, assumptions, and tests do not necessarily apply. There is a tacit consensus that much needs to be done in order to understand the fundamental mechanism of their action. Considerable work has been done to elucidate the chemistry of alkyl silicates in solutions,¹⁻⁵ however, little information exists on what occurs to the alkyl silicate once a film is applied on the substrate.

This type of information can be obtained readily with most conventional types of coatings. For example, the drying time of an alkyd paint may be defined by some rather objective criteria. If the drying process of the alkyd resin itself is to be studied, a film of the clear vehicle may be made, at representative thickness, to obtain valid data. Similar situations may be visualized in the case of films

*River Road, Bound Brook, NJ 08805.
Presented at the 58th Annual Meeting of the Federation of Societies for Coatings Technology in Atlanta, GA, October 29, 1980.

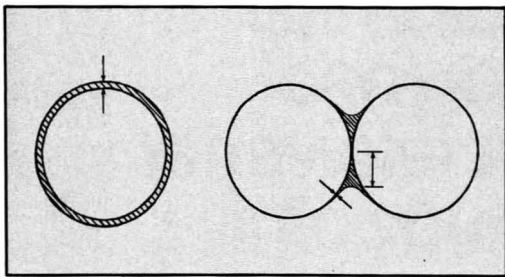
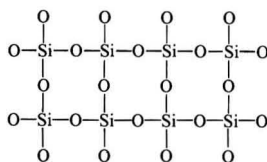
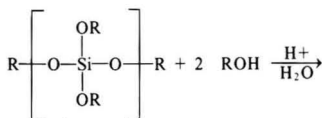
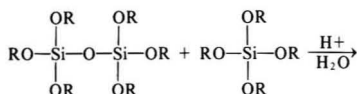
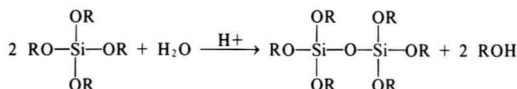


Figure 1—Patterns of binder distribution in a zinc-rich coating

that dry by solvent evaporation only, such as vinyls or nitrocellulose, or systems that undergo a chemical reaction, such as melamines or epoxies. In all of these cases, the composition of the resulting polymer film is known, either by synthesis, or by adopting a model representing the reacted species.

The task is more difficult in the case of alkyl silicates. Changes in the film can be caused only by the processes of hydrolysis and condensation, as shown schematically in the following equations:



While in the initial stages of hydrolysis the polymer has sufficient organic radicals to render it soluble. As the reaction progresses, the inorganic character grows until, ideally, all organics have been hydrolyzed, and the film is totally inorganic. While the extent of hydrolysis of alkyl silicates in solution can be controlled rather well by careful measurement of the amount of water added to the medium, monitoring the instantaneous condition in a drying film of a zinc-rich coating is impaired since it involves very small changes in a component that is

present in low concentration. The major component, zinc, overshadows and obscures the detection of the binder.

Moreover, the polymer cannot be readily isolated for separate study. If one attempts to obtain a clear, unpigmented film of an alkyl silicate, the result is a discontinuous deposit of brittle chips which are not useful for the measurement of film properties. To the unaware coatings technologist, the material may not appear as having filming properties. This is partly correct, since the function of the alkyl silicate is more as a binder, or adhesive, between particles of zinc and to the substrate, than as a solid matrix in which the particulate solid pigment is dispersed.

There is another limitation to the study of representative films of alkyl silicates. It can be calculated that if complete hydrolysis would occur, for example, in a 90:10 zinc-to-SiO₂ ratio zinc-rich coating, and the resulting SiO₂ would be uniformly distributed around the zinc particles, the thickness of the SiO₂ layer would be in the order of a few thousand nanometers (hundred angstroms) (Figure 1A). Of course, this situation is not likely to occur. More plausible is a distribution following the meniscus generated by surface tension, such as shown in Figure 1B, in which the binder's thickness will vary considerably. Thus, while some portions of the binder will have relatively ready access to atmospheric moisture, other parts will require considerable time for water diffusion.

This configuration is supported by Scanning Electron Microscope (SEM) observations as shown in Figure 2. Attempting to study the film formation of an alkyl silicate in clear films strong enough to handle would mean using thicknesses several thousand times greater than those resulting in an actual zinc-rich film. The surface area exposed per unit weight of binder would thus be far smaller, so the rate of capturing the atmospheric water needed for the film-forming process would be substantially lower.

Yet, some form of monitoring of films of alkyl silicate zinc-rich coatings is essential to the industry. The sought-after, but elusive parameters "drying time," rate of hardening, time to recoat, time to place the job in service, etc., are all manifestations of that need.

The objective of the work was to understand the changes in the drying of alkyl silicate zinc-rich coatings. Often, it was found that a given experimental technique clarified a narrow segment of the overall problem. It is only through the understanding and fitting of various aspects of the problem that a coherent overall picture can be assembled.

NONVOLATILE CONTENT

The curing mechanism of alkyl silicates proceeds through a series of hydrolysis steps, liberating alcohol which subsequently evaporates. It is therefore plausible to attempt to monitor the curing process by some method that measures the loss of mass.

The coatings industry uses solids content as one of the most simple and reliable tests available. A solids content determination is made by simply baking a given amount

of material to constant weight; the operation takes a couple of hours, and requires only common laboratory equipment.

When the solids of a polymer solution are determined, the results will depend on the nature of the material being tested. If the polymer is a high molecular weight thermoplastic that dries by solvent evaporation only, the resulting value will be quite close to the actual polymer concentration. When solids are determined in a heat-reactive polymer, the results usually can be correlated well with a given final chemical structure, which accounts for any loss of mass. In those few cases where the curing process involves the uptake of a component in the air (as with alkyls), the rate of such reaction is so slow that it is hardly measurable.

Alkyl silicates are different. They are polymers in solution, thus they will undergo the normal process of solvent evaporation. The next step, though, is unique in that during cure (through hydrolysis by uptake of atmospheric moisture and subsequent condensation) more alcohol is generated as a by-product. This alcohol may be considered, initially at least, to be part of the solvent composition.

The rate at which the various steps of this process occurs can be affected by temperature changes. Thus, the initial evaporation of solvent will obviously be greatly accelerated by increasing the temperature. Hydrolysis, while also accelerated by higher temperatures, depends on the availability of moisture to effect the reaction, and so the overall thermal effect is likely to be lower than for the evaporative step. Further increases in temperature will probably change the *nature* of the resulting polymer network. In other words, the configuration of the polymeric network will be different if the film is allowed to grow by slow reaction at ambient conditions (as it will be in actual use) than if forced by heat.

At sufficiently high temperatures, all organic portions of the molecule are given off, and the remainder are the true, ultimate "solids" of the alkyl silicate: silica arranged in a tridimensional polymeric network. While such a result is achieved only upon very severe calcination conditions (1800°C), it is obvious that from room temperature up to calcination there is an infinite number of possible conditions which will result in correspondingly different ratios of organics given off by various mechanisms. Therefore, the results of a conventional "solids" determination will not be an accurate measure of the nonvolatiles matter which the same amount of alkyl silicate solution would yield under room temperature drying conditions.

Another factor affecting those processes is the mass-to-surface ratio described above. It is clear that a useful amount of alkyl silicate in a dish used for a solids determination will be much thicker than the film that surrounds a zinc dust particle in an actual coating. Therefore, the rate of humidity uptake, being directly proportional to the surface area exposed, will be much lower during a determination of solids in the neat material.

This discussion explains the observation, frequently puzzling even for experienced people, that "solids" determinations of alkyl silicates have poor reproducibility,

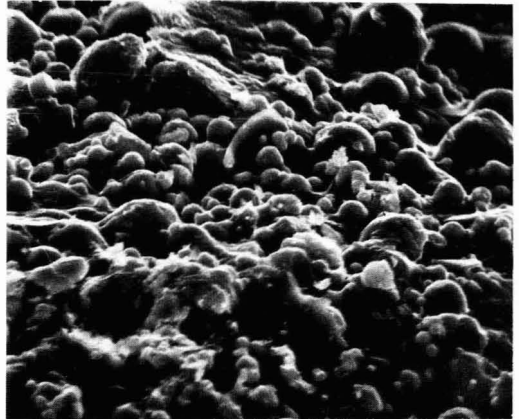


Figure 2—Scanning electron micrograph (2150×) of an alkyl silicate zinc-rich coating showing pattern of binder distribution

and varies not only with the baking temperature, but even with the type of oven, and the geometry of the sample.

"Solids" determination, therefore, is not an adequate method to monitor changes occurring in an alkyl silicate zinc-rich coating. Conceivably, one could attempt to do it with the complete coating (vehicle plus zinc) (Figure 3). There is a sharp initial weight loss which slowly tapers off, leveling out into a very gentle plateau. Obviously, the initial weight loss is caused by the fast release of free solvent in which the alkyl silicate is dissolved. The relatively large percentage of solvent given off in the initial portion of the curve makes it possible to carry the experiment in a common analytical balance. Doing so, the plateau may be seen as incorrectly as the "constant weight" condition of the conventional "solids" determination.

In reality, this is not so. The plateau is actually a very gentle but steady slope, which continues downward for a very long time, indicating that the volatile matter contained in the film has not been expelled completely. The magnitude of that weight change is generally so small that it is very difficult, if not impossible, to detect even in a common analytical balance. However, understanding of the nature of this slope is essential in explaining the mode of action of alkyl silicates.

THERMOGRAVIMETRIC ANALYSIS

Accurate determinations of minute weight losses can be made even in very small samples with the aid of a thermogravimetric analyzer. This is simply an ultrasensitive balance having the capability of programming and controlling accurately the temperature history of the sample while its weight is continuously monitored and recorded in a chart. The technique is particularly appropriate for studying weight changes in alkyl silicate zinc-rich films because it can detect very small changes in a component that is present in small concentrations. The

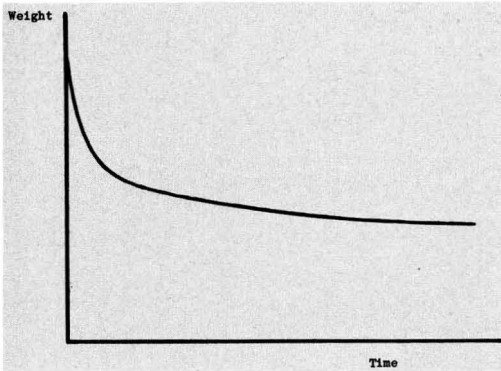


Figure 3—Typical "solids" determination in an alkyl silicate

versatility in programming temperature excursions enables the chemist to study the relative effect of the various processes which take place. The instrument used was the Perkin-Elmer TGS-1, shown schematically in Figure 4.

As discussed, a conventional "solids" determination does not provide meaningful results with alkyl silicates because the values obtained are distorted and augmented by the organic material remaining in the film. Eventually, these organics will hydrolyze and evaporate; therefore, they are a peculiar kind of transitory nonvolatile material. One way to monitor the instant condition of a zinc-rich coating would be to determine the content of residual organic matter. Theoretically, this could be accomplished by running a thermogravimetric analysis to a temperature high enough that would ensure the complete absence of organics (Figure 5). The range covered by the scale can be adjusted, depending on the expected percentage of loss. TGA determinations were made on a zinc-rich coating a month after application to a substrate. The temperature was programmed to rise 10°C per minute, starting at room temperature. The first portion of the curve shows a steady downtrend signaling the emission of organics. However, after about 420°C (melting point of zinc is 419.5°C) the direction of the curve depends on the atmosphere surrounding the sample: if the test is performed in air, the rate of zinc oxidation is greatly increased so that there is a net weight gain. If, on the other hand, the experiment is performed in nitrogen to avoid oxidation, the evaporation of the molten zinc generates a weight loss that overshadows that which could be associated to other processes. The conclusion, therefore, is that thermogravimetric determinations of zinc-rich coatings must be confined to under about 400°C .

A series of determinations within that range are shown in Figure 6. An alkyl silicate zinc-rich coating was sprayed on a substrate, and small portions of it were tested in the thermogravimetric analyzer at the heating rate of $10^{\circ}\text{C}/\text{min}$. Identical determinations were made in other portions of the same panel at periodic intervals. The first curve of Figure 6, determined 10 min after

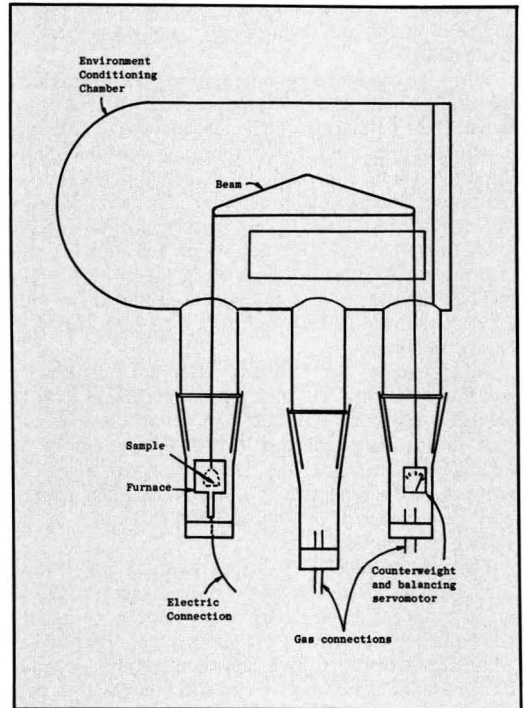


Figure 4—Thermobalance

application, exhibits features comparable to those of Figure 3: a sharp initial weight loss, followed by a gentle downward plateau.

Notice, however, that this curve shows a clearly demarcated step at about 310°C . This could be due to either the presence of an ethyl silicate oligomer boiling at that temperature, or the elimination of organic radicals linked in certain way. As the coating cures, subsequent thermogravimetric determinations show that the solvent portion is entirely depleted, and that the small step at 310°C progressively decreases in size and shifts to a somewhat higher temperature. This reinforces the hypothesis of an oligomer, since the slowly increasing temperature is an indication of molecular growth. Beyond one day, the step is no longer visible, and from there on the curves show the familiar gentle downward slope, except that the amount of weight loss gets smaller. It is clear that even after a year of drying, the coating still contains a measurable amount of organics.

Importantly, the weight loss continues steadily above 100°C , demonstrating that adsorbed moisture is not a factor. Also, the absence of sharp steps in the curves (aside from the one at 310°C , discussed before) demonstrates that elimination of organics is a continuing process, not a threshold situation. Therefore, it can be concluded that there is a great variety of positions where the radicals are attached, with correspondingly different levels of energy requirements for separation.

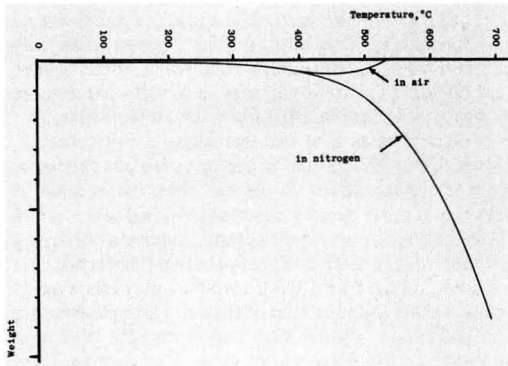


Figure 5—High-temperature thermogravimetric analysis in air and in nitrogen of a dried zinc-rich coating

Of course, all gravimetric determinations at temperatures higher than ambient are liable to the objection that they may not be representative of what occurs in actual use. The ideal thermogravimetric test under isothermal conditions, however, would require dedicating the instrument to a single sample for such an extended period that is clearly impractical.

DENSITOMETRY

The characteristics and properties of coating films are described in a more meaningful manner by volume than by weight relationships of components. This is due to the large differences between the density of pigments and that of binders. In calculating the film composition on a volume basis, it is essential to know the density of binders and pigments. As in the case with the determination of solids content, this is an easy task with conventional binders, which may be obtained in the form of a solid film by merely evaporating solvent, or by completing a chemical reaction.

Extension of this procedure to alkyl silicates is, therefore, quite natural in attempting to describe the composition and characteristics of zinc-rich coatings. Calculations are usually made on the assumption that the binder is the theoretical final product that should result when an alkyl silicate solution is applied, all of its solvents evaporate, and it subsequently undergoes hydrolysis and condensation to its ultimate stage, that is, SiO₂. The value of binder density generally used, therefore, is that found in tables listing the density of silicon dioxide, which, depending on its crystalline form, ranges between 2.2 and 2.6 g/cc.

The results of thermogravimetric analysis give a clear indication that the changes in an alkyl silicate are not that simple or fast. Although the initial solvent evaporation stage indeed proceeds as expected, the chemical transformation of the binder does not proceed to full conversion to SiO₂. The increasing rigidity and consequent reduced mobility of the chains result in slower and slower rates of hydrolysis of alkoxy groups. The organic groups which remain attached to the network for pro-

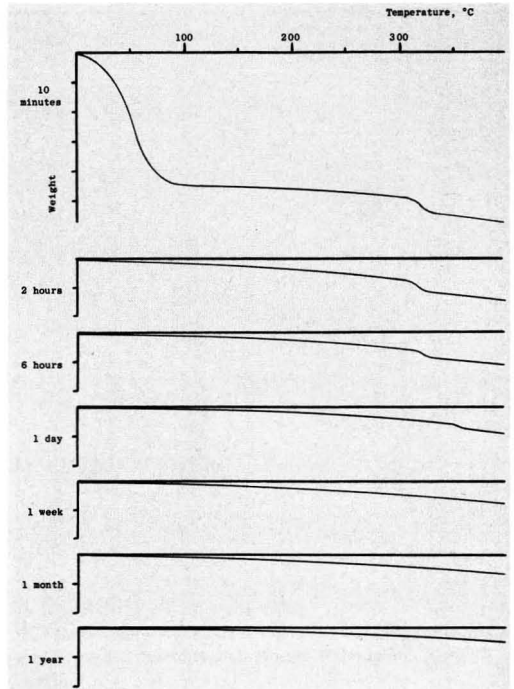


Figure 6—Low-temperature thermogravimetric analysis of an alkyl silicate zinc-rich coating at various times after application

longed periods of time, can be expected to disrupt the crystalline order and produce a density lower than that of SiO₂.

Almost without exception, when a monomer polymerizes, its density increases. Densitometry is a technique frequently utilized to monitor polymerization processes, and may be used to measure the elusive "rate of curing" of alkyl silicate zinc-rich coatings. Unfortunately, the masking effect of the zinc pigmentation described before makes it impossible to measure small differences of binder density in a composite where the inert component outweighs the changing component by a factor of almost 10. In this case, measurement of density of films of neat alkyl silicates is the only feasible route.

When clear films of alkyl silicates are allowed to dry, they don't form a continuous film, but rather they crack in small pieces which subsequently curl and flake off the substrate. Since the flakes are irregular and curly, they are not suitable for the study of film properties. Being transparent, they are even hard to see. However, they can be dyed, becoming readily visible in a liquid medium. The density of these flakes can be determined by a micro-densitometric technique. A procedure was developed for obtaining free alkyl silicate films by casting and distributing very thin films in flat-bottom (Petri) dishes.

Density of solids is often determined by the column density gradient method, (ASTM D-1505), which is difficult and cumbersome to prepare and calibrate. A less precise, but far more practical approach is that of making individual densitometric titrations.

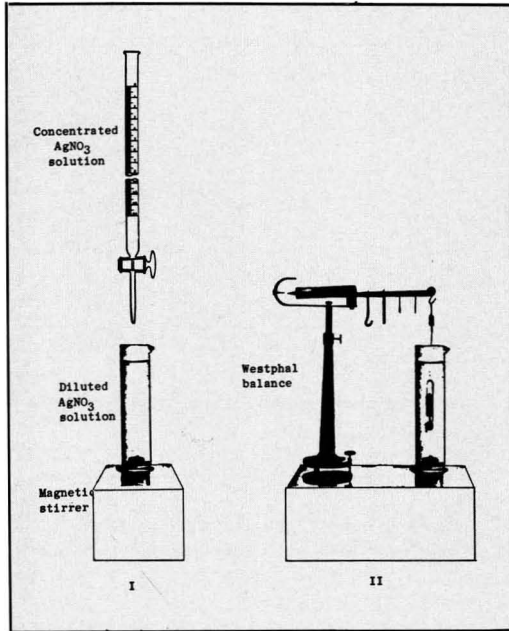


Figure 7—Density determination

The apparatus used is shown in *Figure 7*. The procedure consisted of placing small chips of the film in a clear solution of silver nitrate contained in a cylinder equipped with a magnetic bar, held on a magnetic stirrer base. Salt solutions of increasing specific gravity were used. Silver nitrate was selected because of the very high specific gravity attainable. The evaluation was started with a silver nitrate solution having a density of about 1.2. Since the initial density of alkyl silicate films was higher than 1.2, the chips tended to settle in the bottom of the tube, when the system was in repose.

A nearly-saturated solution of silver nitrate in water was then added dropwise with continuous agitation, and stopping periodically to ascertain whether the chip of film tended to sink or to float. As more of the concentrated solution of silver nitrate (having a density of about 2.4) was added, a point was reached when the density of the solution approached that of the chips, so that they settled to the bottom of the tube more and more slowly. When this stage was reached, the rate of addition of the concentrated solution of silver nitrate was slowed down and more mixing time was allowed between additions. When the fluid medium had density equal to that of the film, the chips seemed suspended in the fluid without tendency to float or sink. The titration was then suspended, and the density of the solution was determined with a Westphal balance, a simple, fast, and accurate method.

These densitometric titrations were continued for extended periods of time on alkyl silicate films drying under a variety of conditions. Typical data obtained is plotted in *Figure 8*, which shows the density variation

of films of 80% hydrolyzed ethyl and ethoxyethyl silicate as a function of time, both in films exposed to air only and in films which were cured underwater. It can be seen that all air-dried films increase in density much more slowly than do the films that were cured underwater. This fact demonstrates that the increasing density (that is, degree of polymerization) is due to hydrolysis (and subsequent condensation). A second observation made is that the rate of density increase of ethyl silicate and ethoxyethyl silicate under the same conditions of drying is almost identical. These data prove that there is no steric hindrance of the hydrolysis due to the bulky ethoxyethyl group, as compared to that of the ethyl groups. Another observation in *Figure 8* is that both sets of curves approach an asymptotic limit value. The air-dried films seem to level at a density of about 1.7, while the films immersed in water level off at about 1.9. In either case the asymptotic values are far below the 2.3–2.6 generally assumed. *Figure 8* also shows that the rate of density increase is likely to slow down substantially as time passes. It is highly improbable, therefore, that the density of those films will ever reach that of pure SiO_2 . At the rates of increase shown at the last stages of the experiment, it can be estimated that it would take between 5 to 10 years of density increase at the same rate to reach a density of 2.3. It could be postulated that hydrolysis has taken place to form silanols which end-block the polymer. However, this view would not support the observed long-term continued density increase.

MECHANICAL PROPERTIES

The process of drying and curing of a coating film involves a series of slow and continuous changes from a fluid liquid, to a viscous liquid, to a soft solid, to a hard solid. That is, the mechanical properties of the material change with time.

Most methods utilized in coatings technology to monitor the rate of drying of coatings involve some kind of mechanical measurement, subjective or quantitative. In oil-based coatings, for example, tack-free and print-free tests are mechanical in nature, although subjective and imprecise. These definitions of dry time are not applicable to zinc-rich coatings because they do not have tack and do not show prints.

The method of "dripping water" where a jet of water is aimed at the coating, is useful in the evaluation of alkyl silicate zinc-rich coatings because it has a direct correlation with the development of early resistance to rain. This property is a major practical advantage of alkyl silicates over water-based alkali silicate zinc-rich primers. While the former develops resistance to rain in a few minutes, the latter may take as much as 24 hours to develop comparable resistance, making it susceptible to be washed out by an unexpected rain. Actually, rain is beneficial for accelerating the process of film formation of alkyl silicates because the increased concentration of one of the reactants (water) results in a faster rate of hydrolysis. Many manufacturers recommend to hose down the coating a few hours after application in order to accelerate the hydrolysis process. On a microscale, the

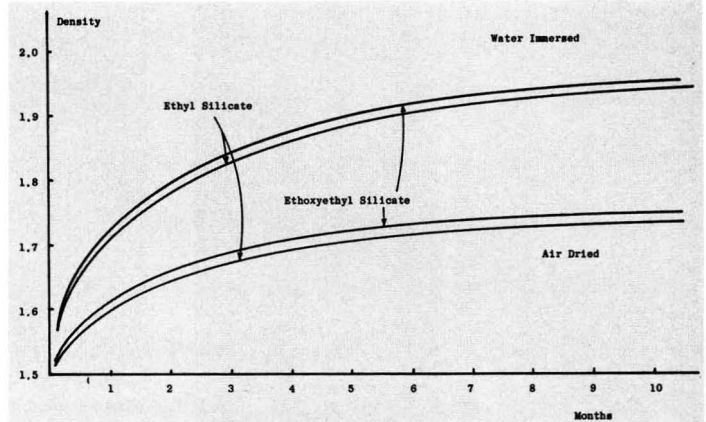


Figure 8—Density of films of alkyl silicates

meaning of the dripping water test comprises elements of mechanical impact and physical dissolution.

Another yardstick to determine the degree of drying zinc-rich coatings is the time necessary to get "hard." This has been and still is one of the most controversial and least understood aspects of this type of coatings. Practical testing is done with the fingernail, a coin, or a pencil. Attempts at quantifying the measurement have included instruments such as the Hoffman scratch tester. The problem with zinc-rich coatings is that either indentation or scratch test results are dependent on the apparent density of the coating: zinc-rich coatings are porous, and more or less porosity can result from various factors, including different application techniques. The rigidity of that porous structure is dependent on the concentration of voids. In addition, practically any physical indenture, however light, in a zinc-rich coating produces compaction of the zinc particles into a shiny mass that makes it difficult, if not impossible, to discern a superficial burnishing from a break through the film or even from the steel substrate itself.

CIRCULAR DRY-TIME RECORDER

This device, shown in Figure 9, consists of a ball-tipped probe driven by an arm connected to the gear-reduced shaft of an electric motor. When the device is placed on a freshly-applied coating, the ball-tipped pin describes a path of changing appearance as the coating dries. The type of path described is dependent on the coating used, thus arbitrary stages of drying must be defined in each case. A typical path described by an alkyl silicate zinc-rich coating is shown in Figure 10.

At the start (Point 0), the coating is still fluid for a short period of time, so it flows back to fill in the path made by the probe. At one point (Point 1), the viscosity of the coating has increased sufficiently so that it does not flow back; this point is arbitrarily designated as "Flow-Free." Increasing mechanical strength is evidenced by a structure which soon is pushed by the probe clean off the substrate, (Point 1,2) until a point is reached (Point 2) when the strength of the film is sufficient to resist the

force of the probe, which then rides over the surface of the film. This point is arbitrarily designated as "Through Dry." Very slight marks on the surface of the film are sometimes seen for a short while after the Through Dry point; their end is designated as "Hard Dry" (Point 3). Superimposing a graduated transparent template on the dried path after these conventional points have been marked, the operator can determine the dry times fairly accurately.

In order to eliminate the variables of solvent loss between spray gun and substrate, and different porosity due to different spraying techniques, this test is best determined on drawdowns made on sandblasted steel panels, so as to result in dry films of about 75 μm (3 mils) dry, the range most commonly used in the field.

Table 1 shows results obtained with representative products. The data obtained demonstrates that the values given by the Circular Dry Time recorder are mainly

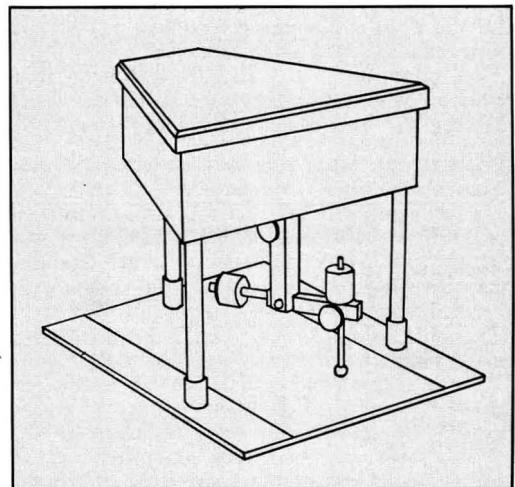


Figure 9—Circular dry time recorder

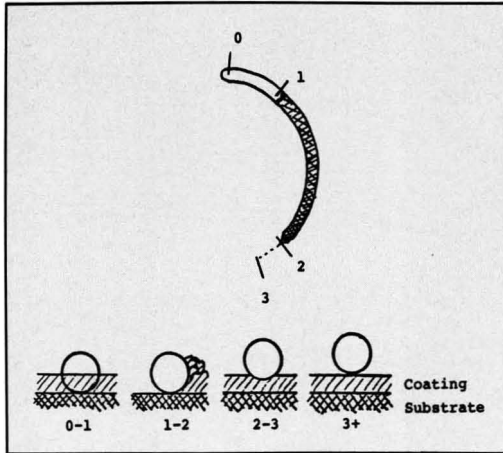


Figure 10—Typical zinc-rich tracing with a circular dry time recorder

related to the evaporation rate characteristics of the solvent. Beyond the "Through Dry" point, since the probe does not produce any visible trace, the procedure does not provide information on the changes occurring in the film.

DYNAMIC MECHANICAL TESTING

The development of the mechanical properties of a film can be monitored by the material's response to cyclic external forces. One of the instruments used is the Torsional Pendulum. In this instrument, the specimen is held in place by two clamps; the upper clamp is attached to the inertial counterbalanced wheel, which imparts an oscillating deformation to the sample. This deformation is transmitted to the arm attached to the other clamp; a motion transducer generates an electronic signal which is amplified and recorded. The instrument has a chamber where the environmental conditions to which the specimen is subjected can be controlled.

The principles for calculating the mechanical properties of the specimen have been described elsewhere,⁸ showing that shear modulus G' is proportional to the

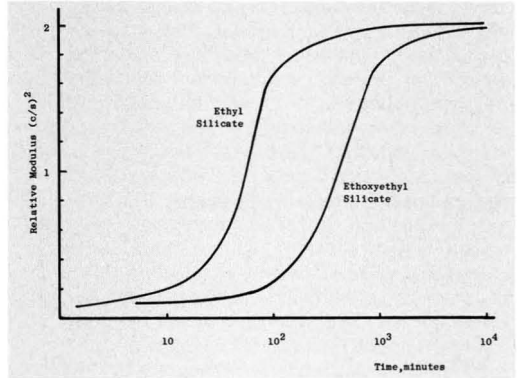


Figure 11—Dynamic mechanical testing of alkyl silicate zinc-rich coatings

square of the frequency of oscillation W . Therefore, the data is plotted as W^2 vs time.

Specimens, prepared by dipping strips of cellulose support medium in the paint, were then attached to the clamps, and measurements were started immediately by manually imparting a displacement on the inertial wheel. The oscillations generated are registered in a recorder, from whence W can be calculated.

When these data are plotted vs time on a semilogarithmic graph, curves typical of those shown in Figure 11 are obtained. This graph shows the changes in relative moduli of two zinc-rich primers based on ethyl and ethoxyethyl silicate. The ethoxyethyl curve shows a slower development of modulus as compared to ethyl; this trend is in agreement with the Circular Dry Time recorder data shown in Table 1.

A typical interpretation of the various sections of the curve for a reactive system indicates that the first inflection point would represent the induction time of the reaction; the slope of the midsection would represent the rate of the reaction, a steeper slope indicating a faster reaction, and the second inflection point leading to a stabilization of the modulus values, would indicate the end of the reaction. The significance of the data resides more on the location of the inflection points than on the numerical values, since these are only relative. However, the fact that the time to development of the inflection points is short, and that they correlate with the data obtained by circular dry time recorder, suggests a mechanism of solvent evaporation to critical packing of particles and subsequent plateau. Experiments aging specimens for relatively long periods of time (e.g., a week) showed that no measurable changes occurred, as compared to data obtained after about 1,000 min (i.e., overnight).

Similar experiments were performed in the Rheovibron®, another instrument designed to measure the mechanical properties of materials by impressing periodic forces. The mode of testing, however, differs from the torsion pendulum in that it operates at a definite frequency, and the force is applied as a tensile strain. Therefore, the data has the connotation of tensile modulus,

Table 1—Circular Dry-Time Recorder Test Results

Coating	A	B	C	D ^a	E ^a	F ^a
	Ethanol/ Cellosolve		Cellosolve			
Solvent	Ethanol					
Drying Time, Minutes						
Flow-Free	2	6	30	5	3	5
Through Dry	10	23	53	8	9	13
Hard Dry	11	25	58	10	10	16

(a) Typical commercially-available products—solvent composition unknown.

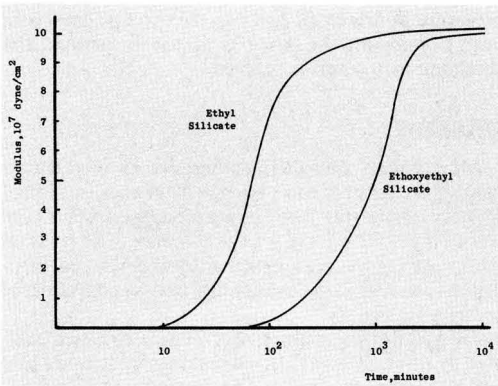


Figure 12—Dynamic mechanical testing of alkyl silicate zinc-rich coatings in a Rheovibron

rather than shear modulus, as is the case with the pendulum. The operation of the Rheovibron is based on the fact that, if a sinusoidal tensile strain is applied on one end of a specimen of viscoelastic nature, the sinusoidal stress generated at the other end of the sample will be displaced from the strain by a given phase angle. Modulus is calculated from the amplitude of stress and strain and angle value.

The specimen is held horizontally by two clamps, one of which is attached to the driver unit providing the oscillatory motion; the other is connected to a load transducer. Outputs from both the strain and stress transducers are combined to provide a single signal which is amplified and displayed in a meter. The instrument is equipped with an environmental chamber which permits conditioning of the sample during measurement. The data is computer processed, generating a table of results, which are replotted in semilogarithmic coordinates. Figure 12 shows the data obtained with typical formulations. The shape of the curves show a remarkable similarity to those obtained with the torsion pendulum. As can be seen, the modulus value reaches a plateau after a few hours, confirming the Torsion Pendulum results. Likewise, several samples were tested up to one week. Invariably, no measurable modulus increase was found.

MODEL OF FILM FORMATION

Instrumental measurement difficulties have hindered a clear understanding of the mechanism of film formation of alkyl silicate zinc-rich coatings. However, individual procedures and techniques can provide a clear, although limited, idea of narrow segments of alkyl silicate behavior. These separate pieces of information can be used to build a coherent model which conforms to the observed results, and offer a better understanding of how these coatings work.

Figure 13 incorporates the five elements discussed:

TIME: Shown in a logarithmic scale to emphasize events occurring immediately after application, and compress in the same scale a very long time.

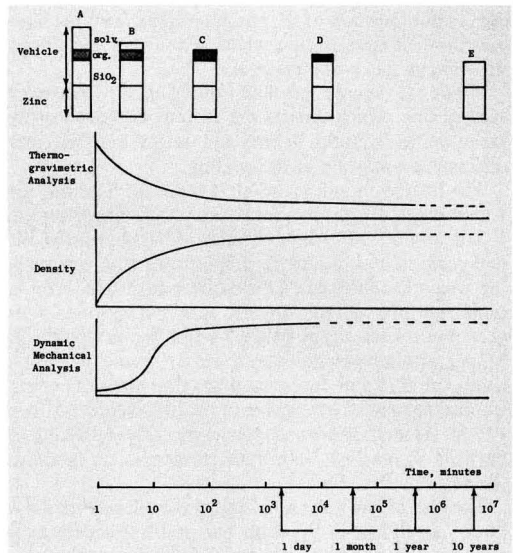


Figure 13—Model of film formation of alkyl silicate zinc-rich coatings

DYNAMIC MECHANICAL ANALYSIS: Shows, semiquantitatively, a curve representing typical determinations. The line is solid up to one week, signifying the time during which actual measurements were made. The dotted portion is the expected path on long-term exposure.

DENSITY: Describes, in a solid line, the density increase observed in clear alkyl silicate chips over a period of one year. Beyond that point, the dotted line indicates the estimated trajectory.

THERMOGRAVIMETRY: Shows, also in a semiquantitative form, the weight loss for a representative alkyl silicate zinc-rich coating. This curve is a summary of the results shown in Figure 6.

MODEL COMPOSITION: These three graphs serve to build the graphical model of film formation of alkyl silicate zinc-coatings shown in the upper part of Figure 13.

The bar graph section shows the theoretical composition of an alkyl silicate zinc-rich coating at several stages of the drying process. The various sections of each graph represent concentration by volume, in order to provide better visual resolution of the changes taking place. The composition has been limited to its essential ingredients of zinc and an alkyl silicate solution. The various ingredients are shown as separate sections of the bar graph. The top section of this bar graph indicates the concentration of solvent in the alkyl silicate zinc-rich primer prior to application. The second portion in the bar graph identifies the organic radicals attached to the SiO₂ network. Of course, these radicals are not separated from the network but are homogeneously combined in the chains. The third portion of the bar graph signifies the SiO₂ content of the formulation. This intends to depict the final theoretical amount of SiO₂ which can be expected to be produced by complete hydrolysis and condensation of the given amount of alkyl silicate used.

The bottom portion of the bar graph represents the concentration of metallic zinc, which of course is unchanged throughout the curing process.

Figure 13 should be read following an imaginary vertical line, which crosses the various curves showing variations in modulus, density and weight, and describes the instant condition of the coating.

The first bar graph at the left (Condition A) shows the composition of the zinc-rich primer before application.

The second bar graph (Condition B) represents the composition of a film of the alkyl silicate zinc-rich coating which has just been sprayed on a substrate. Here, a large portion of the solvent has evaporated. This accounts for the sharp weight loss shown in the weight TGA graph, accompanied by a sharp increase in density. Since the film still contains substantial amounts of entrapped solvent, the modulus of the film is still very low. As the solvent evaporates, however, critical packing of particles is reached, with a sharp increase in modulus (Conditions B-C-D).

The loss of free solvent is almost complete after a few hours, as shown in the third bar graph (Condition C) showing only a trace of retained solvent. Once the physical evaporation of the solvent has been almost completed, the chemical cure of the binder becomes the most important change in the film. The alkyl silicate reacts with atmospheric moisture, giving off alcohol molecules which slowly diffuse and evaporate from the film. This is proven by the weight loss in the TGA determinations, the very slow increase in density, as well as reaching the plateau in the modulus determinations. The process of hydrolysis, condensation, and elimination of organic material of the film continues slowly (Conditions C-D), increasing the density of the film and decreasing its weight. These changes have little effect on the tensile properties of the film because molecular chains no longer have the freedom of movement to approach each other and produce elimination of a molecule of water.

This model of the film formation of alkyl silicate zinc-rich coatings clearly indicates that the major properties of the film are determined within the first few days after application of the coating, and that no major changes can be expected for a long time, even years, thereafter.

The decreasing slope found in the densitometric measurements demonstrates that the rate of hydrolysis decreases substantially after a few days. This is reasonable, since the chains become increasingly rigid, and the progressive depletion of organic radicals makes it more and more difficult for the water to find a hydrolyzable group. Of course, the rate at which this decrease will occur depends on a number of variables, such as whether the zinc-rich coating is immersed or not, top-coated or not, etc. The ultimate theoretical condition is denoted by

condition E, where all hydrolyzable groups have been split. Considering the slow rate of density increase, this condition may never be reached.

SUMMARY

Alkyl silicate zinc-rich coatings are an increasingly important class of primers because of the excellent corrosion protection that they impart to steel, as well as the inertness resulting from a silicate binder. The study of these coatings has been hindered by experimental difficulties in measuring relevant properties by conventional coatings techniques.

The results of evaluating alkyl silicate zinc-rich coatings by three different instrumental techniques are presented: Thermogravimetry, Densitometry, and Dynamic Mechanical Analysis. The significance of the data obtained is discussed. The conclusions are incorporated into a model of an alkyl silicate zinc-rich coating that conforms to the observed behavior at the various stages of the life of the coating, from prior to application until one year after application and beyond. It is concluded that the properties of alkyl silicate zinc-rich coatings undergo most of their change in the first few hours after application, suggesting a mechanism of film formation through solvent evaporation which leads to critical packing of zinc particles, and a consequent increase in modulus. Subsequently, solvent evaporation is completed, leading to the unique situation of the binder generating more of its own solvent, which evaporates immediately. The density of the growing polymer increases at an extremely slow rate. Limit values strongly suggest a substantial concentration of organics remaining, finding reinforced by a continuing loss of mass by thermogravimetry. The image emerging from this model is that of zinc held by a polymer of continuously changing characteristics. This concept may be very useful in understanding some other of the peculiar characteristics of alkyl silicate zinc-rich coatings.

References

- (1) Bass, S. L. and Leitheiser, R. H., *Yale Sci. Mag.*, 34, 71 (1959).
- (2) Aelion, R., Loebel, A., and Eirich, F., *J. Am. Chem. Soc.*, 72, 5705 (1950).
- (3) Aelion, R., Loebel, A., and Eirich, F., *Rec. Trav. Chim.*, 69, 61 (1950).
- (4) Cogan, H. D. and Setterstrom, C. A., *Ind. Eng. Chem.*, 39, No. 11, 1364 (1947).
- (5) Peace, B. W., Mayhan, K. G., and Montle, J. F., *Polymer*, 14, 9 (1973).
- (6) Lange, N. A., "Handbook of Chemistry," 8th ed, 1952, p 284.
- (7) Ginsberg, T., Merriam, C. N., and Robeson, L. M., *J. Oil & Colour Chemist's Assoc.*, 59, 315 (1976).

Miscibility and Viscosity Considerations In Organic Cosolvent Selection For Water-Borne Coatings

Peter M. Grant
Tennessee Eastman Company*

Water-borne coatings utilize organic cosolvents to improve the solubility and rheological characteristics of a neutralized resin in water. To provide high-gloss coatings with desirable physical properties, cosolvents should ensure miscibility while the coating solvents evaporate during film formation. Such continuous miscibility depends on the coupling efficiency of the organic cosolvent. Coupling efficiency serves as a measure of the ability of a cosolvent to make a water-immiscible material miscible with water. Coupling efficiency is affected by temperature and depends on the distribution of the cosolvent between the organic and aqueous phases of the system. Miscibility diagrams of glycol ether/water-containing systems illustrate the effect of organic cosolvent on miscibility at elevated temperature and show that phase separation can occur on heating if the choice of cosolvent is incorrect for the resin, amine, and degree of neutralization. The choice of cosolvent also affects the viscosity of the coating system, as shown by the viscosity curves obtained on diluting cosolvent solutions of neutralized resin with water.

These concepts and the data given in this paper contribute to an understanding of water-borne coatings and to the selection of a cosolvent or cosolvent blend that will give desired application and coatings properties.

INTRODUCTION

Water-borne coatings are of great interest to the coatings industry because of their environmental desirability. A water-reducible system typically contains an amine-neutralized resin and other additives in water plus a high-boiling organic cosolvent to improve the solubility and the rheological and wetting properties. Formulations of these coatings are usually heated to evaporate the volatile components and, in the case of an enamel, to assist crosslinking. As the solvents evaporate, the water-to-organic-cosolvent ratio is reduced, and some amine is liberated, thus rendering the polymer less water-soluble.

Some formulations give glossy coatings when air-dried and flat coatings when force-dried. This behavior indicates that immiscibility or insolubility can occur at the higher temperature. Air drying or force drying may also change the cosolvent/water ratio due to the temperature dependence of evaporation behavior. To form films with high gloss and desirable physical properties, the neutralized resin must be soluble in the organic-cosolvent/water, and the mixture must remain miscible during film formation. Also the mixture should have rheological characteristics during the film forming process which decrease the likelihood of a reduction in viscosity which would encourage sagging. The rate of evaporation of solvents has been studied¹⁻⁵ and equations to predict the viscosities of aqueous solvent blends presented.^{6,7} This paper presents experimental data to determine the effect of glycol ether cosolvent on miscibility and viscosity which contribute to the selection of organic cosolvents that ensure miscibility during the compositional changes

* Research Laboratories, Kingsport, TN 37662.

Table 1—Coupling Efficiency of Glycol Ethers and Alcohols

Coupling Solvent	Coupling Efficiency Volume Fraction at Miscibility, %	
	Mineral Spirits/Water (1/1)	Isobutyl Isobutyrate/Water (1/1)
Ethylene glycol monomethyl ether (EM)	> 85	64
Ethylene glycol monoethyl ether (EE)	80	55
Ethylene glycol monopropyl ether (EP)	70	50
Ethylene glycol monobutyl ether (EB)	57	61
Ethylene glycol monohexyl ether (EH)	77	78
Diethylene glycol monomethyl ether (DM)	> 85	69
Diethylene glycol monoethyl ether (DE)	> 85	61
Diethylene glycol monopropyl ether (DP)	78	51
Diethylene glycol monobutyl ether (DB)	68	41
Diethylene glycol monohexyl ether (DH)	61	63
Methanol	> 85	60
Ethanol	80	50
Propanol	67	56
n-Butanol	78	76
tert-Butanol	61	60
Propylene glycol monomethyl ether (DM)	81	57
Propylene glycol monopropyl ether (PP)	71	70
Propylene glycol monobutyl ether (PB)	81	82
Propylene glycol methylpropyl ether (PDM)	79	62

that occur throughout the film formation process. It also shows that selection of organic cosolvents is important in controlling viscosity behavior and avoiding runs and sags.

COUPLING EFFICIENCY OF ORGANIC COSOLVENTS

The coupling efficiency of an organic cosolvent, or a coupling solvent, is a measure of its ability to make miscible an otherwise immiscible organic/water mixture. It is difficult to determine the coupling efficiency of a cosolvent for neutralized-resin and water mixtures by direct means. Therefore, a water-immiscible organic liquid was used as a model for the neutralized resin. By the procedure developed by Hansen,⁸ equal volumes of immiscible organic liquids and water were titrated with coupling solvent to the point of true mutual solubility, i.e., to the point where visual turbidity disappeared. Efficiency was expressed as the volume fraction of glycol ether in the mixture at the point of miscibility; a low-

Table 2—Effect of Alkyl Chain Length on Coupling Efficiency

Dialkyl Phthalate/Water (1/1)	Volume Fraction at Miscibility, %					
	Glycol Ether					
	EM	EE	EP	EB	EH	PP
Dimethyl phthalate	47.4	41.2	39.4	56.5	78.7	62.3
Diethyl phthalate	51.2	45.9	42.9	58.3	81.5	79.2
Dibutyl phthalate	68.7	60.0	51.2	61.9	79.6	79.2
Diocetyl phthalate	>83.3	72.2	62.3	55.9	79.6	69.5

number value for the required volume fraction indicates high coupling efficiency. The cosolvents that couple most efficiently require the presence of a lower volume fraction to achieve miscibility.

Effect of Structure of Glycol Ether Coupling Agents on Coupling Efficiency

The resultant coupling efficiencies of glycol ethers and alcohols for a mineral spirits/water model and an isobutyl isobutyrate/water model at 70°F (21°C) are shown in Table 1. The most efficient coupling was shown by a specific alkyl chain length of coupling solvent. Thus, ethylene glycol monobutyl ether (EB) was the most efficient alkoxyethanol for a mineral spirits/water model, but the more polar ethylene glycol monopropyl ether (EP) was the most efficient alkoxyethanol for the more polar isobutyl isobutyrate/water model. With alkyl ethers of diethylene glycol, a longer aliphatic chain was required to balance the effect of the diethylene glycol moiety, which is more hydrophilic than the ethylene glycol moiety. Thus, diethylene glycol monohexyl ether (DH) was the most efficient alkoxyethoxyethanol coupler for mineral spirits/water, and diethylene glycol monobutyl ether (DH) was the most efficient alkoxyethoxyethanol for isobutyl isobutyrate/water. Alkanols and alkoxypropanols showed a similar behavior.

Effect of Structure of Immiscible Organic Models on Coupling Solvent Efficiency

The dependence of the optimum coupling solvent on the nature of the immiscible organic model was confirmed by the use of a series of dialkyl phthalates. In Table 2, it can be seen that EP solvent was superior to EB solvent for the shorter-chain, more hydrophilic dialkyl phthalates, but not for dioctyl phthalate/water. Ethylene glycol monohexyl ether (EH) and propylene glycol monopropyl ether (PP) were relatively less efficient.

Relationship Between Coupling Efficiency And Partition of Coupling Solvents

The distribution of an insufficient amount of coupling solvent to cause complete coupling between the immiscible organic and water phases was determined by gas chromatographic analysis of the phases. As shown in Table 3, the most efficient alkoxyethanol coupling solvent for mineral spirits/water, EB solvent, was the

Table 3—Relationship of Glycol Ether Distribution and Coupling Efficiency

Immiscible Organic	Coupling Solvent	Coupling Solvent (%) in		Coupling Efficiency (Vol Fr, %)
		Aqueous Phase	Organic Phase	
Mineral spirits	EM	35.7	0.2	> 85
	EE	33.1	0.2	80
	EP	32.0	5.0	70
	EB	7.7	34.6	57
	EH	0.5	40.7	77
Isobutyl isobutyrate	EM	32.7	2.6	64
	EE	29.0	8.7	55
	EP	14.7	26.1	50
	EB	4.9	31.7	61
	EH	0.3	34.9	78
Diethyl phthalate	EP	14.9	21.3	43
	EB	2.5	28.4	58
Dioctyl phthalate	EP	22.0	8.9	62
	EB	8.3	30.5	56

Water/immiscible organic/coupling solvent = 2/2/1 by vol, 70° F (21° C).

lowest homolog preferentially distributed to the organic phase of the mineral spirits/water model. Similarly, the most efficient alkoxyethanol coupling solvent for isobutyl isobutyrate/water, EP solvent, was the lowest homolog preferentially distributed to the organic phase of the isobutyl isobutyrate/water model. The results for the dialkyl phthalate/water systems showed that EP solvent preferentially distributed to diethyl phthalate but not to dioctyl phthalate; it was a more effective coupler for diethyl phthalate than for dioctyl phthalate. In each case, it is significant that the most efficient coupling solvent was the lowest alkoxyethanol homolog preferentially distributed to the organic phase.

This preferential distribution depends on the polarity of the immiscible organic material. Thus, more polar immiscible organic materials are coupled most efficiently by more polar coupling solvents. These models suggest that as the polarity of the water-reducible neutralized resins increases, coupling solvents of higher polarity should be selected.

Coupling Efficiency of Solvent Blends

Coupling efficiency can be optimized by using solvent blends. When each coupling solvent in the blend was too hydrophilic, or when each was too hydrophobic for optimum coupling, the efficiency of the blend was nearly the proportionate average of the coupling efficiencies of the constituents. However, a blend of a solvent that was too hydrophilic with one that was too hydrophobic enabled a more uniform distribution of cosolvent between the phases and gave a coupling efficiency superior to that produced by the individual solvents. For example, as shown in Figure 1 for the isobutyl isobutyrate/water

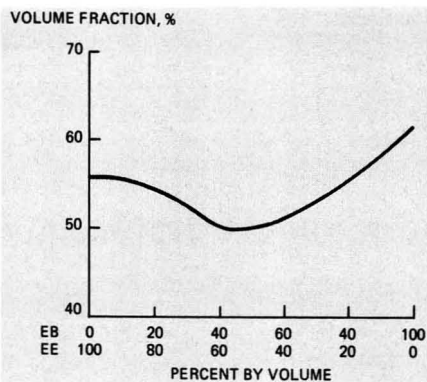


Figure 1—Coupling efficiency of EB/EE blends for isobutyl isobutyrate/water (1/1)

system, a one-to-one blend of too hydrophilic ethylene glycol monoethyl ether (EE) with too hydrophobic EB solvent had the superior coupling efficiency of EP solvent. Thus, cosolvent blends can be selected to achieve optimum coupling efficiency.

Effect of Temperature on Coupling Efficiency and Partition of Coupling Solvent

Temperature significantly affected the coupling efficiency of glycol ethers. For the isobutyl isobutyrate/water model, Figure 2 shows that the more hydrophilic methoxyethanol and ethoxyethanol increased in coupling efficiency as the temperature increased, but the longer chain alkoxyethanol homologs became less efficient as the temperature increased. Figure 3 shows a similar effect with diethylene glycol ethers: the ethoxy and propoxy derivatives were more efficient and the butoxy and hexoxy derivatives were less efficient at increased temperatures. Other model systems, such as mineral spirits and water, showed similar results.

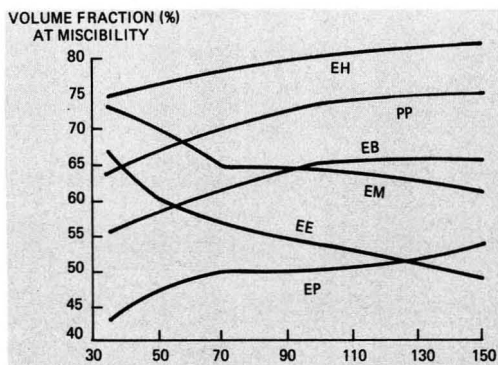


Figure 2—Effect of temperature on coupling efficiency for isobutyl isobutyrate/water (1/1)

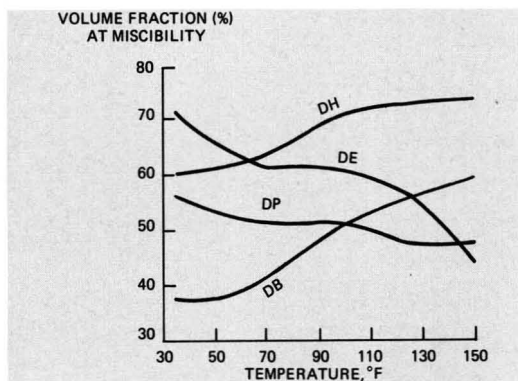


Figure 3—Effect of temperature on coupling efficiency for isobutyl isobutyrate/water (1/1)

To gain some insight into this relationship, an amount of glycol ether insufficient to produce miscibility was partitioned at 70° F (21° C) and at 150° F (66° C) between the isobutyl isobutyrate and water phases, and the phases were analyzed by gas chromatography. The results (Table 4) showed that each glycol ether partitioned more to the organic phase at the higher temperature than at the lower temperature. Thus EE solvent and diethylene glycol monoethyl ether (DE), which partitioned predominantly to the water phase, distributed more evenly at 150° F and had higher coupling efficiency. However, EB and DB solvents, which partitioned predominantly to the organic phase, distributed less evenly at the higher temperature, and the coupling efficiencies deteriorated.

These data support the concept that for maximum coupling efficiency, the solvents should tend to distribute uniformly between the phases. Also, these relationships between the coupling efficiency of glycol ethers and temperature suggest that the most efficient coupling solvent for an ambient-temperature, air-drying system is not the most efficient coupling solvent for use in a high-temperature, forced-drying system.

Table 4—Effect of Temperature on Relationship of Glycol Ether Distribution and Coupling Efficiency for Isobutyl Isobutyrate/Water (1/1)

Coupling Solvent	Coupling Solvent (%) In			Coupling Efficiency (Vol Fr, %)
	Aqueous Phase	Organic Phase	Difference	
At 70° F (21° C)				
EE	26.0	7.0	19.0	56
EB	5.1	32.9	27.8	61
DE	25.5	2.7	22.8	61
DB	8.3	27.2	18.9	41
At 150° F (66° C)				
EE	25.8	8.6	17.2	49
EB	3.2	34.3	31.1	65
DE	24.3	4.6	19.7	44
DB	4.0	30.0	26.0	59

Isobutyl isobutyrate/water/coupling solvent = 2/2/1 by vol.

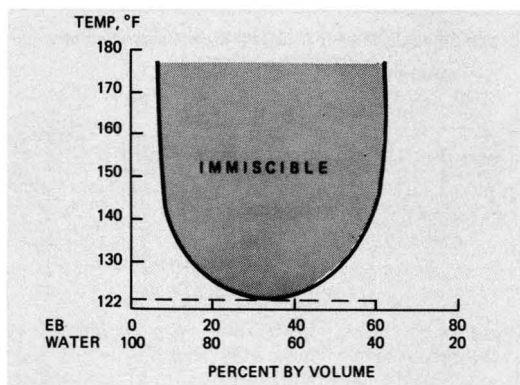


Figure 4—Miscibility diagram for EB solvent/water

EFFECT OF TEMPERATURE ON MUTUAL SOLUBILITY

Effect of Glycol Ether Structure On Lower Critical Solution Temperature Of Glycol Ether/Water Blends

Glycol ethers, and EB solvent in particular, are preferred organic cosolvents in water-borne coatings. In 1926, Cox and Cretcher⁹ determined a miscibility-vs-temperature diagram for ethylene glycol monobutyl ether/water mixtures. The lower part of this curve is shown in Figure 4.

As shown, EB solvent/water in a 20/80 ratio, which is typical for a water-reducible paint formulation, became immiscible at 127° F (52° C). The lower critical solution temperature, i.e., the temperature below which all proportions are miscible, was 122° F (50° C). The more hydrophilic EE and EP solvents were miscible with water in all proportions to 170° F (77° C), as shown in Table 5.

Addition of another solvent to EB solvent can increase or decrease the area of immiscibility and the lower critical solution temperature. When as little as 10% n-butanol, a cosolvent often used in water-borne coatings, was added to EB solvent, the lower critical solution temperature was reduced to 103° F (40° C), which is undesirable. However, solvent additives that are more hydrophilic will increase the lower critical solution temperature. Addition of 10% DE solvent to EB solvent produced a blend miscible with water in all proportions to 170° F (77° C). As shown, too, addition of 30% of another solvent to EB had a greater effect than addition of 10%.

PP solvent gave a greater area of immiscibility and a lower value for the lower critical solution temperature than did EB solvent. The butyl ether of diethylene glycol was more miscible with hot water than was the butyl ether of ethylene glycol.

Such miscibility diagrams help in selecting organic cosolvents that are less likely to cause problems due to phase separation in water-borne coatings.

Table 5—Lower Critical Solution Temperatures of Organic Cosolvent/Water Blends

Organic Solvent	Lower Critical Solution Temp, °F (°C)
EE	> 170 (> 77)
EP	> 170
EB	122 (50)
EB + 10% n-BuOH	103 (22)
EB + 10% tert-BuOH	127 (53)
EB + 10% DB	134 (57)
EB + 10% EE	159 (70)
EB + 10% DE	> 170
EB + 30% n-BuOH	< 75 (< 24)
EB + 30% tert-BuOH	147 (64)
EB + 30% DB	154 (68)
EB + 30% EE	> 170
EB + 30% DE	> 170
EH	< 75
PP	89 (32)
DE	> 170
DP	> 170
DB	> 170

Effect of Glycol Ether Structure, Resin Neutralization, and Temperature on Miscibility of Glycol Ether/Resin/Water Blends

The results mentioned previously from Table 4, that glycol ethers are partitioned less to the water phase at elevated temperatures, are consistent with miscibility diagrams, thus showing that glycol ethers tend to be less miscible with water at elevated temperatures. To simulate a water-borne coating formulation more closely, the effects of resin neutralization and glycol ether selection on miscibility were determined.

Soya alkyd resin Arolon® 378, underneutralized, neutralized, and overneutralized with triethylamine, was added to different proportions of glycol ether and water and then heated. The resultant miscibility diagrams (see Figure 5, where the shaded area represents separation) show that the degree of neutralization and the selection of glycol ether had a substantial effect on miscibility. Neutralized resin is usually more miscible than underneutralized or overneutralized resin. Addition of 10% of DE to EB solvent improved the miscibility. EP solvent gave the best latitude in miscibility. EE solvent alone gave miscibility problems with overneutralized resin, but a one-to-one blend of EB and EE solvents gave better miscibility than either solvent alone. Other work has shown that changing the resin or the amine changes the miscibility diagram.

The development of such miscibility diagrams for specific formulations contributes to the selection of a cosolvent that will ensure miscibility at all stages during film forming. It is desirable to eliminate the possibility that immiscibility can occur during drying as the cosolvent/water ratio increases and the temperature of the film increases.

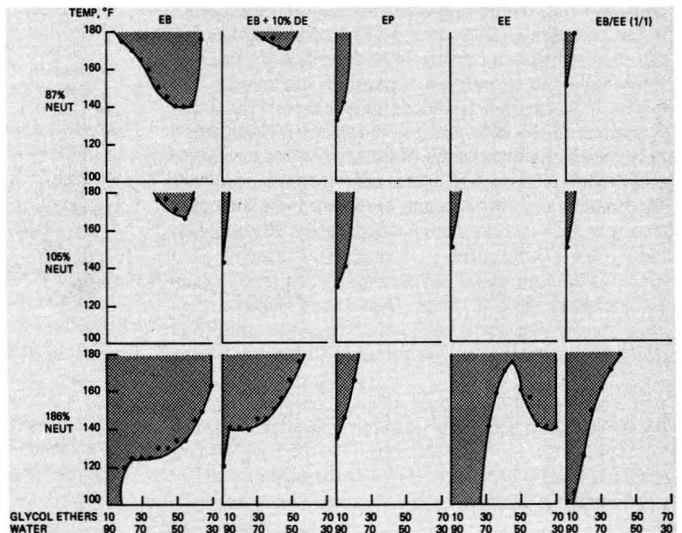
VISCOSITY/DILUTION CURVES

Effect of Glycol Ether Structure On Viscosity/Dilution Curves

Another consideration for the selection of an organic cosolvent is to achieve a sprayable formulation viscosity at a maximum solids level having rheological characteristics that discourage sagging. The Brookfield viscosity for the dilution with water of a 66.7% solids solution

Arolon is a registered trademark of Ashland Chemical Co.

Figure 5—Miscibility diagrams for glycol ether/water containing 30% "Arolon" 378 resin + triethylamine



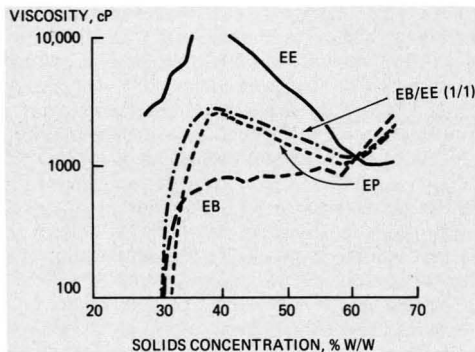


Figure 6—Viscosity on diluting "Aroclor" 378 resin + triethylamine 66.7% in alkoxyethanol with water at 23°C

of Aroclor 378 soya alkyd resin, 105% neutralized with triethylamine, in a glycol ether/water blend, is shown in Figure 6. The solution in EE solvent gave a high viscosity peak on dilution with water, whereas the solutions in EB did not. Solvent blends such as EE and EB gave viscosity/dilution curves intermediate between those of their components. Similarly, a solution in DE solvent showed a viscosity peak on dilution with water; solutions in DB did not.

Replacing the soya alkyd resin with an oil-free alkyd¹⁰ demonstrated a similar relationship between the effect of the glycol ether and the shape of the viscosity/dilution curve. A solution in EE solvent had a very high viscosity peak on dilution with water; a solution in EB did not.

Curves for the viscosity/evaporation relationship that occurs during the drying of a coating can approximate the reverse of the curves for viscosity/dilution relationships. When the viscosity decreases on evaporation of the solvent, there is a chance that the coating will sag; that is, a high peak in the viscosity/dilution curve represents a warning that sagging may occur. Therefore, knowledge of such curves will help in selecting a glycol ether cosolvent that will minimize the likelihood of sagging.

The occurrence of viscosity peaks on dilution of a resin salt solution with water has been described by Hill and Brandenburger to polyion expansion and micelle formation.^{11,12} As water is added, there is an increased dissociation of the salt groups and increased repulsion between the anions, which cause an increase in macromolecular size. Also, aggregates of hydrophobic polymer segments swollen with organic cosolvent form a micellar structure that increases solution viscosity. Presumably,

for example, EE solvent gives an environment which is more conducive to polyion expansion and micelle formation than does EB solvent.

CONCLUSION

The choice of an organic cosolvent or cosolvent blend for a water-borne coating formulation should include consideration of miscibility and viscosity properties. Immiscibility which may occur on heating a formulation and can lead to low-gloss coatings can be avoided by choosing a glycol ether homolog or blend which has an appropriate hydrophilic/hydrophobic balance to enable it to distribute uniformly between the potentially immiscible phases and couple them most efficiently. The optimum cosolvent composition depends on the resin, the neutralizing agent, and the degree of neutralization. Sagging may occur in a coating due to a viscosity decrease during evaporation of the solvent. This can be avoided by using a cosolvent which does not give a high peak in its viscosity/dilution curve. Cosolvents which have effective coupling properties may give undesirable viscosity properties. Overall consideration of coupling efficiency, miscibility diagrams, and viscosity dilution data can contribute to the selection of an organic cosolvent that will give the most desirable application and coatings properties.

References

- (1) Rocklin, A. L., *JOURNAL OF COATINGS TECHNOLOGY*, **48**, No. 622, 45 (1976).
- (2) Rocklin, A. L., *JOURNAL OF COATINGS TECHNOLOGY*, **50**, No. 646, 46 (1978).
- (3) Rocklin, A. L., *Proc. Water-Borne Higher-Solids Coatings Symp.*, **6**, No. 1, 110 (1979).
- (4) Dillon, P. W., *JOURNAL OF COATINGS TECHNOLOGY*, **49**, No. 634, 38 (1977).
- (5) Stratta, J. J., Dillon, P. W., and Semp, R. H., *JOURNAL OF COATINGS TECHNOLOGY*, **50**, No. 647, 39 (1978).
- (6) Rocklin, A. L. and Edwards, G. D., *JOURNAL OF COATINGS TECHNOLOGY*, **48**, No. 620, 68 (1976).
- (7) Rocklin, A. L. and Barnes, J. A., *JOURNAL OF COATINGS TECHNOLOGY*, **52**, No. 665, 23 (1980).
- (8) Hansen, C. M., *Ind. Eng. Chem., Prod. Res. Dev.*, **16**, No. 3, 266 (1977).
- (9) Cox, H. L. and Cretcher, L. H., *J. Am. Chem. Soc.*, **48**, 451 (1926).
- (10) Technical Bulletin, "Enamel Prepared from Polyester Resin WS-3-1C," Eastman Chemical Prod., Inc., Kingsport, TN 37662.
- (11) Hill, L. W. and Brandenburger, L. B., *Prog. Org. Coat.*, **3**, 361 (1975).
- (12) Brandenburger, L. B. and Hill, L. W., *JOURNAL OF COATINGS TECHNOLOGY*, **51**, No. 659, 59 (1979).

Considerations on a Cantilever (Beam) Method For Measuring the Internal Stress In Organic Coatings

Dan Y. Perera and D. Vanden Eynde
Laboratoire I.V.P.*

The conditions necessary to obtain valid results with a cantilever (beam) method for measuring the internal stress in organic coatings are discussed. The method consists of measuring the deflection of a cantilever substrate coated on one side and vertically clamped at one end to a support. A significant error can be introduced if the effect of clamping is disregarded and the cantilever substrate is not carefully chosen. The maximum internal stress of two coatings investigated (a thermoplastic and a thermosetting varnish) appears to be independent of coating and cantilever substrate thicknesses. Erroneous conclusions can be drawn if an inadequate mathematical equation is used to calculate the internal stress.

INTRODUCTION

The importance of the study of internal stress (called also residual stress) in inorganic coatings (e.g., applied by vacuum deposition or electroplating¹⁻⁴) and in plastic materials^{5,6} is well established. It was demonstrated that the presence of this stress may lead to detachment and/or cracking of the coating.

Interest in the study of development of internal stress in organic coatings is more recent⁷⁻²⁵ and is related to the appearance of damage which could not be explained by inadequate coating application, substrate preparation, etc.

During the drying process of organic coatings, and independent of the way the film formation mechanism occurs (solvent evaporation, coalescence, chemical reaction or their combination), the coating tends to shrink. If

the contraction is partially restrained by the film adhesion to a substrate and/or the mobility of macromolecular segments is hindered, stresses will develop in the film.

It should be mentioned that during the service life of a coating significant stresses can also develop as a result of variation in relative humidity and/or temperature. When internal stress exceeds the adhesive and/or cohesive forces of the film, damage (detachment and/or cracking) occurs.

The method used to measure the internal stress depends mainly on the nature and the dimensions of the material to be investigated. Among the methods proposed in the literature one can note the following: optical^{5,6,15,26} (photoelasticity for thick transparent materials), stress gauges,²⁶ brittle lacquer coatings^{26,27} and the cantilever (beam).^{9-13,16,17,19(a),21} The cantilever (beam) method appears to be the most commonly used and suitable method for evaluating the internal stress in organic coatings. This method is based on the fact that if a coating applied on a flexible substrate is under stress, the coated substrate will curve in the direction which relieves the stress. If the curvature (the deflection) is determined and the elastic properties of the substrate are known the stress can be calculated.

In general, two variations of this method are proposed in the literature: a substrate coated on one side (1) vertically attached at one end^{9,17} and (2) freely supported on two knife edges.^{12,16,21} Each variation has its particular advantage, but if correctly used they should give identical results.

The measuring system discussed in this paper is a further development of those described in references (9) and (17).

The principal aim of this paper is to discuss the technique used and the conditions to be met in order to obtain valid results.

* Belgian Paint Research Institute, Av. P. Holoffe—BE-1342, Limelette (Belgium).

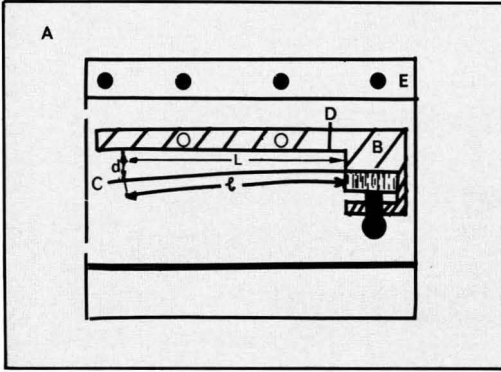


Figure 1—Schematic drawing of the experimental system

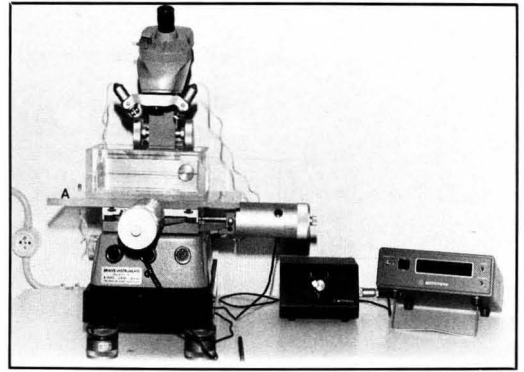


Figure 2—Photograph of the experimental system

CALCULATION OF INTERNAL STRESS

By applying the beam and/or the plate theory, mathematical relationships correlating the cantilever substrate deflection with the internal stress (S) can be obtained.^{9,13,28,29} Probably the mathematical expression which most closely approximates reality is that developed by Corcoran:¹³

$$S = \frac{d E_s t^3}{3^2 c(t+c)(1-\nu_s)} + \frac{d E_c(t+c)}{t^2(1-\nu_c)} \tag{1}$$

where:

- d = deflection of the cantilever substrate
- E_s = elastic modulus of the cantilever substrate
- E_c = elastic modulus of the coating
- ν_s = Poisson's ratio of the cantilever substrate
- ν_c = Poisson's ratio of the coating
- t = thickness of the cantilever substrate
- c = thickness of the coating
- L = length of the substrate between the point at which it is clamped and point at which deflection is measured.

The equation is the result of the combination of two theories: (a) the plate theory which considers that a coating is under stress in a plane in two directions implying the introduction of the term (1 - ν) and a spherical deformation of the substrate, and (b) the beam theory (the dimensions of the cantilever substrate used in experiments are those of a beam) which implies a uniaxial stress situation and a cylindrical deformation of the substrate.

Equation (1) assumes that among other things: a perfect adhesion of coating to cantilever substrate exists; the elastic properties of coating and substrate are isotropic; the elastic limit of the cantilever substrate is not exceeded; and the internal stress is constant through the coating thickness.

The second term in equation (1) expresses the stress relief in the coating due to the bending of the substrate. When E_s ≫ E_c and t ≫ c the second term in equation (1) can be neglected, the error introduced being smaller than the experimental error.^{9,13} This avoids the necessity of knowing the values of E_c and ν_c, parameters difficult

to determine (this is discussed later). Thus equation (1) can be reduced to

$$S = \frac{d E_s t^3}{3L^2 c(t+c)(1-\nu_s)} \tag{2}$$

DESCRIPTION OF THE EXPERIMENTAL SYSTEM

The system (see Figures 1 and 2) consists of a box placed on a plate (A) which is free to move in the horizontal plane. The box contains a support (B) to which is clamped the cantilever substrate (C). All measurements are made with a microscope with reference to an initial point (D) engraved on the support at an exactly known distance from the substrate clamping point. By moving A, D is located in the optical axis of the microscope. In order to measure deflection (d) at various distances from D, the box is relocated at fixed points on A, using the holes provided (E). Calibrated shims are used as cantilever substrate. The characteristics of the calibrated shims are given in Table 1. The values of E_s and ν_s were determined with stress gauges.

The accuracy of the measurements is for the most part dependent on the precision of manufacture of the apparatus and on the careful leveling of the whole system.

Selection of Cantilever Substrates

The cantilever substrate must be carefully selected. This is done by clamping the uncoated cantilever substrate to the support and measuring the d-values at different values of L. Since no perfectly flat substrates exist, only substrates showing a slight but cylindrical curvature should be used. If the internal stress due to coating shrinkage is investigated, the paint is applied on the "concave" side of the cantilever substrate. Despite the use of calibrated shims, one should nevertheless determine the actual thickness.

Coating Application

Degreased cantilever substrates are laid down on a magnetic table and the coating cast with a doctor blade of desired thickness. The part of the cantilever substrate

Table 1—Characteristics of the Cantilever Substrates Used

	Width (mm)	E_s (GPa)	ν_s
Cold laminated steel	12.7	201 ± 5	0.294 ± 0.05
Cold laminated steel	50	198 ± 5	0.296 ± 0.05
Stainless steel	12.7	179 ± 5	0.295 ± 0.05

to be clamped is masked during the application of paint.

As soon as possible (depending on the drying rate of the paint) the coated substrate is carefully clamped to the support and the deflection registered as a function of time. If any paint reaches the noncoated side of the cantilever substrate, it is removed (usually by gently scratching with a sharp razor blade) before the coated substrate is clamped.

When coatings which rapidly develop internal stress are investigated, the reference position of the cantilever substrate cannot correctly be determined. For such cases the curvature obtained with the uncoated substrate is taken as the reference position.

VERIFICATION OF THE METHOD

Measurement of the Cantilever Plate

Equations (1) and (2) require the knowledge of the length of the cantilever substrate (l) at which the deflection is measured. As a result of the continuous substrate deflection, this distance is not easy to determine.

In order to simplify the measurement, as a first approximation l can be taken equal to L [i.e., the distance on the support between the point at which the substrate is clamped and point at which deflection is measured (see Figure 1)].

It can be shown by analytical geometry that a second approximation gives:

$$l^2 = L^2 + d^2 \quad (3)$$

The error introduced in the calculation of S by considering the first approximation ($l = L$) instead of the second one (equation 3), even for high deflections, is less than $\approx 0.7\%$.

Effect of Clamping

It is well known that the clamping of a cantilever substrate can affect its deflection (e.g., restrict the bending and change the form of the substrate). This effect, observed experimentally or from calculations by using a finite element method,³⁰ diminishes as one moves further away from the clamping point.

To reduce this effect as much as possible, the deflection, d , of the substrate should be measured at different distances of L (e.g., between 6 to 15 cm). For all cases investigated, S becomes practically independent of L for $L > 8$ cm. Under these conditions, the effect of clamping is less than the experimental error. In this paper the values of S were calculated for deflections taken at $L = 11$ cm. It is worth mentioning that the values of S

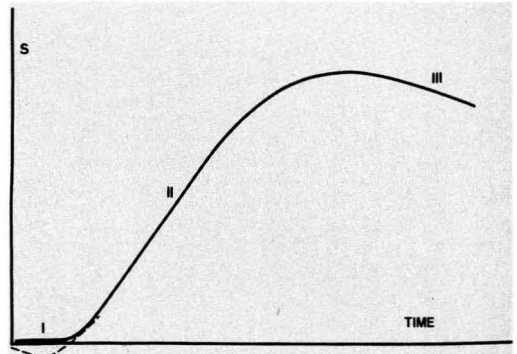


Figure 3—Schematic description of development of internal stress (S) as a function of time

obtained in this way agreed well with those determined with the freely supported cantilever substrate method.^{12,16,21} If the d -values are taken at $L < 8$ cm, the error introduced (by default) can be more than 9%.

Form of the Cantilever Substrate

The experimental system developed enables one to determine the deformation of the cantilever substrate only at its edges (by measuring d at different values of L).

To ensure that the deformation is identical across the whole cantilever substrate, parallel tests were carried out with a moiré technique. This was done by placing a moiré grind against the uncoated side of the clamped cantilever substrate, and the fringes obtained by reflection recorded by means of an optical system. The details of this technique are given in reference (29). This technique, in spite of laborious calculations, has the advantage of giving a complete image of the whole surface of the substrate.

The measurements made with three varnishes (an epoxy resin, a polyurethane, and a thermoplastic resin) applied on substrates 12.7 and 50 mm wide and 150 mm long show that the deflection above, below and along the axis of the substrate is cylindrical, independent of the drying time of the coating. If any spherical deformation takes place it falls within the range of the experimental error (6% to 8%).

This indicates that in such cases one might use equation (4) and/or (5) (the beam theory^{28,29}) to calculate the internal stress.

$$S = \frac{d E_s t^3}{3l^2 c(t+c)(1-\nu_s^2)} + \frac{d E_c(t+c)}{l^2(1-\nu_c^2)} \quad (4)$$

$$S = \frac{d E_s t^3}{3l^2 c(t+c)(1-\nu_s^2)} \quad (5)$$

For cantilever substrates made of steel the internal stress calculated from equations (4) and (5) gives values of about 22% smaller than those obtained from equations (1) and (2).

Since in reality the internal stress does not develop only in one direction, i.e., along the cantilever substrate (beam theory) but in two directions (plate theory), equations (1) and/or (2) (see reference 13) were adopted in the present paper.

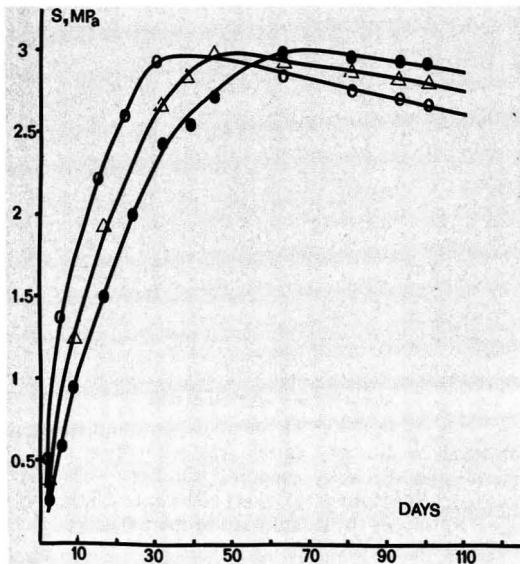


Figure 4—PIBM. Development of Internal stress, S (MPa), for three thicknesses of coating (\circ , $c = 55 \mu\text{m}$; Δ , $c = 72 \mu\text{m}$; \bullet , $c = 86 \mu\text{m}$) as a function of time (days) at T ($^{\circ}\text{C}$) = 21 ± 0.8 and $\text{RH}(\%) = 52 \pm 1$; t (substrate thickness) = 0.158 mm ; H (substrate width) = 12.7 mm

DEVELOPMENT OF INTERNAL STRESS

From experiments carried out with numerous types of organic coatings it was found that once a coating is applied on a surface, the development of the internal stress can, in general, be characterized by three phases (see Figure 3).

So long as the paint can contract, no internal stress develops (Phase I). In some cases^{19(b),31} (epoxy resin, chlorinated rubber, polyurethane, some alkyds) negative stresses (compressive) were observed. This was attributed to the film swelling as a result of moisture absorption.

Phase II of the curve shows the increase of the internal stress in the film. The exact moment at which the internal stress develops is a point of discussion. For thermoplastic coatings, it was stated²⁰ that the internal stress starts to develop when the T_g (the glass transition temperature)

of the film is above the temperature at which the test is carried out. For emulsion paints which, in general, have a T_g lower than room temperature, but develop internal stress, the starting point probably coincides with the beginning of the coalescence²⁵ (i.e., when coating particles reach their random densest packing).

In phase III, the internal stress decreases with time. This decrease can occur slowly or rapidly, depending on the type of coating. If no damage occurs in the film (cracks, detachment), the decrease is a result of the relaxation process which takes place from the moment the stress develops, but only becomes evident in phase III. It also means that the measured S -values are a resultant of two opposite processes, one tending to develop stresses in the film (due to volume shrinkage) and the other tending to diminish them (due to stress relaxation).

EFFECT OF COATING AND CANTILEVER THICKNESSES

As already mentioned, the mathematical equations used to calculate the internal stress (S) assumes that S is constant through the coating thickness. This implies that S should be independent of film (c) and cantilever substrate (t) thicknesses.

From the literature it appears that this is not always the case, indicating the possibility of a stress distribution through the film thickness. This is certainly so for solvent cast coatings during drying.

Since internal stress develops during drying of a coating (a process which is dependent on film thickness), a comparison between internal stress values obtained with different c can only be made with coatings with identical drying characteristics.

While for some thermoplastic coatings^{19(a)} the maximum internal stress (S_m) was found to be independent of c and t , a dependence was noted for some thermosetting coatings.^{8,17}

In order to clarify these cases two varnishes were investigated, namely a thermoplastic [Polyisobutyl methacrylate (PIBM), Röhm Plexigum P675; solvent = toluene] and a thermosetting [Epikote® 1001/Versamid® 115 (2/1) + 6% DMP30 (on Epikote); solvents: mixture of ethylene glycol, butanol, toluene, methyl isobutyl ketone].

The results obtained (mean values of five measurements) are given in Figure 4 and Tables 2 and 3 for the PIBM varnish and in Figure 5 and Table 4 for the epoxy resin.

The following conclusions could be drawn:

(a) As expected, thicker films take longer to reach the S_m values. For PIBM this time is between 30 to 65 days, and for the epoxy resin between 450 to 1100 days.

(b) For PIBM, S_m is independent of c and t . The simplified equation (2) is sufficient to calculate S_m values with sufficient accuracy. The values of E_c used in equation (1) [E_c (PIBM) = 1 GPa and E_c (epoxy resin) = 2.5 GPa] are those obtained by stress-strain measurements

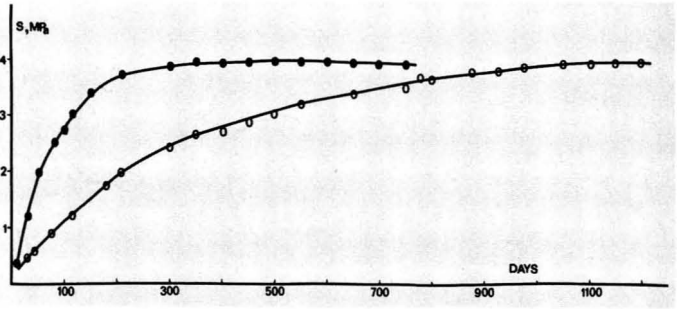
Table 2—PIBM. Maximum Internal Stress Values (MPa) with Different Thicknesses of Coating^a

c	H = 12.7 mm t = 0.158 mm		H = 50 mm t = 0.157 mm	
	Eq. 1	Eq. 2	Eq. 1	Eq. 2
55	2.99 ± 0.24	2.96 ± 0.24	3.04 ± 0.24	3.01 ± 0.24
72	2.98 ± 0.24	2.94 ± 0.24		
86	2.97 ± 0.24	2.91 ± 0.24		

(a) c (μm) and two widths of cantilever substrate (H), at 21 ± 0.8 ($^{\circ}\text{C}$) and $\text{RH}(\%) = 52 \pm 1$. $L = 110 \text{ mm}$. Equations (1) and (2) indicate the mathematical equations used in calculations.

Epikote is a registered trademark of Shell Chemical Co. Versamid is a registered trademark of Chemical Div. of General Mills, Inc.

Figure 5—Epoxy resin. Development of internal stress, S (MPa) for two thicknesses of coating (\bullet , $c = 66 \mu\text{m}$; \circ , $c = 110 \mu\text{m}$) as a function of time (days) at $T(^{\circ}\text{C}) = 21 \pm 0.8$ and $\text{RH}(\%) = 52 \pm 1$; t (substrate thickness) = 0.209 mm ; H (substrate width) = 12.7 mm



with free films conditioned under the same experimental conditions as those under which the internal stress tests were carried out. The approximate values of ν_c were taken from the literature [$\nu_c(\text{PIBM}) = 0.4$ and $\nu_c(\text{epoxy resin}) = 0.36$].

(c) For the epoxy resin, the values of S_m calculated from simplified equation (2) can indicate a possible dependence on c and t (S_m increases with t and decreases with c). This possibility is negligible if the values of S_m are calculated from equation (1) (some difference in S_m values remains but is within the limit of the experimental error). This also indicates that in certain cases (e.g., the tests made with $t = 0.102 \text{ mm}$) the experimental conditions do not comply with the requirements ($E_s \gg E_c$, $t \gg c$) necessary for the use of equation (2).

For the two coatings investigated, S_m is essentially independent of c . However, other types of coatings can show a different behavior if the internal stress²⁰ components (modulus, M , internal strain, ϵ , and Poisson's ratio, ν) are affected by c :

$$S = \frac{M \cdot \epsilon}{1 - \nu} \quad (6)$$

For example, if the film structure does not change with c , for coatings forming by solvent evaporation, S_m is mainly dependent on ϕ_s (solvent volume fraction at coating solidification) and the relaxation process. A higher ϕ_s (i.e., a higher ϵ) will increase the S_m while the stress relaxation (i.e., smaller M) will tend to decrease it. If ϕ_s is independent of c and the relaxation process is negligible, S_m will also be independent of c . If this is not the case, the variation of S_m with c will be a resultant of the two (opposite) processes.

Table 3—PIBM. Maximum Internal Stress Values (MPa) with Different Thicknesses of Cantilever Substrate^a

	$t = 0.102$	$t = 0.158$	$t = 0.211$	$t = 0.265$
Eq. 1	2.76 ± 0.24	2.99 ± 0.24	3.20 ± 0.24	3.15 ± 0.24
Eq. 2	2.70 ± 0.24	2.96 ± 0.24	3.18 ± 0.24	3.13 ± 0.24

(a) t (mm): c (coating thickness) = $55 \mu\text{m}$, at $21 \pm 0.8 (^{\circ}\text{C})$ and $\text{RH}(\%) = 52 \pm 1$. H (substrate width) = 12.7 mm . Equations (1) and (2) indicate the mathematical equations used in calculations.

SUMMARY

The method of measuring the internal stress in organic coatings discussed in this paper is valid if a number of conditions are met (e.g., the apparatus is precisely manufactured, deflection is measured at a distance where the clamping effect on the cantilever substrate curvature is negligible, cantilever substrates are carefully selected).

The internal stress values obtained by this method are in complete agreement with those measured by freely supporting the coated cantilever substrate on two knife edges (the overhanging beam method).

The maximum internal stress values of the coatings investigated (a thermoplastic and thermosetting varnish) are essentially independent of the coating and the cantilever substrate thicknesses. Erroneous conclusions can be drawn if the simplified equation (2) is used without the necessary conditions ($E_s \gg E_c$, $t \gg c$) being satisfied.

ACKNOWLEDGMENTS

The authors wish to thank Dr. P. Janssen Bennyneck, Director of Laboratoire I.V.P., for his support and critical analysis of the manuscript and express appreciation to Scandinavian Paint and Printing Ink Research Institute and especially to Mr. E. Nilsson for the initial help in the development of the experimental system.

This work was supported by l'Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture (I.R.S.I.A.).

Table 4—Epoxy Resin. Maximum Internal Stress Values (MPa) with Thicknesses of Cantilever Substrate^a

	t	0.102	0.156	0.209
$c = 66$	Eq. 1	3.71 ± 0.29	3.97 ± 0.29	3.98 ± 0.29
	Eq. 2	3.45 ± 0.29	3.82 ± 0.29	3.86 ± 0.29
$c = 110$	Eq. 1	3.58 ± 0.29	3.78 ± 0.29	3.86 ± 0.29
	Eq. 2	3.03 ± 0.29	3.47 ± 0.29	3.67 ± 0.29

(a) t (mm) and two thicknesses of coating, c (μm), at $21 \pm 0.8 (^{\circ}\text{C})$ and $\text{RH}(\%) = 52 \pm 1$. H (substrate width) = 12.7 mm .

References

- (1) Brenner, A. and Sendorf, S., *J. Res. Nat. Bur. Std. USA*, **42**, 105 (1949).
- (2) Wilcock, J.D. and Campbell, D.S., *Thin Solid Films*, **3**, 3 (1969).
- (3) Wilcock, J.D., Campbell, D.S., and Anderson, J.C., *Thin Solid Films*, **3**, 13 (1969).
- (4) Shoji, F. and Nagato, S., *Proc. of 6th Intern. Vacuum Cong., Japan*, 579 (1974).
- (5) De Waard, R., Stock, Ch.R., and Alfrey, T. Jr., *ASTM Bulletin (TP56)* **53**, (1952).
- (6) Zubov, P.J., Lepilkina, L.A., Gilman, T.P., and Leites, A.Z., *Colloid J.*, **23**, 469 (1961).
- (7) Elm, A.C., *Official Digest*, **28**, No. 380, 752 (1956).
- (8) Zubov, P.J., et al., *Kolloid. Zh.*, **22**, 497 (1960); **23**, 418 (1961); **23**, 563 (1961); **24**, 30 (1962); **24**, 174 (1962); **25**, 299 (1963); **25**, 434 (1963); **25**, 505 (1963); **27**, 326 (1965).
- (9) Sanzharovskii, A.T., et al., *Vysokomolekul. Soedin.*, **2**, No. 11, 1698-1702, 1703-1708, 1709-1714 (1960).
- (10) Gusman, S., *Paint Technol.*, (Jan.) 17 (1963).
- (11) Simpson, W. and Boyle, D.A., *J. Oil & Colour Chemists' Assoc.*, **46**, 331 (1963).
- (12) Dannenberg, H., *Soc. Plastics Eng. J.*, **21**, 669 (1965).
- (13) Corcoran, E.M., *JOURNAL OF PAINT TECHNOLOGY*, **41**, No. 635 (1969).
- (14) Gamski, K., *Chim. Peintures*, **33**, No. 4, 135 (1970).
- (15) Imamura, H., *Mokuzai Gakkaishi*, **16**, 168 (1970); **19**, 89 (1973); **19**, 393 (1973); **22**, 325 (1976); **22**, 331 (1976).
- (16) Aronson, P.D., *J. Oil & Colour Chemists' Assoc.*, **57**, 66 (1974).
- (17) Nilsson, E., *Förg Och Lack*, **21**, 318 (1975); Saarnak, A., Nilsson, E., and Kornum, L.O., *J. Oil & Colour Chemists' Assoc.*, **59**, 427 (1976).
- (18) Prosser, J.L., *Modern Paint and Coatings*, (July) **47** (1977).
- (19) Croll, S.G., *JOURNAL OF COATINGS TECHNOLOGY*: (a) **50**, No. 638, 33 (1978); (b) **51**, No. 659, 49 (1979).
- (20) Croll, S.G., *J. Appl. Polymer Sci.*, **23**, 847 (1979).
- (21) Croll, S.G., *J. Oil & Colour Chemists' Assoc.*, **63**, 271 (1980).
- (22) Haagen, H., *Farbe und Lack*, **85**, No. 2, 94 (1979).
- (23) Zorll, U., *Adhesion*, **10**, 291 (1979).
- (24) Sato, K., *Progr. Org. Coatings*, **8**, 143 (1980).
- (25) Bierwagen, G.P., *JOURNAL OF COATINGS TECHNOLOGY*, **51**, No. 658, 117 (1979).
- (26) Association Belge pour l'Etude, l'Essai et l'Emploi des Matériaux (A.B.E.M.), "Cours d'initiation à l'analyse des contraintes," Brussels (1973).
- (27) Kanno, A. and Murato, Y., *Proc. of 15th Jap. Cong. Mater. Res.*, 177 (1972).
- (28) Chow, T.S., Lin, C.A., and Penwell, R.C., *J. Polymer Sci., Polymer Physics Ed.*, **14**, No. 7, 1311 (1976).
- (29) Ebbeni, J. and Kestens, J., *Proc. of Exper. Stress Anal. Cong., Munich*, 483 (1978).
- (30) Kornum, L.O., *Scandinavian Paint and Printing Ink Research Institute, Report T9-75 M* (1975).
- (31) Perera, D.Y., Private Communication.

**United Kingdom Orders
of FSCT Educational Literature**

In the United Kingdom, Federation publications and other industry aids are available from the Birmingham Paint, Varnish and Lacquer Club. Please contact: Mr. Ray Tennant, Carrs Paints Limited, Westminster Works, Alvechurch Rd., Birmingham B31 3PG, England.

Molecular Weight And Molecular Weight Distribution Of Poly(methyl methacrylate) In Emulsion Polymerization

R. Mertens
University of Antwerp—RUCA*

Molecular weight and molecular weight distribution of emulsion polymerized methyl methacrylate was investigated in the presence of an anionic emulsifier (Sipon LS 100, sodium lauryl sulfate), a cationic emulsifier (Bacfor BL 80, lauryldimethylbenzyl ammonium bromide) and a blend of the anionic emulsifier with a nonionic emulsifier (Sinnopal OP 8, octyl phenol polyethoxyethanol). In all cases, the ratio \bar{M}_v/\bar{M}_n was in the range typical of the most probable molecular weight distribution. However, the absolute molecular weight produced with the cationic emulsifier was significantly higher than with the other two emulsifier systems.

INTRODUCTION

From a review of literature on emulsion polymerization of methyl methacrylate it appears that almost all of the published data concern the effects of various emulsifiers on the kinetics of the polymerization.

No systematic study was found concerning the influence of emulsifier and emulsifier concentration on molecular weight and molecular weight distribution; that is the purpose of this study.

Polydispersity is a measure of the breadth of the molecular weight distribution and is defined as the ratio of two different molecular weight averages. To study the molecular homogeneity or polydispersity the following qualitative relationship was used:

$$PDI = \frac{\bar{M}_v}{\bar{M}_n} \quad PDI : \text{polydispersity index}$$

By means of very accurate osmotic and viscometric methods, the number average molecular weight \bar{M}_n and the viscosity average molecular weight \bar{M}_v were measured. These experimental values were compared with the generally assumed Smith-Ewart theory on emulsion polymerization. The equations derived by Smith-Ewart are¹:

$$R_p = \frac{N k_p [M]}{2 N_A} \quad (1)$$

where R_p = overall rate of polymerization
 N = number of latex particles
 k_p = propagation rate constant

$[M]$ = monomer concentration in the latex particles
 N_A = Avogadro's number

$$N = k \left(\frac{\rho}{\mu} \right)^{0.4} \left(a_s [E] \right)^{0.6} \quad (2)$$

where k = a constant
 ρ = a rate of generation of initiator radicals
 μ = volumetric growth rate of a particle
 a_s = average surface area of a soap molecule
 $[E]$ = Emulsifier concentration

The number average degree of polymerization is

$$\bar{x}_N = \frac{k_p N [M]}{\rho} \quad (3)$$

The theory predicts that the molecular weight should be proportional to 0.6th power of concentration of emulsifier

$$\bar{M} \sim [E]^{0.6}$$

*Laboratory of Chemical Technology, Schildersstraat 41 B-2000, Antwerp, Belgium.

Table 1—Polymerization Formulation for Study

Component	Weight
1. Monomer	200 g
2. Ammonium persulfate (analytical grade)	0.1 g
3. Emulsifier	0.1 wt % - 4.0 wt % referred to monomer
4. Distilled water	400 g

EXPERIMENTAL

Materials and Polymerization Technique

Methyl methacrylate for synthesis was obtained from commercial sources (Union Chimique Belge) and was distilled to remove the inhibitor before starting the emulsion polymerization. As far as the emulsifying agent is concerned, we confined ourselves to the use of:

- Sipon LS 100 Sodium lauryl sulfate: (Sinnova) 95%,
- Bacfor BL 80: (Sinnova) 80% lauryldimethylbenzyl ammonium bromide was used as a cationic emulsifier, and
- Sinnopal OP 8 (Sinnova): octyl phenol polyethoxyethanol is a condensation product of ethylene oxide with octyl phenol, and was used as a nonionic emulsifier. For this research it was most desirable that one polymerization formulation be suitable for use in all the polymerizations. Table 1 presents the overall formulation that was used in every reaction studied in this work.

Table 2—Influence of Different Emulsifiers and Emulsifier Concentration on Molecular Weight and Polydispersity^a

Sample	Emulsifier weight percent ^b	$\bar{M}_n \times 10^{-3}$	$\bar{M}_w \times 10^{-3}$	PDI	
Sipon LS 100					
PMMA 1	0.1	5.43	1.160	2.1	
PMMA 2	0.5	5.17	1.336	2.6	
PMMA 3	1.0	8.34	1.782	2.1	
PMMA 4	1.5	8.32	1.678	2.0	
PMMA 5	2.0	4.74	1.270	2.7	
PMMA 6	3.0	4.97	1.345	2.7	
PMMA 7	4.0	4.94	1.231	2.5	
Mixtures: Sipon LS 100 + Sinnopal OP 8					
PMMA 31	0.1	0.1	4.22	1.215	2.9
PMMA 32	0.1	0.25	11.91	1.717	1.4
PMMA 33	0.1	0.5	6.91	1.574	2.3
PMMA 34	0.1	1.0	5.05	1.645	3.3
PMMA 35	0.1	1.5	4.60	1.560	3.4
PMMA 36	0.1	2.0	4.61	1.645	3.6
Bacfor BL 80					
PMMA 51	0.5	7.19	2.150	3.0	
PMMA 52	1.0	12.14	2.480	2.0	
PMMA 53	1.5	15.02	3.020	2.0	
PMMA 54	2.0	20.87	3.150	1.5	
PMMA 55	3.0	17.14	4.040	2.4	

(a) See Figures 1 and 2.

(b) Based on monomer charge.

Polymerizations were carried out in a two-liter thermostated reaction vessel equipped with a condenser and thermometer. Stirring was effected by means of an anchor-type stirrer. The stirring rate was controlled at 200 rpm. Nitrogen was bubbled through the reaction mixture before and during the polymerization. A temperature of $80^\circ \pm 1^\circ \text{C}$ was chosen as the reaction temperature for all the syntheses. Water, emulsifier, initiator and 10 wt % of the total monomer were added to the flask. The remaining 90% of monomer was added continuously into the flask by a metering pump over 135 minutes. The polymerization conversion was determined by evaporation of the volatile components at 110°C in vacuum. Hydroquinone was used as a short-stop. All reactions showed a conversion over 90%. The emulsion was broken by pouring it into a large excess of methanol. The coagulated polymer was filtered on a fritted glass funnel, washed several times with water and methanol and dried in a vacuum oven at 75°C . Finally, the polymer was purified by dissolving it in toluene and precipitating with methanol.

Determination of Molecular Weight

Molecular weight parameters were determined experimentally by osmometry (\bar{M}_n) and solution viscosity (\bar{M}_v). Number-average molecular weights were determined using a Wescan membrane osmometer, Model 231, on the PMMA solutions in toluene at 37.9°C . The membrane used was a Schleicher and Schüll deacetylated acetylcellulose membrane carefully conditioned from water to isopropanol and then into toluene.

Data were analyzed using equation (4)²

$$\left[\frac{\pi}{c} \right]^{1/2} = \left[\frac{RT}{\bar{M}_n} \right]^{1/2} \left[1 + \left(\frac{\Gamma_2}{2} \right) c \right] \quad (4)$$

Here, π is the osmotic pressure, \bar{M}_n is the number-average molecular weight, Γ_2 is the second virial coefficient and c is the concentration. Intrinsic viscosities were determined with an automatic recording Ubbelohde capillary viscometer (Schott Mainz DBR) in toluene at 30°C . The kinetic energy correction was always applied. The correction for non-Newtonian behavior has been carried out according to techniques applied previously to solutions of polyisobutylene.³

Viscosity-average molecular weights of the samples were calculated from the empirical relationship⁴

$$[\eta]_{0.1, 30^\circ \text{C}} = 7 \times 10^3 \times \bar{M}_v^{0.71} \quad (5)$$

RESULTS AND DISCUSSION

The data for the molecular weight averages \bar{M}_n and \bar{M}_v , obtained by osmometry and viscometry for the samples of emulsion polymerized poly(methyl methacrylate), using different emulsifiers and emulsifier concentrations are shown in Table 2. Figures 1 and 2 provide graphical representation of the data. A numerical expression of polydispersity is given by the ratio of the viscosity-average molecular weight to the number-average molecular weight \bar{M}_v / \bar{M}_n .

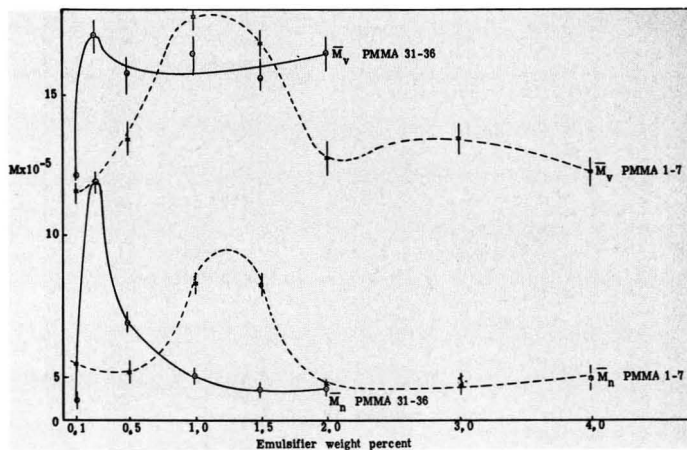


Figure 1—Influence on molecular weight of various emulsifiers and their concentration

Values of polydispersity given in Table 2 and Figure 3 show the variation in polydispersity. From the influence on molecular weight of the various emulsifiers, and their concentration, we ascertain that the poly(methyl methacrylate) series 1-7, in which sodium lauryl sulfate was used, and the poly(methyl methacrylate) series 31-36 (emulsifier 0.1 wt % sodium lauryl sulfate + Sinnopal OP 8) follow the same trend. The number-average molecular weight in both curves increases to a maximum value at PMMA 3 (1.0 wt % sodium lauryl sulfate) and PMMA 32 (0.25 wt % Sinnopal OP 8) followed by a decrease at higher emulsifier concentrations to a relatively constant number-average molecular weight of about 500,000. The maxima from the molecular weight-emulsifier curves correspond with the minima of the polydispersity curves. At higher emulsifier concentrations \bar{M}_v / \bar{M}_n becomes equal to 2.5 for the PMMA 5-6-7 and \bar{M}_v / \bar{M}_n to 3.6 for PMMA 36.

The molecular weights of the polymers synthesized with lauryldimethylbenzyl ammonium bromide (Bacfor BL 80) (PMMA 51-55) are quite different from the two preceding series. The viscosity-average molecular weight appears to increase linearly in the emulsifier interval 0.5 wt % - 3.0 wt %. The number-average molecular weight was found to increase also in the region 0.5 wt % - 2.0 wt % Bacfor BL 80. At a concentration of 3 wt % of this emulsifier the value of \bar{M}_n is slightly lower. Especially noteworthy is the fact that the weights of all the polymers in the PMMA 51-55 series have higher values than the PMMA 1-7 and PMMA 31-36 series.

As can be seen in Figure 3 and Table 2 the polydispersity turns out to be at a minimum at a concentration of 2 wt % emulsifier (Bacfor BL 80). At smaller and higher emulsifier concentrations the molecular weight distribution is broadened.

We do not have a good explanation for the higher molecular weight in the cationic emulsifier samples or for the varying polydispersity index. We have considered the repulsive energy barrier between the negatively charged micelles of sodium lauryl sulfate and the negatively charged primary free radicals (persulfate initiated emulsion polymerization), which repulsion might prevent primary radical capture and chain termination. But this

would suggest higher molecular weight for anionic emulsifiers and this is opposite to what is found. Chatterjee, Banerjee, and Konar⁵ suggest that the primary free radicals probably do not initiate the polymerization in the monomer-loaded micelles. Rather, a macroradical containing the initiator fragment, during the process of capture by a micelle, will project its active end toward the micelle, while the charged end will be directed away from the particle-water interface, so that the electrostatic repulsion will not be experienced by the macroradicals during their entry into the charged micelles. An alternate speculation for the molecular weight differences is that the anionic and nonionic

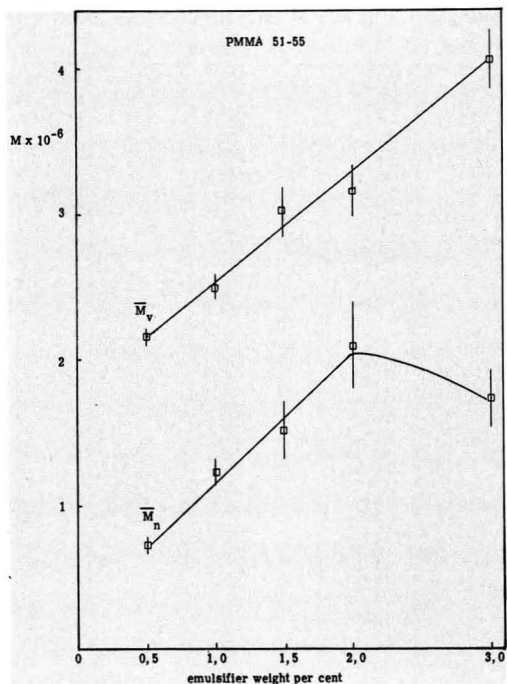


Figure 2—Influence on molecular weight of lauryldimethylbenzyl ammonium bromide (Bacfor PL 80)

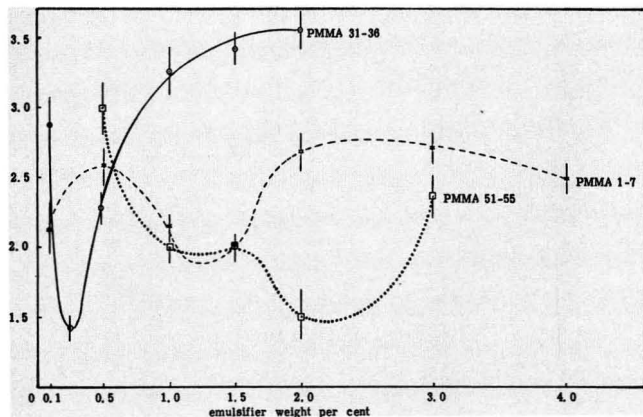


Figure 3—Influence on polydispersity of various emulsifiers and their concentration

surfactants used are better chain transfer agents than the cationic surfactant. This could explain the lower molecular weight and a molecular weight maximum for systems in which the higher molecular weight normally achieved through smaller particle size (via higher soap level in the Smith-Ewart theory) is overwhelmed by the increasing chain transfer activity of the higher anionic surfactant level.

Figure 4 shows on a double logarithmic scale, the influence of lauryl-dimethylbenzyl ammonium bromide (Bacfor BL 80) on molecular weight. By equations (1), (2), and (3) the molecular weight should be proportional to 0.6th power of concentration of emulsifier. The dashed line suggests the path of \bar{M}_n corresponding to this proportionality. The lack of agreement between the experi-

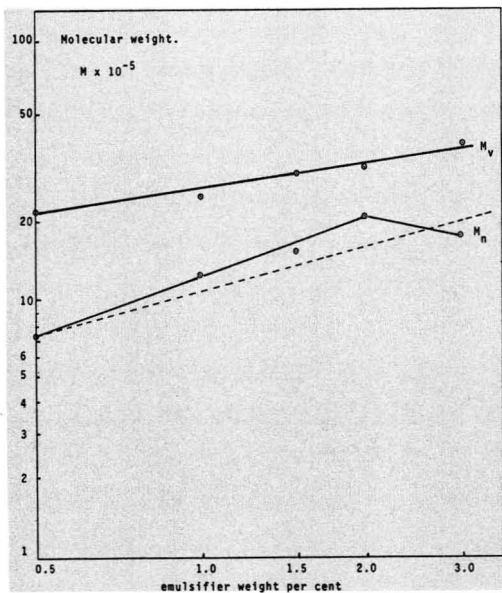


Figure 4—Data of Figure 2 replotted on double logarithmic scales

mental dependence of \bar{M} upon $[E]$, and the Smith-Ewart theory is due in part to the experimental conditions. Indeed the Smith-Ewart theory is only applicable if all the reactants are added at the beginning of the reaction while we used continuous monomer addition over 135 minutes.

CONCLUSIONS

It has been found that the nature and the concentration of the emulsifier influence molecular weight and polydispersity of emulsion polymerized methyl methacrylate. The use of the emulsifiers Sipon LS 100 (sodium lauryl sulfate) (anionactive) and a mixture of Sipon LS 100 and Sinnopal OP 8 (octyl phenol polyethoxyethanol) (non-ionic compound) results in a lower molecular weight than when the polymers are synthesized with a cation active emulsifier Bacfor BL 80 (lauryldimethylbenzyl ammonium bromide). In all cases, the ratio of \bar{M}_v / \bar{M}_n is close to 2.5 which is characteristic of the most probable distribution. Our results on polydispersity are similar to those of Guillod and Bauer,⁶ Krackeler and Naidus⁷ and James and Piirma.⁸ They all find values of \bar{M}_v / \bar{M}_n in the range of 2.0 to 4.0.

References

- (1) Smith, W.V. and Ewart, R.H., *J. Chem. Phys.*, **16**, 592 (1948); *J. Am. Chem. Soc.*, **70**, 3695 (1948).
- (2) Flory, P.J., "Principles of Polymer Chemistry," Cornell University Press, London, p 280 (1953).
- (3) Fox, T.G., Jr., Fox, J.C., and Flory, P.J., *J. Am. Chem. Soc.*, **73**, 5, 1901 (1951).
- (4) Cohn-Ginsberg, E., Fox, T.G., and Mason, H.F., *Polymer*, **3**, 97 (1962).
- (5) Chatterjee, S.P., Banerjee, M., and Konar, R.S., *J. Polymer Sci.: Polymer Chem. Ed.*, **16**, 1517-1525 (1978).
- (6) Guillod, M.S. and Bauer, R.G., *J. Appl. Polymer Sci.*, **16**, 1457-1463 (1972).
- (7) Krackeler, J.J. and Naidus, H., *J. Polymer Sci., Part C*, **27**, 207-265 (1969).
- (8) James, H.L., Jr. and Piirma, I., "Emulsion Polymerization," *ACS Symposium Series 24* (1976), p. 197-210.

Society Meetings

Chicago

Mar. 2

John A. Gordon, of the University of Missouri-Rolla, presented a talk on the various functions of the Federation Educational Committee.

A talk, entitled "VOC EXEMPT CHLORINATED SOLVENTS," was presented by Violet Stevens, of Dow Chemical Co.

L.F. KINNEY, *Secretary*

Dallas

Mar. 12

William B. Woods, of Tenneco Chemicals, Inc., spoke on the subject of "CONTAMINATING MICROORGANISMS IN PAINT."

Mr. Woods began by stating the primary sources of contaminating microorganisms in paint which include process water, aqueous and natural raw materials used in the manufacture of paint, and airborne dust and debris. Avoiding contamination is impractical if not impossible, according to Mr. Woods. Therefore, the use of microbicides to prevent spoilage is a common practice.

Degradation can be manifested as a loss in viscosity, offensive odors, generation of gas, color formation in the paint, and changes in tint color acceptance through degradation of the surfactants with loss of emulsion stability or pigment flocculation.

According to Mr. Woods, the primary source of contamination of stored bulk aqueous raw materials such as latex is the air introduced through the storage tank air vent as the material is removed. This contamination can be minimized by scrubbing dirt from the air using a humidifier or bubbling the air through a disinfectant solution.

With regards to processing equipment, Mr. Woods discussed several methods for disinfecting after each use.

Mr. Woods concluded by discussing the cost and effectiveness of mercury-containing preservatives which he considered to be the best.

WILLIAM A. WENTWORTH, *Secretary*

Houston

Mar. 11

William Woods, of Tenneco Chemicals, spoke on "LATEX PAINT SPOILAGE VERSUS PLANT HOUSEKEEPING."

L.D. JACOBSON, *Secretary*

Kansas City

Mar. 12

Gil Cain, of Hercules Incorporated, presented a talk entitled, "PEOPLE PROTECTING PEOPLE."

MIKE BAUER, *Secretary*

Los Angeles

Mar. 11

Frank Zurlo, of Byk-Mallinckrodt, presented "SHORT TERM EVALUATION TECHNIQUES FOR LIQUID AND PARTICLE BEHAVIOR IN COATINGS SYSTEMS."

The work Mr. Zurlo discussed was conducted by a Dynometer, a very sensitive instrument which measures settling in process, surface tension, and quantitatively evaluates existing sediment. Basically, the instrument has three parts: the transducer which converts mechanical movement into electrical impulses, the amplifier which increases the impulses to measurable units, and the recorder which writes the measured impulse on a chart.

Mr. Zurlo showed the results of tests to determine settling in progress with three test paints. The instrument showed significant difference in the settling of the three samples.

Another experiment was demonstrated with two latex paints where two different dispersants were compared. The initial settling test was run and the amount of settling over a seven month period was compared.

A third experiment measured and evaluated the surface tension and the recording of lamella formation.

Mr. Zurlo concluded his talk by stressing the usefulness of the Dynometer in formulating, determining settling, and measuring foaming control of paints.

Q. Please discuss the detailed definition of the lamella in the defoamer application, and how does it relate to viscosity of the fluid or the bubble wall?

A. The lamella is defined as the membrane of liquid between the surface and the ring in the instrument. The longer the lamella, the stronger the bubble wall. Viscosity does not necessarily relate to the surface tension.

Q. Is this instrument selective of anti-foams or is it selective of resins?

A. You can compare resin systems without antifoam and decide which one gives more foaming.

L. LLOYD HAANSTRA, *Secretary*

Louisville

Feb. 18

Richard Enslinger, of NL Industries, Inc., discussed "PIGMENT DISPERSION."

The presentation began with a slide show describing the various types of particles encountered in a bag of pigment which includes primary particles, pigment aggregates, and pigment agglomerates. The importance of oil absorption, critical PVC, and pigment volume were related to pigment dispersion.

Mr. Enslinger characterized milling equipment into two categories: smashing and smearing operation. Using the correct equipment and vehicle viscosity for proper dispersion was depicted graphically. Viscosity of the dispersion was shown to be dependent on pigment loading and the critical PVC. Since critical PVC can affect hiding, corrosion resistance, and scrub resistance, the importance of this parameter in determining the dispersion viscosity of various mill bases was summarized as a very important feature of pigment dispersion.

J.A. LANNING, *Secretary*

New York

Mar. 10

Marvin Schnall presented a talk on "ADDITIVES". Using several charts, Mr. Schnall defined additive and discussed the different types used in the paint and coatings industry. He also discussed the purpose, application, and results of the various additives.

A talk entitled "DIFFERENT METHODS OF DATA PROCESSING," was given by Gerald Kaplan. He discussed the methods such as Manual, Batch, and Remote Computing. Time share and In-House methods were also explained. Mr. Kaplan reviewed the expectations, advantages and disadvantages and the benefits realized when using computers.

Arthur Lowell presented "EMULSION POLYMER RESIN MODIFICATION." He explained that it was possible to tailor the physical and chemical properties of polymers prepared by emulsion polymerization to be adapted to any particular application. He demonstrated several techniques available for property modification. Mr. Lowell explained that the preparation of graft and interpenetrating network copolymers by emulsion polymerization can also be used to obtain resin modification.

TED YOUNG, *Secretary*

Piedmont**Mar. 18**

Honored guests attending the meeting were Federation President-Elect, Howard Jerome and Executive Vice-President, Frank Borrelle.

Mr. Jerome stressed the need for motivation and involvement in Society and Federation activities. A real problem, according to Mr. Jerome, is getting people involved. He pointed out that making a contribution to the Federation is making a contribution to industry. He stated that all members have a common interest in the Federation and urged participation.

Mr. Borrelle presented a slide show depicting all aspects of the Federation organization. The slides acquainted members with Federation officers and committee members, explained the budget and annual allotments, and presented various publications and audio-visual aids available from the Federation. Slides recapping the October Paint Show in Atlanta were also featured. Mr. Borrelle concluded his presentation by urging attendance at the upcoming Federation Annual Meeting and Paint Show in Detroit, October 28-30.

SARA ROBINSON, *Secretary*

Rocky Mountain**Mar. 9**

Frank Zurlo, of Byk-Mallinckrodt, presented "SHORT TERM EVALUATION TECHNIQUE FOR LIQUID AND PARTICLE BEHAVIOR IN COATING SYSTEMS."

Mr. Zurlo demonstrated how a dynamometer could be used to determine in relatively short times, the settling characteristics of a paint. He also showed how the instrument could determine the foaming tendencies of paints by measuring and plotting the surface tensions of the paints.

DONALD R. BAGGE, *Secretary*

St. Louis**Mar. 17**

William Meadows, of Cyprus Industrial Minerals, spoke on "TALC—AN OLD MINERAL WITH NEW USES."

Talc, a naturally occurring mineral, can be found worldwide, but only a few locations contain high grade talc suitable for use in coatings, according to Mr. Meadows. In the U.S., the purest talc can be obtained in Montana. Lesser grades can be found in California, New York and Vermont, he said.

Pure talc contains 32% magnesium and 63% silica oxides and 5% water of

hydration which is very tightly held, even at high temperatures, explained Mr. Meadows. He described the physical form of talc as plane or plate-like, with this property reducing porosity of films and enabling it to act as a primer pigment. It is considered to be the softest mineral, and varies in hardness from source to source, with Montana talc reported to have the softest texture.

Mr. Meadows discussed the use of talc in coatings. Its uses are to: reduce gloss, change viscosity, improve chemical resistance, improve dry-hide, and reduce moisture penetration of the dried film. Montana talc is most suitable for all these uses because it is easy to incorporate and is resistant to acids. Eastern talc tends to be harder and more fibrous.

Talc was suggested as a low cost replacement for calcined clay. It is less expensive because its production is less energy intensive, said Mr. Meadows. In a vinyl acrylic at a PVC of 5%, standard tests indicated similar opacity, less porosity versus calcined clay, explained Mr. Meadows. In industrial primers and heavy duty finishes, talc promoted corrosion resistance due to its plate-like structure lining. Talc can also be used in air dry and bake finishes by post grinding additions of soft Montana talc, according to Mr. Meadows.

Mr. Meadows presented data on a four-year study conducted in the North Sea off of Belgium of a styronated-alkyd emulsion water-borne finish. Talc gave the best results versus other pigments tested (other than clay).

JOSEPH J. WROBEL, JR., *Secretary*

St. Louis**Mar. 25**

Officers and members of the St. Louis Society for Coatings Technology, Paint & Coatings Association, Decorating Products Association, and Painting and Decorating contractors of St. Louis attended the meeting to hear plans for the national promotion "Picture It Painted." Richard Weiss, Director of NPAC's Consumer Products Division, discussed the project.

Mr. Weiss told the group of the plans to glamorize coatings, emphasize their versatility, ease of application, and low cost. He discussed radio and television commercials and the logo selected for the campaign.

Bonnie Benhayon was introduced as NPAC's representative for the St. Louis projects.

Mr. Weiss concluded by stating that most consumers do not know what they can do with coatings. Therefore, many articles in the campaign will be devoted to stimulating creative interest and increasing coatings use.

JOSEPH J. WROBEL, JR., *Secretary*

TECHNICAL COMPUTER APPLICATIONS IN THE COATINGS INDUSTRY

A Bibliography



This 11-page bibliography consists of references grouped into the following sections:

- Applications—General • Analytical Methods • Color and Optical Properties • Evaluation; Performance • Formulation • Manufacture and Plant • Pretreatment; Applications; Finishing • Printing Inks • Polymers/Resins • Testing

Most of the references were located by searching the subject Indexes of Chemical Abstracts and/or Review of Current Literature/World Surface Coatings Abstracts. Produced by the FSCT Technical Information Systems Committee (in cooperation with the International Coordinating Committee) this work should be of great value in our industry. Price \$2.00.

Order from:

Federation of Societies for Coatings Technology
1315 Walnut Street
Philadelphia, PA 19107

Elections

BALTIMORE

Active

JANKOWIAK, CHRISTINE—The O'Brien Corp., Baltimore, MD.
MARINO, KENNETH E.—Benjamin Moore & Co., Colonial Heights, VA.
MINCHEW, CARL—Benjamin Moore & Co., Colonial Heights.

Associate

CONZELMANN, PAUL—Duron Inc., Beltsville, MD.

CHICAGO

Active

BLOCH, DANIEL R.—S.C. Johnson & Son Inc., Racine, WI.
GREGOR, JOHN T.—Finnaren & Haley Inc., Lisle, IL.
LEWARCHIK, RONALD J.—DeSoto, Inc., Des Plaines, IL.
PEARSON, PAUL O.—Valspar Corp., Rockford, IL.
PETER, HAROLD E.—Elpaco Chemical Coatings, Elkhart, IN.
ROBEY, NANCY R.—DeSoto, Inc., Des Plaines.
WEAKLEY, TIM H.—DeSoto, Inc., Des Plaines.

Associate

FENECH, RONALD—International Minerals & Chemical Corp., Des Plaines, IL.
PETTIJOHN, THOMAS W.—Wayne Chemical Corp., Naperville, IL.

GOLDEN GATE

Active

DECRISTOFORO, ANTHONY—Penofin Corp., Sacramento, CA.
DOMINIC NG, Y.—Dexter-Hysol Corp., Pittsburg, CA.
FIGUEROA, ERLINDA N.—The O'Brien Corp., South San Francisco, CA.
MOONEY, CHARLES—D.J. Simpson Co., South San Francisco.
SHARMA, JATINDER—Ampex Corp., Redwood City, CA.

Associate

GUILD, HOWARD—E.T. Horn Co., Oakland, CA.
WHITE, KENNETH RAY—Nalco Chemical Corp., Concord, CA.

KANSAS CITY

Associate

LAURENT, H. JEFF—F.R. Hall, Kansas City, MO.

NEW YORK

Active

BURLAGE, JOHN W.—Pacific Anchor Chemical Co., Cedar Knolls, NJ.
DEWACKER, DENNIS, R.—Reichhold Chemicals, Inc., Bloomfield, NJ.
GARRET, MERRIL D.—C-D-I Dispersions, Newark, NJ.
HARVIE, ROBERT—Thibaut & Walker Co., Inc., Newark, NJ.
IQBAL, MOHAMMAD—Amsterdam Color Works, New York, NY.
KICKI, EDWARD M.—Aurachem Corp., Harrison, NJ.
SHAH, PRAVIN—Thibaut & Walker Co., Inc., Newark.
SHEEHY, NEIL—Thibaut & Walker Co., Inc., Newark.

Retired

HENDRICKS, JOHN J.—Flushing, NY.
KENNEDY, JAMES J.—Freehold, NJ.
KLEIN, MILTON—Forest Hills, NY.
WINSTON, BERTHOLD—Forest Hills.

ST. LOUIS

Active

COLEMAN, VOLKER—M.A. Bell, St. Louis, MO.
FITZGERALD, THOMAS W.—Sterling Lacquer Mfg. Co., St. Louis, MO.
GAYSON, KENNETH—Benjamin Moore & Co., St. Louis.
HALET, EUGENE F., JR.—Sterling Lacquer Co., St. Louis.
SONTHEIMER, THOMAS J.—M.A. Bell, St. Louis.

Associate

COURTNEY, DAVID W.—Chemcentral, Maryland Heights, MO.
DEGISI, ANTHONY—Tenneco Chemicals, Prospect, KY.
HUGHES, ED R.—Harmon Colors Corp., Marietta, GA.
MERRALL, DIANE—Hilton-Davis, St. Louis.
MILLER, BOBBY D.—Commercial Filters, St. Louis.

Solve your problems with our additives.

Paint Mate of the Month:

Flow Control & Leveling Agent (Water Reducible) (FCLA-WR)

- Water reducible or solvent • Improve flow and leveling
- Improve surface smoothness • Prevent craters, pinholes and mottling

(Also effective in high solids)



Quality additives since 1946

8012 South Chicago Ave., Chicago, Ill. 60617
Phone (312) 221-4433

To receive lab samples and further information on this and our other fine additives, write or call us collect.

Technical Articles in Other Publications

Compiled by the Technical Information Systems Committee—H. Skowronka, Chairman

Farbe und Lack (In German)

Published by Curt R. Vincentz Verlag, Schiffgraben 41-43,
3000 Hannover 1, Postfach 6247

Vol. 87 No. 2

February 1981

- Kittel, H.—“Laboratory in the Paint Factory”; 85-87.
 Ferch, H., Eisenmenger, E., and Schafer, H.—“Colour Characteristics of Black Lacquers. Part 10: Basic Principles and Applications of Carbon Black”; 88-94.
 Strauss, U., Streitberger, H.J., and Zwernemann, K.—“Cathodic Dip Coating in Practice”; 94-99.
 Preininger, E.—“Parameters in Rapid Weathering”; 100-104.
 Kelch, W., and Endriss, H.—“Lead Chromate Pigments in the Paint Industry—Technical, Safety and Ecological Aspects”; 104-109.
 Brushwell, W.—“Energy Savings in the Manufacture and Application of Lacquers”; 110-112.
 Gross, H.—“Introduction of the Term ‘Nominal Film Thickness’ (DIN 55 926 Part 5): Second Communication”; 112-113.
 German Standard Draft DIN 53 773 Part 2: Testing of colouring materials in plastics; Testing of colouring materials in polyvinyl chloride pastes (plastisols); Preparation of test specimens—118.

Organic Coatings and Plastics Chemistry Preprints

Published by American Chemical Society,
Division of Organic Coatings and Plastics Chemistry

Vol. 44

March 1981

- Biological Activities of Polymers
 Herbicidal, Fungicidal and Related Activity (6 papers)
 Drug Related Activity (6 papers)
 Antitumor Polymers (6 papers)
 Miscellaneous Biological Activity (6 papers)
 General Papers and New Concepts in Applied Polymer Science (19 papers)
 Fast Polymerization Reactions and Reaction Injection Molding (18 papers)
 Borden Award Symposium honoring E. Baer: Structure—Property Relationships of Polymeric Solids (18 papers)
 Plastics for the 1980s (11 papers)
 Commodity and Engineering Plastics (22 abstracts)
 Macromolecular Secretariat—Instrumental and Physical Characterization of Macromolecules (58 abstracts)
 Note: Please contact G.G. Schurr at Sherwin-Williams Research Center, 10909 S. Cottage Grove Rd., Chicago, IL 60628 for information regarding price and availability of this publication.

NEED LABORATORY SERVICES?

D/L Laboratories is an independent organization that is highly experienced and well equipped to give you the following services in:

PAINTS & COATINGS • CALKS & SEALANTS • ALLIED PRODUCTS

- Surveys
- Feasibility Studies
- Technical Promotion
- Personnel Training
- Testing & Evaluation
- Certification
- Specification Development
- Manual Preparation
- Field Inspection
- Complaint Investigation
- Legal Assistance
- Expert Testimony

MAY WE HELP YOU? Please describe your specific problem or area of interest below and mail this coupon, write or call us COLLECT.

SEND FOR FREE BROCHURE



(212) 777-4410
 Dept. JCT
 116 East 16 Street, New York, N.Y. 10003
 Established 1952

Gentlemen: Please contact me to discuss the item(s) below. I understand that I am under no obligation.

Phone (____) _____ Best Time ____AM ____PM

Send Me Your Brochure, General Interest Only

Name _____ Title _____

Firm _____

Address _____

City _____ State _____ Zip _____

NEW! AGITATED PRESSURE CUP!

Air-driven!
 The ideal way to keep metallics, heavy body paints and coatings mixed in the cup! Variable speed, air-driven agitation accommodates a wide range of viscosities.
 The pressure cup delivers approximately 50% more material, compared to siphon cups, usually with less air.
 The results? Increased control, more economical use of material and a superior finish!
 Representative, distributor and dealer inquiries invited.
 For full information, write or call:
Safe and easy to use!



ECLIPSE SYSTEMS, INC.

SINCE 1908
 SUBSIDIARY OF AEROSYSTEMS TECHNOLOGY CORPORATION

CORK HILL ROAD, FRANKLIN, NJ 07416 • 201/827-7878

Meetings/Education

AFP/SME to Sponsor 'Finishing 81', Oct. 13-15 in Detroit

The Association for Finishing Processes of the Society of Manufacturing Engineers, AFP/SME will sponsor a three-day conference entitled, "Finishing '81", at Cobo Hall, Detroit, Mich., October 13-15.

Sixteen technical sessions emphasizing economics, compliance, and energy in relation to the finishing industry will be featured. The technical presentations will address such finishing disciplines as: powder coating, radiation curing, high solids, water-borne, surface preparation, wood finishing, plastic coatings, quality control, innovative technology, and finishing robots.

Many of the technologies, processes, and methods discussed in the sessions will be demonstrated first-hand by industry experts. Demonstrations will include: surface preparation, coating application systems, quality control and testing equipment, curing equipment and sys-

tems, coating materials, material handling equipment and systems, safety equipment, precoated materials and coating surfaces.

For further information, contact Susan E. Buhr, Administrator, Technical Activities Dept., AFP/SME, One SME Dr., P.O. Box 930, Dearborn, MI 48128.

Lehigh University to Offer Emulsion Course in June

The 12th annual one-week short course "Advances in Emulsion Polymerization and Latex Technology," will be offered at Lehigh University, Bethlehem, Pa., June 8-12.

The course is designed for engineers, chemists, scientists, and managers who are actively involved in emulsion work and for those who wish to develop expertise in the area. This in-depth study of the synthesis and properties of high polymer latexes will include subject matter featuring a balance of theory and applications as well as a balance between chemical and physical problems. Lectures, given by leading academic and industrial workers, begin with introductory material and reviews, and progress through recent research results.

The course fee is \$500 for the entire week or \$150 per day for any part.

Further information can be obtained from Dr. Mohamed S. El-Aasser, Dept. of Chemical Engineering, Whitaker Lab. #5, Lehigh University, Bethlehem, PA 18015.

Advertise In The
JCT Classified Ads

CAVITIES CAVITIES CAVITIES

Our thermo-optic flash-calcined aluminum silicates — OPTIWHITE®, OPTIWHITE P®, AND TISYN — are loaded with cavities which provide exceptional light-scattering properties for more hiding power... an amorphous particle shape assures low angular sheen and sheen control.

OPTIWHITE, the most versatile of our thermo-optic silicates, provides true hiding power with the greatest whiteness and formulation efficiency. Eliminates need for flattening agents or coarse extenders to maintain low angular sheen and sheen control.

OPTIWHITE P, AND TISYN, provide excellent opacity in latex or solvent systems. They are ideal pigments for functional hiding extenders for TiO₂ — and recommended for this purpose by major suppliers of TiO₂.

Write for complete details
and working samples.

Burgess
Pigment COMPANY

Mines and Plants: Sandersville, Georgia

EXECUTIVE SALES OFFICES:

P.O. BOX 349, SANDERSVILLE, GA 31082

HYDROUS AND ANHYDROUS
ALUMINUM SILICATE PIGMENTS • KAOLIN CLAYS

*Light-Scattering
voids in our
thermo-optic clays
mean better
hiding power at
lower cost.*



Rohm and Haas Co., Philadelphia, PA, has announced the appointment of **John E. Gallagher** as Fluid Process Chemicals Marketing Manager of its Industrial Chemicals North American Business Team.

Also announced by the firm, was the appointment of **Charles E. Hoey** as Research and Development Manager for its Polymers, Resins and Monomers North America business. Several Technical Representatives were also appointed in this division: **Myron H. Bender** and **Nancy A. Nase**, in the Michigan District; **Robert P. McFerran**, based in the Northeast District; **Marcia L. Sabiston**, in the Ohio Region; and **Margo A. Ciez**, in the Midwest District.

Dr. William H. McNeely, Vice-President of Research and Development for Kelco, Co., Div. of Merck & Co., Inc., has retired after 36 years of service.

The company has also announced the promotion of **James F. Kearney** to Division Manager for Kelco's industrial division.

Dr. Bruce L. Libutti has been promoted to Manager of Research for Drew Chemical Corp., Boonton, NJ. In this position, he will be responsible for research and development on treatments for fuel and boiler and cooling water as well as marine cleaners.

Edward T. Turpin, Scientist-polymer development for Glidden Coatings & Resins, has been honored by SCM Corp. for his development of new techniques in polymer chemistry. His patent technology involves the synthesis of polymers to permit replacement of air-polluting organic solvents with water in chemical coatings applications for several industries. His achievement has led to the introduction of a new water-borne coil coating primer which can be used almost universally under any quality topcoat and a new air-dry/force-dry electrocoating composition. He is a member of the Cleveland Society.

Glidden also announced three managerial appointments in its Chemical Coatings Group. **Dr. Robert J. Seidewand** was named Technical Manager, Wood and Ultra-violet Coatings Research Center, Strongsville, OH. Appointed Manager-Technical Services for the firm's Midwest Chemical Coatings region, Chicago, IL was **Robert E. Markovic**. **Thomas A. Melody** was appointed regional Chemical Coatings Sales Manager, San Francisco, CA.



C.E. Hoey



N.A. Nase



P.L. Sheets



R.I. Wishnick II

Phillip L. Sheets has been appointed Market Manager, Universal Colorant Dispersions for the Harshaw Chemical Company's Color Department. In this position, he will be responsible for marketing the firm's line of universal colorant dispersions and merchandising aids.

Chemical Manufacturers Association's Communications Dept. has announced a series of appointments. **Richard L. Wilson** has been named Director of Public Relations and Advertising. Named to Director of CMA's national news service was **Jeffrey Colin Van. Nanda W. Haynes** was appointed Manager of Public Information, and **Priscilla J. Perkins** and **Patricia A. Sokoloff** were appointed to the positions of Communications Program Coordinator and Coordinator of Consumer Information, respectively.

Scott Bigelow was appointed Chemist and Paint Formulator of Rainbow Paint Co., Springfield, MO.

William Craig, Midwestern District Sales Manager for Neville Chemical Co., retired on April 1, after a career of 52 years in the coatings industry.

He joined Neville in 1943 and for some ten years worked in the control and research & development labs. In 1957, he was transferred to Chicago as Senior Technical Sales Representative. Ten years later he was appointed Midwestern Sales Manager and held that post until his retirement.

A native of Scotland, Mr. Craig joined the coatings industry in Pittsburgh, with the M.B. Suydam Co. Throughout his long career, Mr. Craig (known as "Speedy Gonzalez" to many of his long-time friends) sold hydrocarbon resins in every major coatings market in the U.S.

Witco Chemical Corp. has appointed **Robert I. Wishnick II** as General Manager of its Isocyanate Products Division, New Castle, DE. Also announced was the appointment of **Eric Davies** as Director of Management Information Systems, at the firm's Paramus, NJ EDP headquarters and at its various field locations.

Nathan W. Putnam has been appointed Director of Sales for the Pigments Department of CIBA-Geigy Corp., Ardsley, NY. In this position, he will be responsible for the direction of the pigments field sales force. Also, **Daniel Barufaldi** has been named Director of Marketing for the Pigments Department. He will be responsible for all marketing activities.

Elected Chairman of the Board for 1981 for the American Society for Testing and Materials (ASTM) was **Sydney D. Andrews**, Director of the Division of Standards, Florida Department of Agriculture and Consumer Services. **Richard H. Goodemote** will serve as Vice-Chairman for the board.

Six new directors were chosen by ASTM for 1981-1983. They are **Robert Baboian**, Texas Instruments, Inc.; **Paul F. Finn**, Finn Industries; **David M. Greason**, Dow Chemical Co.; **John J. McMahon**, Institute of the Ironworking Industry; **David A. Swankin**, Swankin and Turner;

James A. Cave has been appointed Color Computer/Technical Systems Manager for Reliance Universal, Louisville, KY.

At Sheboyan Paint Co., Sheboyan, WI, **Frank Yinko** was promoted to Assistant Technical Director of the Solvent-Base Lab; **Tom Brassler** to Assistant Technical Director of the Water-Base Lab.

Alvin S. Floen has been named Regional Manager, Pigment Sales for the Eastern Region of the New Jersey Zinc Co. He succeeds **P. Richard Hosang**, who retired on December 1, after 44 years with the company.

The Mearl Corp., NY, announced the appointment of **Gonzalo Ponce de Leon** as Manager, International Sales. Also, **Fred LoFaso** has been promoted to General Sales Manager for the firm's Pigment Division.

NL Chemicals/NL Industries, Inc. has announced the following staff appointments for its Central Sales Region. **James W. Hartsgrove** has been named Central Regional Sales Manager and **Peter J. Zakia**, District Sales Manager.

Mobay Chemical Corp., Dyes and Pigments Div., Pigments Department, has made the following appointments. **R. Wayne Underhill** has been named Sales Manager, in charge of sales activities throughout the United States. He is a member of the CDIC Society. **Lance P. Smerak** has been appointed Eastern Regional Manager, based in Haledon, NJ. Mr. Smerak is a New York Society member. Appointed Sales Representative in Texas, was **Ed. R. Hughes**. He is a member of the St. Louis Society.

James P. Culliton has joined Engelhard's Minerals & Chemicals Division as Assistant General Manager of its Attapulgus, GA operations.

Serafino (Sandy) Palleschi, a Past-President of the Toronto Society, has formed Serif Coatings & Chemicals, Inc., in Mississauga, Ont., Canada. The firm is owned by he and his brother, Al. Mr. Palleschi has been associated with the Canadian paint manufacturing industry for many years.

William F. Reardon has been appointed Operations Manager at Cabot Corp., Cab-O-Sil Division, Tuscola, IL.

Joseph Kirakoz has joined Deft, Inc. as Operations Manager and Technical Director of the Irvine, CA facility, where he will oversee all production and technical aspects of the plant. Mr. Kirakoz is a Los Angeles Society member.

Paint Chemists Celebrate 45th Anniversary

These graduate chemists were employed by the same paint consulting laboratory in 1936, and have remained active in the Paint and Coatings Industry. Now in 1981, 45 years later they are presently:

Sidney B. Levinson, President of D/L Laboratories, New York, NY, is a 40-year member of the New York Society.

Alexander C. Haber, formerly Technical Director of Arnesto Paint Co., New York, NY, died, October 1980. Mr. Haber was a member of the New York Society for 35 years.

Alfred Driscoll, Consultant, is a 35-year member of the New York Society.

Formerly Account Supervisor for AMSCO Div. of Union Oil of California, **Norman Haber** has retired. Mr. Haber is a 35-year member of the New York Society.

Joseph R. Cataldo has retired as Technical Director of Standard Tex Co., Brooklyn, NY and has been a member of the New York Society for 35 years.

Monroe Rapaport is President of Pyrolac Corp., Hawthorne, NJ and has worked in the industry for 40 years.

Joseph Cantor is President of Josad Consultants, Inc. and was formerly Technical Director of Fyn Paint & Lacquer Co., Brooklyn, NY. He is a 35-year member of the New York Society.

Elias Singer is Chairman Emeritus of Troy Chemical Corp., Newark, NJ with 40 years of service to the paint and coatings industry.

Formerly President of Farnow Inc., **Benjamin Farber** has retired after 40 years of service to the industry.

Herman J. Singer, a 35-year member of the New York Society, and formerly President of Lehman Brothers, Jersey City, NJ, is a consultant.



AFTER 45 YEARS—Back in 1936, when the top photo was taken, ten graduate chemists worked for what was probably the first consulting laboratory in the paint industry. Now, in 1981, nine reunited and posed for the bottom picture. Top—left to right: Sidney B. Levinson, Alfred Driscoll, Norman Haber, and Joseph R. Cataldo. Bottom—left to right: Monroe Rapaport, Joseph Cantor, Herman J. Singer, Elias Singer, and Benjamin Farber.

Milton Golden, Vice-President of Standard Brands Paint Co., was honored with the Ike Sinaiko Humanitarian Award, presented by the Paints, Plastics, Petroleum, Chemicals Division of the United Jewish Welfare Fund at its February 19 luncheon in Los Angeles, CA.

Mr. Golden was selected as recipient of the award in recognition of his diligent service for various community organizations, including the United Way, the Guardians, B'nai B'rith and ORT, in addition to his longtime leadership of the United Jewish Welfare Fund.

Mr. Golden is a member of the Los Angeles Society.

Ed Gaskell, Chairman of the Board of California Resins and Chemicals, Inc., Vallejo, announced the appointment of **Alec Pickering** as President of the firm. **Peter Chiesa** has been named Chief of Laboratory and Technical Services, and **Kendall Pickering** will supervise technical sales.

Tioxide Canada Inc. has appointed **Stewart Taylor** as Western Area Manager and **Rob H. Kuhnen** as Toronto Technical Salesman. These appointments followed the retirement of **David Cook**, as Western Area Manager.

The 1981 ISCC Godlove Award was presented to **Robert Merrill Boynton** at the Golden Anniversary Banquet of the Inter-Society Color Council on April 27. The Award, established by Margaret Godlove in memory of her husband, Dr. I.H. Godlove, a pioneer worker in color science, is presented for "outstanding contributions to the knowledge and use of color."

Dr. Boynton was cited for his 30 years of research in the field of color vision and his very significant contributions in the operations of the human color-vision system.

Dr. Boynton, a native of Illinois, received degrees from Amherst College and Brown University. He joined the faculty of the University of Rochester in 1952 as Assistant Professor of Psychology, remaining until 1974 where he progressed to Professor of Psychology and Optics, and Director of the Center for Visual Science. During two one-year sabbatical leaves, Dr. Boynton worked as Guest Research Worker at the National Physical Laboratory in Teddington, England, and as Visiting Professor of Physiology at the University of California Medical Center. He is presently Professor of Psychology, University of California at San Diego.

Dr. Boynton has published over one-hundred papers and book reviews. He is author of the recently published book entitled "Human Color Vision," which features current concepts about the nature of color perception.

Larry Faulhaber has been named Midwest Regional Sales Manager for Bee Chemical Co., Lansing, IL. Mr. Faulhaber has served the Western Michigan area as a field sales engineer, and had won the Salesman of the year award.

Obituary

William H. Cary III, 65, former President of Porter Paint Co., died on March 11, 1981. Mr. Cary retired as President of the company in 1976. He joined the firm in 1936 as Manager of the Shipping Department. He advanced into sales management and was elected Vice-President in 1948. In 1963, Mr. Cary was named President of trade sales and was appointed President and Chief Operating Officer of the company in 1970.

EXXON is seeking a Coatings and Polymers Specialist

for Petroleum Refining Applications

Exxon Research and Engineering Company has a career opportunity in the non-metallic materials area for a Coating, Linings and Plastics Specialist to provide basic materials and corrosion technology for Exxon affiliates worldwide.

A BS/MS in Engineering (Materials or Chemical), Science or Metallurgy is required plus a minimum of 5 years experience in the application of coatings, linings and plastics in the refining or chemical industries. A knowledge of typical refining and petrochemical processes would be a plus.

Responsibilities of this position include:

- Failure Analysis/Problem Solving-This involves failure analysis of coatings and polymers and often requires consulting on remedial action plus occasional on-site coordination of repairs.
- Research and Development-Short term R&D to evaluate new coatings and polymers for refinery applications.
- Specifications-Create and update specifications and guides for coatings and polymers.
- Training-To develop and conduct training courses for both in-house and affiliate engineers.

This position offers an excellent salary and a company paid benefits package, with the opportunity for advancement. Our Engineering Center is located in north central New Jersey (near Morristown), a pleasant suburban area with excellent recreation, cultural attractions and situated within close proximity to New York City.

If you are interested in a rewarding career with Exxon, please forward your resume with salary history in confidence to: Exxon Research and Engineering Company, Professional Recruitment, Dept. ER-343, P.O. Box 101, Florham Park, New Jersey 07932.

EXXON RESEARCH and ENGINEERING COMPANY

EXXON

We are an equal opportunity employer. m/f

Literature

Software Packages

Literature has recently been published featuring two new software packages. A new analytical software package has been introduced that enables the operator to display a sample spectrum and then manipulate the data to identify potential spectral interferences and to determine the optimum wavelength and background correction intervals for the analyses. Also featured is an advanced data processing software package which enhances infrared spectroscopy using the infrared data station. For additional information, write The Perkin-Elmer Corp., Main Ave., Mail Station 12, Norwalk, CT 06856.

Variable Rate Screw Feeder

Literature featuring information on a variable rate screw feeder which provides precisely metered product flow is now available. For complete information on Bulletin #400, contact Vibranetics, Inc., P.O. Box 36008, Louisville, KY 40233.

Titanate Coupling Agents

A new reference manual on titanate coupling agents for filled polymers is now available. For additional information, write Kenrich Petrochemicals, Inc., E. 22nd St., P.O. Box 32, Bayonne, NJ 07002.

Drying Time Recorder

A new instrument that is capable of recording the drying time of coatings and other materials in the field, in the laboratory, or in the oven is the subject of recent literature. For more information, write Paul N. Gardner Co., Inc., 218-D Commercial Blvd., Suite 205, Lauderdale-By-The-Sea, FL 33308.

Infrared Spectrophotometer

Literature is now available featuring a new high-performance microprocessor-controlled infrared spectrophotometer. This instrument offers the special feature of presample chopping which allows the user to obtain accurate spectra with samples that reradiate at or above room temperature. For further information, write the Perkin-Elmer Corp., Main Ave., Mail Station 12, Norwalk, CT 06856.

Foam Suppressor

Literature featuring a new foam suppressor which prevents foam from being generated in aqueous coatings, inks, and adhesives that are subject to agitation is now available. For more information, contact Daniel Products Co., 400 Claremont Ave., Jersey City, NJ 07304.

Point Level Gauges

Point level gauges for high or low level process determination are the subject of recent literature. Various types of applications, advantages, operating specifications and principal application considerations of the gauges are featured. Contact the Ohmart Corp., 4308 Allendorf Dr., Cincinnati, OH 45209.

Anti-Settling Agent

Literature is now available featuring a high efficiency anti-settling agent in pourable form. This new generation anti-settling agent for industrial solvent based coatings is designed to lower paint manufacturing costs. A free brochure detailing sample formula applications and test results can be obtained from NL Chemicals/NL Industries, Inc., P.O. Box 700, Hightstown, NJ 08520.

Paint Pigment

A bulletin describing a new, corrosion-inhibiting paint pigment is now available. The pigment containing zinc molybdate for corrosion inhibition, is formulated to provide adhesion to rusted steel substrates. To obtain a copy of Technical Bulletin 363, write Sherwin Williams Chemicals, Publications Dept., 10909 S. Cottage Grove Ave., Chicago,

Letters to the Editor

You Only Get What You Pay For?

TO THE EDITOR:

The "Comment" in the March issue of JCT is misleading, inaccurate and unworthy of publication in an industry magazine. Your reference that only "name brand" paints bought from a "well-known" competitor at a higher price are any good, shows a lack of research including field testing of any nature, and price quality comparisons.

Your inference that only one of the "biggies" can manufacture quality paint is demeaning, to say the least, to any small or medium size regional manufacturer.

I would like to remind you that one of the biggies started the current trend in the early sixties when their products went on sale in a nationwide discount operation at prices which even small regional

manufacturers found hard to believe. Since that point in time, all of the "name brands" have jumped on the bandwagon. As a result of the combination of high raw material prices and the industry in general trying to absorb the increased costs of raw material, labor, and higher overhead, high pvc, low quality paint has been flowing from vats in every producers' plants, including the "well-known" brands. This has dropped the paint industry into the lowest echelon of profits in its history, and at the bottom of the industrial profits ladder.

It is time that industry leaders woke up and took the responsibility of putting the paint industry back where it belongs in the profit picture. This can be done only when we decide to quit bilking the public with super whitewash and start manufacturing quality products again.

In my employment history I have worked for three small to medium size manufacturers, and all made quality paints when the biggies were making quality paints. In order to survive when the biggies came out with cut quality paints, they were forced to cut their quality as well.

TOM FERGUSON
S.E. Operations Manager
Southland Paint Co., Inc.

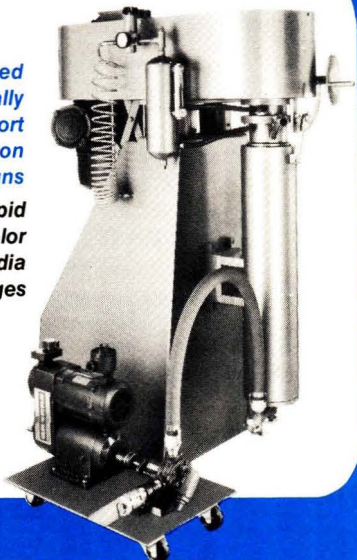
The inference that only "biggies" can make quality paint was made by the reader; and neither intended nor stated in the "Comment" page. In the paint industry, the terms "well-known" and "name brands" apply equally to small, medium, and large manufacturers.—Ed.

Schold

MODEL F-600 SHOT MILL

*Designed
Specifically
for Short
Production
Runs*

**Rapid
Color
and Media
Changes**



SCHOLD'S F-600 Shot Mill is a 4½ gal., sealed and pressurized, high-speed, continuous media mill . . . for deagglomerating, dispersing and milling inks, paints, dyestuffs, pharmaceuticals, fillers and similar liquids . . . makes short runs profitable with rapid color and media changes . . . gives small plant operations the versatility of handling batches from 50 to 500 gal/day and up. Stainless or carbon steel; variable speed drives. Write for engineering bulletin.

SCHOLD RESEARCH INSTITUTE welcomes your product test on Schold equipment in Florida, or special arrangements can be made for an "in plant" test on your premises. Write for details.

SCHOLD  **SCHOLD**
MACHINE CO.

SOUTHERN DIV.: 387-105 Terrace NE, St. Petersburg, FL 33702
Telephones: 813/576-1147 or 576-1132
MIDWEST DIV.: 7201 W. 64th PL, Chicago, IL 60638
Telephones: 312/767-0487 or 458-3788

Coming Events

FEDERATION MEETINGS

(Oct. 28-30)—59th Annual Meeting and 46th Paint Industries' Show. Cobo Hall, Detroit, MI. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, PA 19107).

1982

(Apr. 29-30)—Spring Meetings. Society Officers on 29th; Board of Directors on 30th. Boston, MA. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, PA 19107).

(Nov. 3-5)—60th Annual Meeting and 47th Paint Industries' Show. Sheraton Washington Hotel, Washington, D.C. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, PA 19107).

SPECIAL SOCIETY MEETINGS

(June 15)—Golden Gate Society Seminar, "Safety and Government Regulations." (Louie Sanguinetti, Jasco Chemical Corp., P.O. Drawer J, Mountain View, CA 94042).

(Sept. 23-24)—Montreal and Toronto Societies Joint Symposium on "Coatings Directions for the 80's."

1982

(Mar. 10-12)—Southern Society Annual Meeting. Hyatt Regency, Savannah, Ga. (Dan Dixon, Freeport Kaolin Co., P.O. Box 337, Gordon, GA 31031).

(Mar. 23-24)—25th Annual Technical Conference of the Cleveland Society for Coatings Technology. Baldwin-Wallace College, Berea, OH.

(Apr. 22-24)—Southwestern Paint Convention. Shamrock Hilton Hotel, Houston, TX.

(May 6-8)—Pacific Northwest Society. Annual Symposium. Vancouver, B.C.

1983

(Feb. 23-25)—16th Biennial Western Coatings Societies' Symposium and Show. Hyatt Regency, San Francisco, CA.

OTHER ORGANIZATIONS

(June 15-19)—"Applied Rheology for Industrial Chemists" Short Course. Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., Kent State University, Kent, OH 44242).

(June 17-20)—Oil and Colour Chemists' Association Conference, "Alternative Technologies in Coatings." Beaufort Hotel, Bath, England. (The Director and Secretary, OCCA, Priory House, 967 Harrow Rd., Wembley, Middlesex HA0 2SF, England.)

(June 21-26)—Air Pollution Control Association 74th Annual Meeting & Exhibition. Philadelphia Civic Center, Philadelphia, PA (Public Relations Dept., Air Pollution Control Association, P.O. Box 2861, Pittsburgh, PA 15230).

(June 21-24)—American Society for Testing and Materials Committee D-1 on Paint and Related Coatings and Materials Meeting. Biltmore Plaza, Providence, RI. (Jane R. Turner, ASTM, 1916 Race St., Phila., PA 19103).

(June 22-July 3)—"Advanced Coatings Science" course. North Dakota State University, Fargo, ND. (Dr. R. Chenoweth, Div. of Continuing Studies, NDSU, Fargo, ND 58105).

(June 29-July 3)—SURTEC (International Congress and Exhibition on Surface Technology). International Congress Center, Berlin, West Germany. (Dieter von Schramm, AMK Berlin, 1735 Eye St. N.W., Washington, D.C. 20006).

(July 5-10)—Fourth International Conference on "Surface and Colloid Science." Jerusalem, Israel. (The Secretariat, Fourth International Conference on Surface and Colloid Science, c/o Conventions (Kopel Tours) Ltd., P.O. Box 3054, Tel Aviv 61030, Israel).

(Aug. 10-14)—"Introductory Short Course on Composition of Coatings." University of Missouri-Rolla, Rolla, MO (Norma Fleming, Coordinator, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401).

(Aug. 31-Sept. 4)—"Introduction to Paint Formulation" Short Course. University of Missouri-Rolla, Rolla, MO (Norma Fleming, Coordinator, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401).

(Sept. 7-11)—"Advanced Paint Formulation" Short Course. University of Missouri-Rolla, Rolla, MO (Norma Fleming, Coordinator, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401).

(Sept. 13-16)—Canadian Paint Manufacturers Association Annual Meeting. Four Seasons Hotel, Vancouver, B.C. (Lydia Palazzi, Canadian Paint Manufacturers Assn., 515 St. Catherine St. W., Montreal, Que., Canada H3B 1B4).

(Sept. 14-16)—Second International Conference on "The Durability of Building Materials and Components." Gaithersburg, MD. (Dr. Geoffrey Frohnsdorff, B348, Bldg. 226, Center for Building Technology, National Bureau of Standards, Washington, D.C. 20234).

(Sept. 20-25)—4th Congress of the Association Internationale de la Couleur, "COLOR 81." International Congress Centre (ICC), Berlin (West), Germany. (Prof. Dr. Heinz Terstiege, AIC COLOR 81, Bundesanstalt für Materialprüfung (BAM), Unter den Eichen 87, D-1000 Berlin 45, Federal Republic of Germany).

(Sept. 21-22)—"Techniques and Mechanics of Marketing Specialty Chemicals" Short Course. Hilton Plaza Inn, Kansas City, MO (Norma Fleming, Coordinator, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401).

(Sept. 23-24)—"Managing for Innovation in Coatings" Short Course. Hilton Plaza Inn, Kansas City, MO (Norma Fleming, Coordinator, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401).

(Sept. 28-29)—Golden Jubilee of Colour in the CIE. The Colour Group (Great Britain). Imperial College, London, England. (Ms. M.B. Halstead, Thorn Lighting Ltd., Great Cambridge Rd., Enfield, Middlesex EN1 1UL, England).

(Oct. 13-15)—Association for Finishing Processes of the Society of Manufacturing Engineers. "Finishing '81" Conference and Exposition, "Economics, Compliance, and Energy." Cobo Hall, Detroit, MI. (William J. Yeates, Executive Director AFP/SME, One SME Dr., P.O. Box 930, Dearborn, MI 48128).

(Oct. 13-16)—"Formula 81". RAI Exhibition Centre, Amsterdam, Holland.

(Oct. 25-27)—"Women in Coatings—Meeting the Challenges" Short Course. Detroit, MI (Norma Fleming, Coordinator, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401).

(Nov. 2-4)—American Society for Testing and Materials Committee D-33 on Protective Coating and Lining Work for Power Generation Facilities Meeting. Monteleone Hotel, New Orleans, LA. (ASTM, 1916 Race St., Phila., PA 19103).

(Nov. 3-4)—Decorating Plastic RETEC, 5th Annual Regional Technical Conference, Society of Plastic Engineers, Decorating Division. Louisville, KY. (Edward S. Stumpek, General Electric, One Plastics Ave., Pittsfield, MA 01201).

(Nov. 4-6)—American Society for Testing and Materials Committee, Utilities Nuclear Coating Work Committee Meeting. Monteleone Hotel, New Orleans, LA. (ASTM, 1916 Race St., Phila., PA 19103).

(Nov. 10-12)—"Refresher for Painting Contractors, Maintenance Engineers and Inspectors" Short Course. Hilton Plaza Inn, Kansas City, MO (Norma Fleming, Coordinator, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401).

(Nov. 17-19)—"Job Estimating Workshop for Painting Contractors." Granada Royale, Kansas City, MO (Norma Fleming, Coordinator, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401).

(Dec. 9)—American Society for Testing and Materials Symposium on Selection and Use of Wear Tests for Coatings. Phoenix, AZ. (ASTM, 1916 Race St., Philadelphia, PA 19103.)

1982

(Feb. 7-10)—Inter-Society Color Council. Williamsburg Conference, Williamsburg, VA.

(May 9-14)—XVIIth Congress of FATIPEC, Brussels, Belgium.

(Oct. 11-13)—10th Congress of the Federation of Scandinavian Paint and Varnish Technologists. Copenhagen, Denmark. (G. Christensen, Sadolin & Holmblad Ltd., Holmbladsgade 70, DK-2300, Copenhagen S, Denmark).

1983

(July)—25th Annual Pacific Coatings Convention. Melbourne, Australia. (O.C.C.A.A., 1983 Pacific Coatings Convention, C/- Tioxide Australis Pty. Ltd., Private Bag 13, Ascot Vale, Victoria, 3032, Australia).

Advertisers Index

ASARCO, INC. 21

BURGESS PIGMENT CO. 53

CABOT CORP. 10
CARSTAB CORP. 27
CIBA-GEIGY CORP. 8-9

D/L LABORATORIES 52
DOW CHEMICAL USA 2

ECLIPSE SYSTEMS, INC. 52
EXXON RESEARCH & ENGINEERING CO. 56

B.F. GOODRICH Cover 2
W.R. GRACE & CO., DAVISON CHEMICAL DIV. Cover 3

HERCULES INCORPORATED 16A,B,C,D

NL CHEMICALS/NL INDUSTRIES, INC. 13

PAINT CHEMICALS, INC. 51

ROHM AND HAAS CO. 1, 15

SCHOLD MACHINE CORP. 58
SPENCER KELLOGG DIV., TEXTRON, INC. Cover 4

TENNECO CHEMICALS, INC. 11

UNION CARBIDE CORP. 4-5

'Kumbug' from Hillman

Fortunate were those who attended the Federation conventions during the mid-fifties. In those days we were treated to question and answer sessions conducted by a real *MASTER* of Ceremonies, Colonel Billy Hood. Witty, charming, dramatic, and knowledgeable, the Colonel added hilarity and delight to the technical discussions. Below is a transcript from part of the proceedings at the Southern Annual Meeting in 1955. A silver dollar rewarded both questions and answers—sometimes equally incomprehensible.

Incidentally, the Colonel hasn't changed much. He's still charming, witty, dramatic, knowledgeable and—venerable, suh!—Herb Hillman

COLONEL HOOD: Can anyone tell me how to recover a semi-livered, dark chrome green alkyd paste? It must be pretty much or he wouldn't have gone to the trouble to write this note, and incidentally it says, "P.S. I've got the answer written on the other half of this note." I don't know whether he's testing us but butyl cellosolve does a good job. Gimme a dollar, John.

ARTHUR STAUDERMAN: Monoethylamine usually is a great help.

COLONEL HOOD: It smells so bad.

MR. STAUDERMAN: It sure does.

COLONEL HOOD: I don't like that.

MR. STAUDERMAN: You'll get drunk on that and any of the other amines, but they do an effective job.

COLONEL HOOD: Introduce yourself, Art.

MR. STAUDERMAN: I am Arthur Stauderman, of the Louisville Club. These jells are like poor relations. Sometimes they are really rather obnoxious, but now and then you read somewhere that something will work. We have found that any of the peculiar amines, like diethyl monobutylamine, are rather effective. They certainly work like a charm in the laboratory and are a little more of a nuisance in the factory where you have to have high agitation. Now that poses question Number 1—"How are you going to have a high agitation with something that's like a big pig in a bucket?"

COLONEL HOOD: You come up here, Art, and I'll get down there.

MR. STAUDERMAN: The answer is to get a couple of brawny fellows to chop it up first, sort of in segments, and when no one is looking, thrown in one. After a little while, the thing works. Now I'll give you an example. A drum of material sat in the hot sun in a

government storage yard for two years. They said, "We don't know why it won't work when we take the bung out. Something's wrong in there." Well, there was a good reason for it. The drum and the paint were all in one piece. Well, by cutting the metal off we got the most of it out. Then we tried it in the laboratory and we were amazed. We went at it in a very scientific way—you know—one per cent, two per cent, and three per cent. Up to two per cent nothing happened. But at three per cent we began to notice something was, to use a nasty word, peptizing. All of a sudden something started to happen. So we said, "We've got to stir this stuff. We will stir it a hundred times." You couldn't stir it with a mechanical agitator, you know, for it would have been all over the room. We stopped at five per cent. Then, one fellow said, "I wonder if we would just put the stuff in, put the cover on, and go home—maybe something will happen while we don't look." The next morning we came back and found that the kettle with one percent was the same. Two per cent was practically the same but at three per cent we began to see some improvement. When we got up to five per cent we found a liquid. We also found where we just put the monobutylamine in without stirring, the paint was entirely liquid. And here is the payoff. You'll have to believe this because this is the truth—we had the original viscosity of the material.

The original viscosity of the specification paint was 73 K.U. We put the amine in, put the cover on, and the next day it was all nice and smooth. It made a clean film with no liver or seeds. I wondered what the viscosity was and on measuring found it to be 74 K.U. Now this is almost too much to believe but it's a nice story which we believe because we saw it. We figured "this is duck soup" so let the factory work on it.

So, we got a couple of brawny fellows and they put the stuff in the kettle which smelled up the plant for five days. The time was too much so they gave up but they didn't throw the kettle away. They saved the kettle and they said they were sorry but it's a little bit looser now than it was before. So they pried the kettle off and that was that.

COLONEL HOOD: From now on, Art, you can have my job and I'll take yours down in the audience for you have smelled up the place better than anybody else has ever done before. John, give him that \$1,000 bill. This is one of the best Confederate notes I could find. Turn it over and you'll find General Lee endorsed one corner of it and General Grant the other. I don't know what the question originally was, Art, but you sure did answer it.

C. E. HOLCOMB: Colonel Hood, I'm the guy who asked the question originally. I don't think you answered my question exactly. The paint isn't in a drum. It's in the ball mill with 5,000 pounds of balls.

You can post-add new SYLOID[®] 169 flattening agent in just 5 minutes. Flat.



Reduce the cost of flattening clear wood finishes with Davison's new SYLOID 169.

Add SYLOID 169 to your system straight from the bag. It disperses readily and uniformly. In N/C lacquer for example, 5 minutes at low shear does it. SYLOID 169 is up to 20% more efficient than other

agents, so you'll use less. And it gives uniform reflectance at all angles, for that satiny-smooth, hand-rubbed effect.

To get more batches per shift, at a lower cost per batch, talk to us.

GRACE
DAVISON
CHEMICAL DIVISION

Our water reducible urethane resins line is ...a different kind of animal

Reduced fire hazards and air pollution problems.

Water reducible elastomeric resins for clear or colored coatings for plastics and other substrates.

Air dries through in 3-4 hours.

Full range of "skin types" from hard to very soft aliphatics.

Performs where water reducible acrylics and vinyls won't... without cracking.

Better adhesion to most substrates than solvent reducible resins.

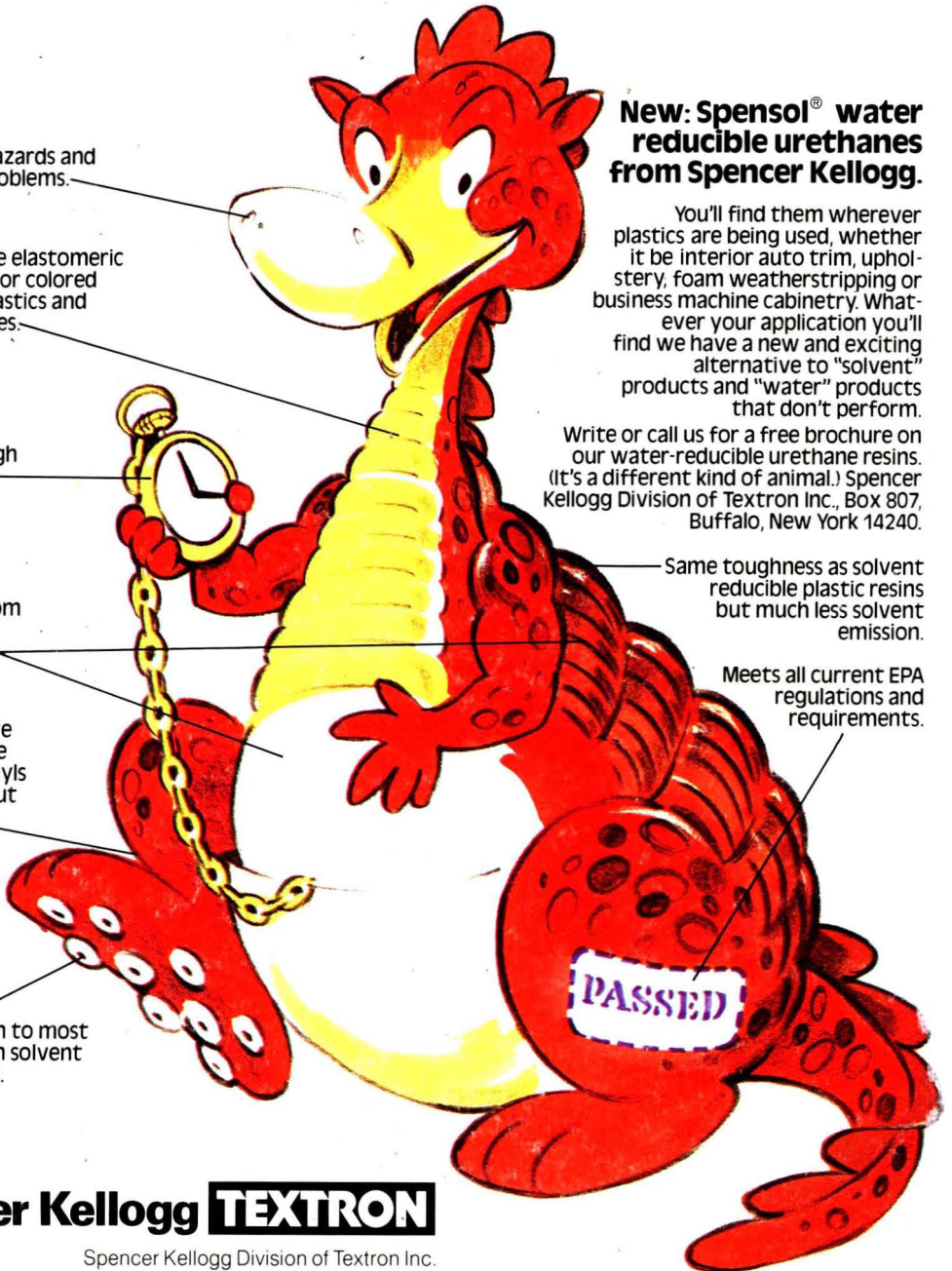
New: Spensol® water reducible urethanes from Spencer Kellogg.

You'll find them wherever plastics are being used, whether it be interior auto trim, upholstery, foam weatherstripping or business machine cabinetry. Whatever your application you'll find we have a new and exciting alternative to "solvent" products and "water" products that don't perform.

Write or call us for a free brochure on our water-reducible urethane resins. (It's a different kind of animal.) Spencer Kellogg Division of Textron Inc., Box 807, Buffalo, New York 14240.

Same toughness as solvent reducible plastic resins but much less solvent emission.

Meets all current EPA regulations and requirements.



Spencer Kellogg **TEXTRON**

Spencer Kellogg Division of Textron Inc.

