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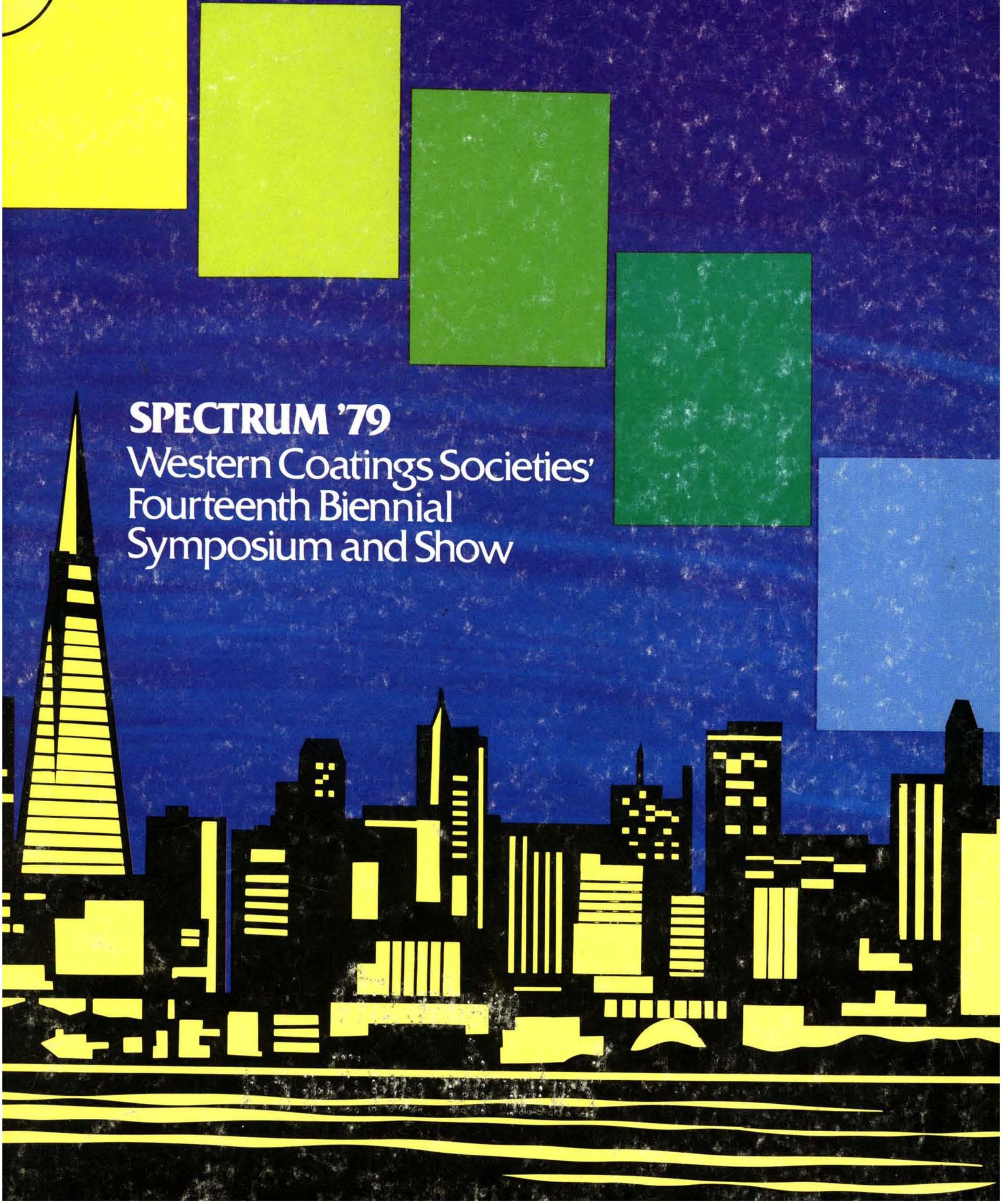
MARCH 1980



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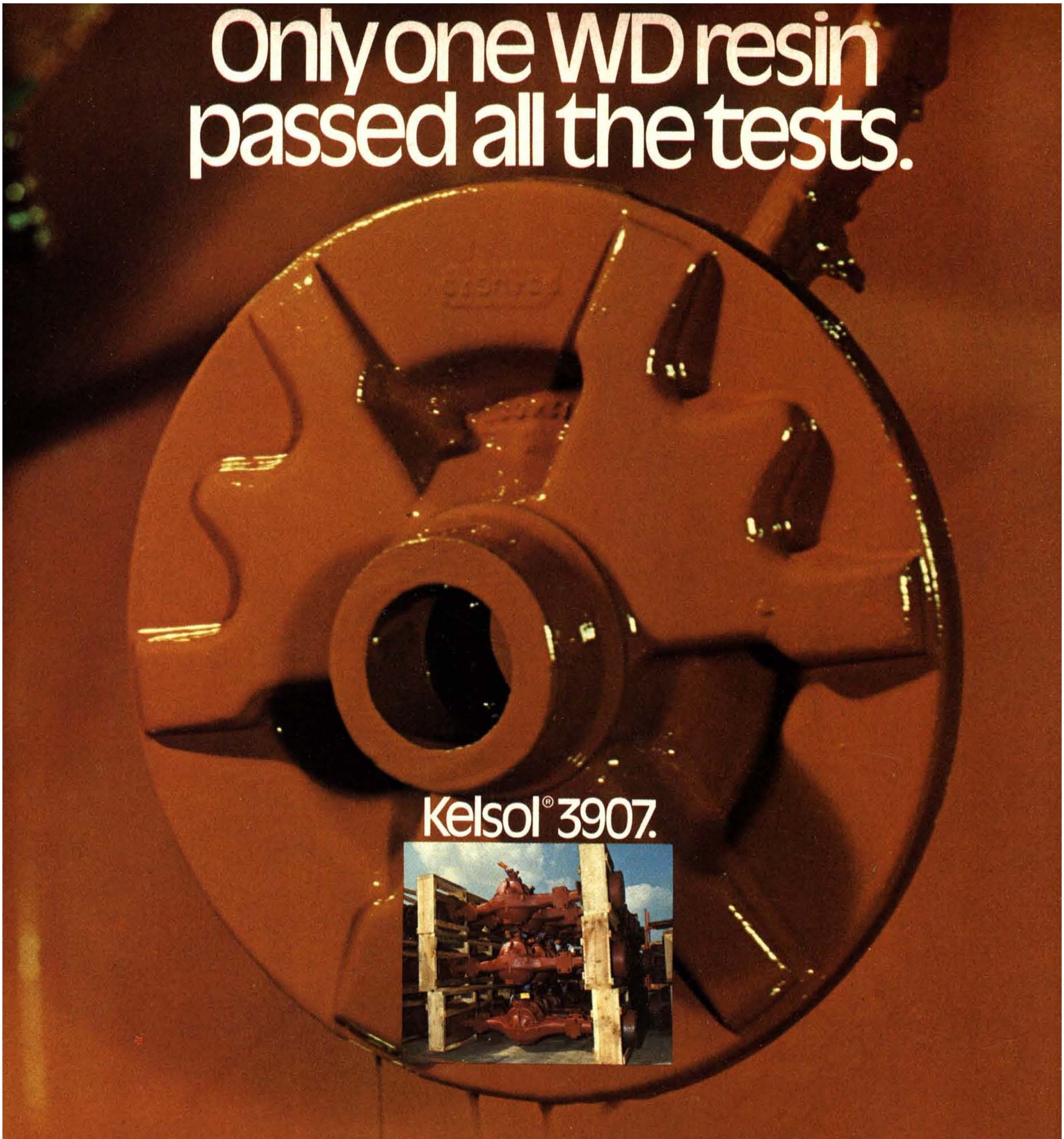

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Volume 52 Number 662

Features

WESTERN COATINGS SOCIETIES SYMPOSIUM PAPERS

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A Guide for Authors is published in each January issue.

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Comment

Gadgets and Gimmicks Return

A popular feature at several Federation Annual Meetings some years ago was a display of "gadgets and gimmicks," a collection of innovative cost-saving devices and test methods, developed by members for use in the laboratory or on the production floor.

This year the Gadgets and Gimmicks display will again be a feature at the Annual Meeting and Paint Industries' Show, to be held October 29–31 in Atlanta.

Winning entries will receive cash prizes ($100, first; $50; second; and $25, third) and a certificate. The entries will be grouped in two categories, production and laboratory, with three prize winners in each.

Descriptions and photos of the award-winning displays will be subsequently published in JCT.

So, if you have a cost-cutting or labor-saving device or test method that you might enter, now's the time to make plans to do so. Submit your idea with a drawing, photograph or other visual means of describing it to either of the following: Laboratory—Thad Broome, Precision Paint Corp., 5275 Peachtree Ind. Blvd., Atlanta, Ga. 31341; Production—Carroll Scholle, 6530 N. Greenview Ave., Chicago, Ill. 60626.

Your entry could not only win a prize but might also generate ideas for cutting costs and improving productivity by those viewing the displays. And both you and the industry would be winners.—TAK

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By adding the pre-reacts containing Hycar® CTBN to an epoxy resin in laboratory tests, a 500% increase in impact resistance, as measured by Gardner impact methods, has been observed by formulators of corrosion resistant maintenance coatings. Recommended end uses include coatings for storage tanks, piping, flooring and electrical apparatus.

Conical Mandrel

Almost every coating formulation containing the pre-react modified with Hycar® CTBN passed the ⅛-inch conical mandrel test. Little if any effect on thermal-mechanical properties and corrosion resistance was experienced.

Salt Spray Resistance

In addition to impact and flexibility, epoxy pre-reacts containing Hycar® RLP improve salt spray resistance (ASTM D 610). Spot rusting was extensive (1-2) for an unmodified clear formulation after 200 hours; slight (8-9) for the same formulation modified.

For minimizing physical wear or chemical corrosion on flooring, piping, storage or other vulnerable equipment, consider adding pre-reacts containing Hycar® RLP to your epoxy coatings. For specific test results, specifications and samples, contact The BFGoodrich Company, Chemical Group, Dept. JP-36, 6100 Oak Tree Boulevard, Cleveland, Ohio 44131.

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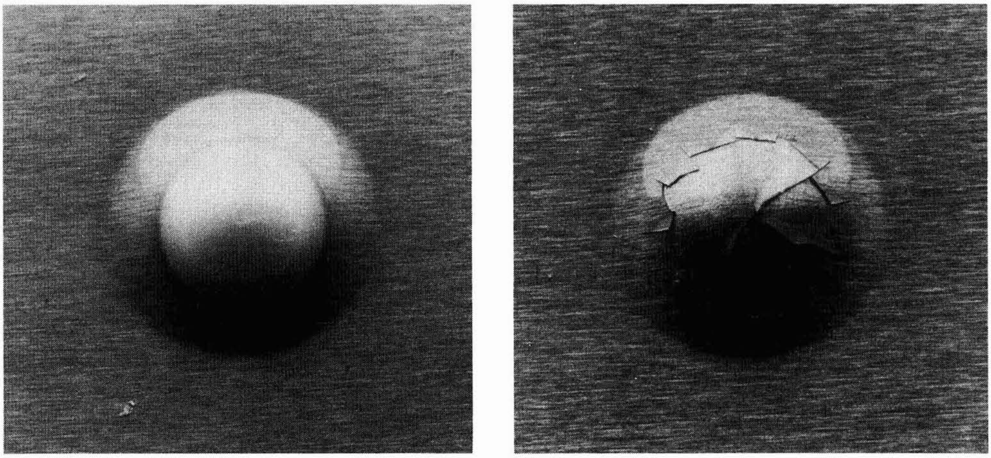

Modified epoxy coating (left) withstands reverse impact test with no rupture of coating. Unmodified control sample (right) displays extensive cracking, exposing base material to corrosive attack.

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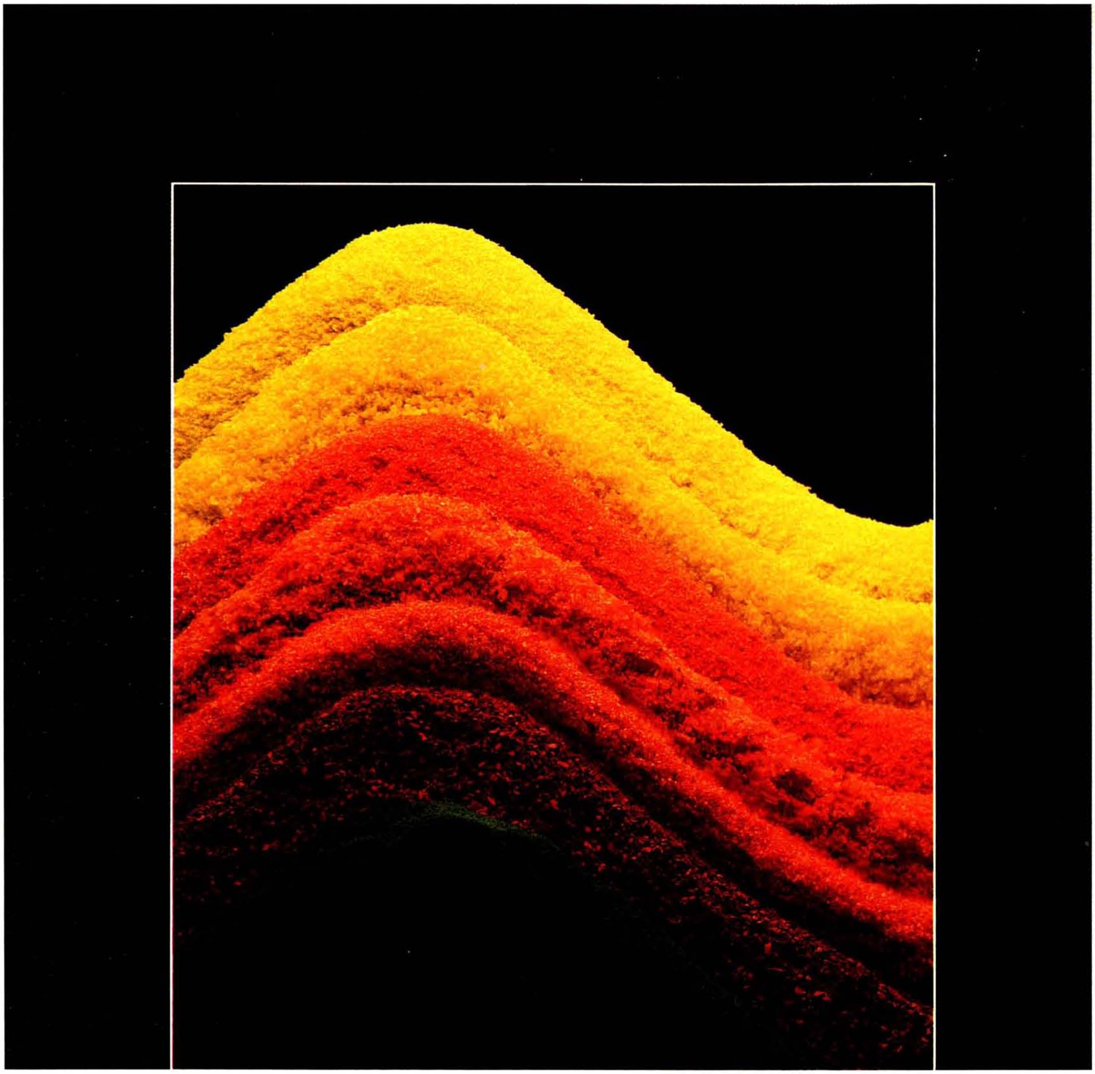


Abstracts of Papers in This Issue

COPPER PHTHALOCYANINE (CPC) PIGMENTS IN INDUSTRIAL WATER-BORNE SYSTEMS—P.G. Schmidt

Journal of Coatings Technology, 52, No. 662, 37 (Mar. 1980)

Copper phthalocyanine pigments in water-reducible paints have been found to be sterically stabilized through secondary bonding forces. The strengths of these bonds were determined by measuring the thermodynamic work of adhesion between the pigment and paint resins. A positive work of adhesion value indicates pigment-polymer bonding, but not necessarily pigment stabilization. A negative value indicates non-bonding conditions and pigment instability. Color stability as "drift" was instrumentally measured and related to pigment-polymer work of adhesion.

AN IMPROVED DRAWDOWN BLADE—D.A. Holtzen

Journal of Coatings Technology, 52, No. 662, 43(Mar. 1980)

Nonuniformity of paint drawdown film thickness results in considerable error when determining scattering coefficients of prime hiding pigments. Simple modification of drawdown blades routinely used in paint laboratories results in improved uniformity and reduces thickness variation by approximately 30%. Redesigned blades minimize pressure, viscosity, and rate effects.

NEW FORMULATING PARAMETERS IN THE SWITCH FROM BAG TO SLURRY CLAY—T.G. Brown, W.S. Stoy, and B.P. Scibek.

Journal of Coatings Technology, 52, No. 662, 49 (Mar. 1980)

Latex flats made by converting to total slurry pigments offer savings primarily because of increased production rates. Dispersant levels should be carefully reduced in this switch.

Delaminated and hydrous kaolin slurries can replace dry calcined clay in higher PVC light and dark tint bases. Delaminated slurries exhibit superior hiding and tinting strength, particularly in light tint systems. Both types of slurries provide better enamel holdout and stain resistance. Burnish and scrub resistance of calcined clays can be compensated for by the adjustment of flatting agents. The 65% PVC high kaolin paints develop maximum opacity and tinting strength, better than the 55% PVC series, with no appreciable sacrifice in film integrity.

NATURAL OCCURRENCE AND VOLATILITY OF BENZENE, TOLUENE, AND XYLENE IN PETROLEUM THINNERS—W.H. Ellis and C.D. McLaughlin

Journal of Coatings Technology, 52, No. 662, 61 (Mar. 1980)

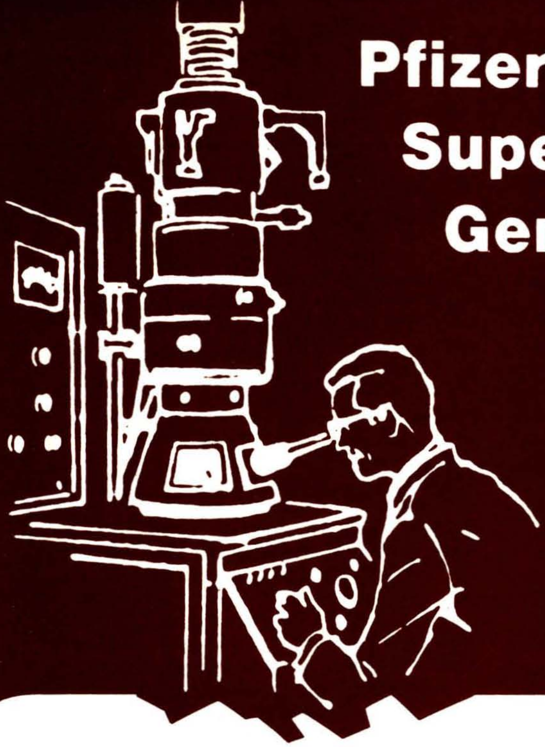
Benzene, toluene, and xylene are of increasing concern to regulatory agencies because of potential acute and chronic health effects. Gas chromatographic analyses of fractions from laboratory fractional distillations showed that occurrence of an aromatic compound in a solvent depends upon its percentage in the original crude oil, the solvent distillation range, and distillation efficiency. Evaporation experiments and analyses of vapor and liquid in equilibrium showed that volatility is sometimes influenced by molecular interactions.

Special analytical techniques were required to determine benzene, toluene, and xylene concentrations in mixtures with other hydrocarbons.

ENERGY CONSIDERATIONS IN STRIPPING PAINT FROM HOOKS AND RACKS—C.J. Madigan

Journal of Coatings Technology, 52, No. 662, 73 (Mar. 1980)

Hooks and racks used to transport parts through industrial paint systems require periodic cleaning to remove accumulated paint. A common paint stripping method is the molten salt bath system. While this is an effective method, there are several drawbacks. Energy and chemical requirements are high. This paper reviews the evaluation of the alternate methods considered for replacement of a molten salt bath system at a large appliance manufacturing facility. Alternate paint stripping methods evaluated are: hot strippers, cold strippers, mechanical abrasion, incineration, paint burn-off, pyrolysis, and fluidized sand bed. Factors considered in the evaluation are: stripping effectiveness, operating time, energy requirements, chemical requirements, and associated environmental, health and safety factors. Energy requirements as well as the energy forms used are important considerations when evaluating a system for future applications, and these considerations are discussed. The basis of the evaluation is a large appliance manufacturing facility where 550 racks are stripped per day, an average of approximately 230 kilograms of paint stripped per day. The results of this study indicate that the paint burn-off, pyrolysis, and fluidized sand systems are acceptable for replacement of the molten salt bath system.



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Annual Meeting Slated for October 29–31 At Civic Center in Atlanta, Ga.

The Federation's 58th Annual Meeting and 45th Paint Industries' Show will be held October 29-31 at the Civic Center, in Atlanta, Ga. Preliminary arrangements are well underway and advance indications are that this year's event will mirror the very successful Annual Meeting and Show last held there in 1974.

Technical Sessions

Program Chairman Hugh W. Lowrey, of Indurall Coatings, Inc., Birmingham, Ala., and his committee are putting together a selection of presentations which should have appeal for a good cross-section of those attending. Theme for this year's event is "Three R's for the Eighties: Research, Resources, and Regulations."

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

Paint Industries' Show

All available exhibit space has been sold out for the 1980 Show, which will be the largest in Federation history. It will be held in the Civic Center, concurrently with the Annual Meeting.

The Paint Industries' Show is the only national exhibit of raw materials and equipment used in the formulation, testing and manufacture of paints and related coatings.

Room Reservations

Blocks of rooms have been set aside at the Atlanta Hilton (headquarters hotel) and the Marriott, Hyatt Regency, and Holiday Inn.

All housing reservations must be on the official form furnished by the Federation.

These forms will be mailed to all members in the next several weeks, and additional copies will be available from Federation headquarters.

Housing will be handled by the Atlanta Convention and Visitors Bureau, who will accept and process only those requests on the official form.

NPCA Meets Same Week

The National Paint and Coatings Association will hold its Annual Meeting on October 27-29 at the Atlanta Hilton Hotel.

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

Head of Gravure Research Institute To Deliver Keynote Address

The Federation is pleased to announce that Harvey F. George, Executive Vice President and Research Director of Gravure Research Institute, will present the E. W. Fasig Keynote Address at the 1980 Annual Meeting.

H. F. George

Mr. George, who will be featured at the Opening Session on Wednesday morning, October 29, will speak on "The Challenges of the 80's in Coatings and Graphic Arts."

Born in New York City, Mr. George received a Bachelor of Mechanical Engineering Degree *cum laude* in 1945 from the City College of New York, where he was elected to Tau Beta Pi, Engineering Honor Society, and Pi Tau Sigma, Mechanical Engineering Honor Society. He received a Master of Industrial Engineering Degree from New York University in 1952 and did doctoral research in management of research and development. Prior to entering the graphic arts field with Merganthaler Linotype Co. in 1949, Mr. George worked as an aircraft stress analyst and structures engineer at Fairchild Aviation Corp., and was project engineer on the development of a Sterling cycle engine for the Navy with North American Philips.

Mr. George has more than 30 years of broad experience in the graphic arts and related fields and has served in his current capacity since 1955. Prior to joining Gravure Research Institute, he was head of the graphic arts research section of Merganthaler for six years. He was recruited by the Board of Directors of GRI to set up and head its first research laboratory. Prior to that GRI research was conducted at Battelle Memorial Institute in Columbus, Ohio. During Mr. George's tenure, the Institute has grown many fold in membership and research expenditures, and has an excellent record of accomplishment in printing research.

Mr. George has traveled extensively, keeping abreast of gravure developments for his organization. He is well known in, and has many contacts within, the graphic arts industry and many printing research institutes throughout the world as a member of the International Association of Research Institutes for the Graphic Arts Industry, of which he is Vice Chairman. He coordinates research programs with the European Rotogravure Association, with which GRI is affiliated.

He holds more than two dozen U. S. and foreign patents on offset and gravure press developments, including the gravure electrostatic assist process which is widely used on gravure presses throughout the world, more than 2,000 units having been installed.

Mr. George is Past President of the Technical Association of Graphic Arts, Past Chairman of the TAPPI Graphic Arts Committee, a member of the Executive Committee of the Research and Engineering Council of the Graphic Arts, Chairman of the Gravure Industry Emisson Control Subcommittee which represents the gravure industry with the EPA and other government agencies, and is active in the Gravure Technical Association. He frequently participates in conferences as both an organizer and speaker and is the author of numerous articles on gravure printing and a contributor to McGraw-Hill's "Encyclopedia of Science & Technology," and Van Nostrand's "Handbook of Pulp and Paper Technology."

He is also a member of the American Society of Mechanical Engineers, Static Electricity Committee of the National Fire Protection Association, Society of Photographic Scientists and Engineers, Society of Photo-Optical Instrumentation Engineers, and the American Society of Association Executives. He received the TAGA Honors Award for outstanding contributions to the graphic arts industry in 1979.

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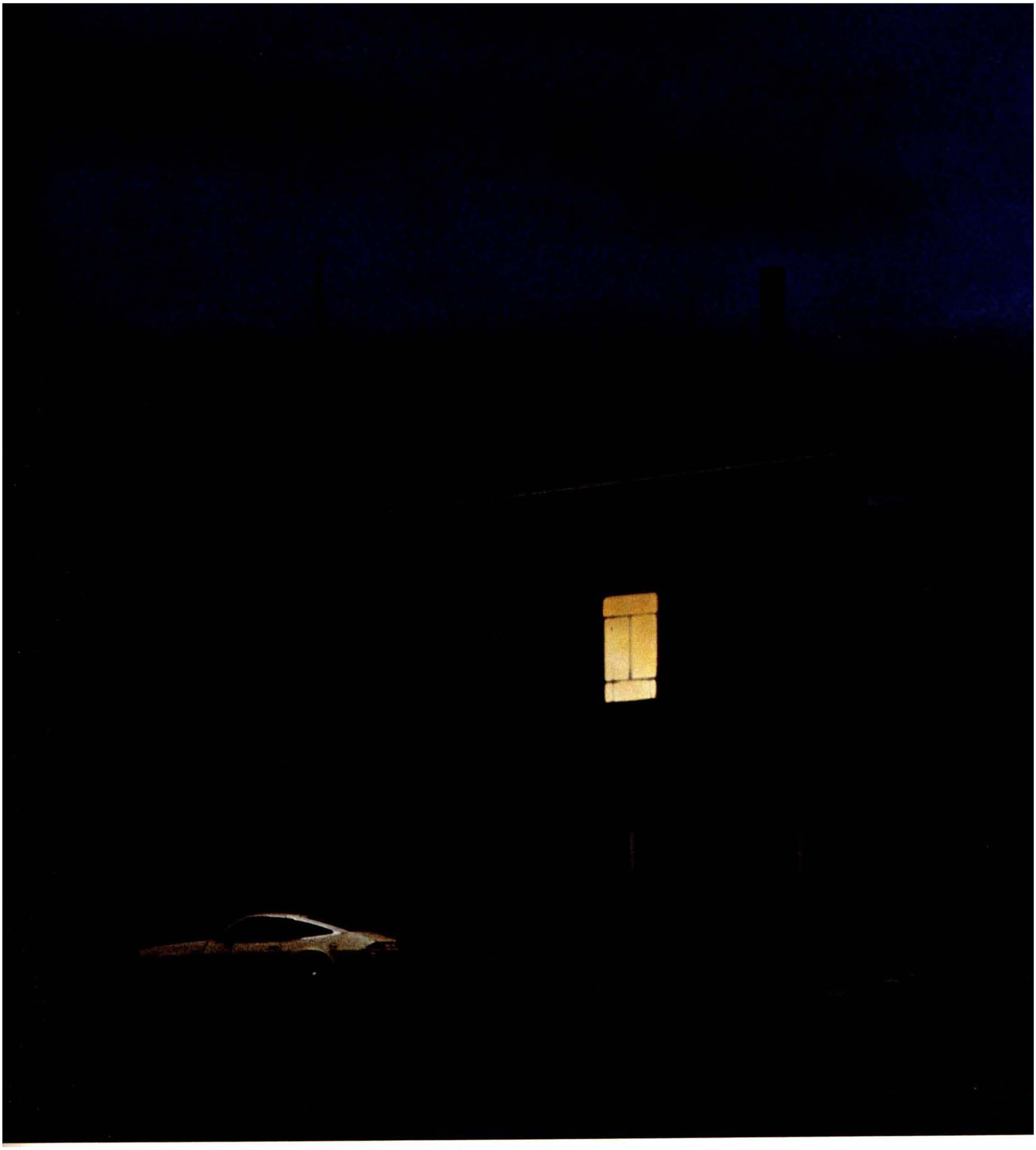
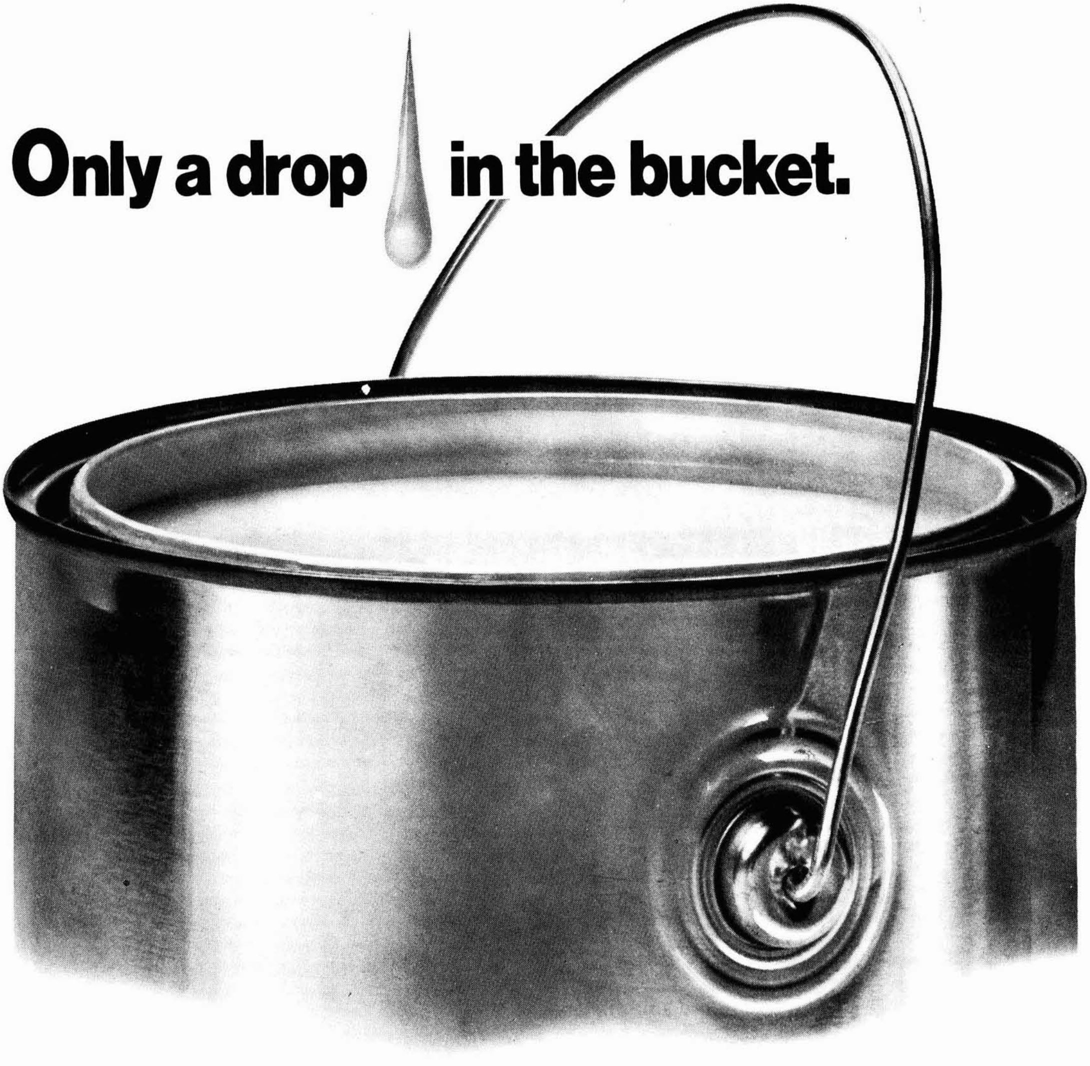



Only a drop in the bucket.

Rx for WINTER STORM DAMAGED HOMES

In recent winters, record snowfalls, sleet, ice and rain have caused severe and costly damage to countless homes in many parts of the United States. The most extreme damage was a number of collapsed roofs from the sheer weight of the accumulated snow and ice. But many other problems resulted from the heavy precipitation, too. One of the most wide-spread was the formation of rooftop ice dams. By the time the warm weather finally arrived, it was evident that these so-called "mini-glaciers" had taken their toll on the interiors and exteriors of thousands of homes.

If your home was one of these casualties, here are some tips on repairing the damage and preventing it in the future...

WHY DO ICE DAMS FORM?

First, let's consider how ice dams are formed and why they can lead to major damage to your interior walls and ceilings, wall cavities and insulation, and even to blistered and peeling paint on the exterior of your house.

Ice dam problems have become more frequent in recent years for several reasons. Construction methods and building standards have changed along with the increased effort to conserve energy. Houses built prior to the 1930's generally had no effective insulation in either ceilings or walls. Roofs were usually steeply pitched and constructed mostly with open sheathing and wood shingles. The shingles had gaps between them which served to ventilate attics and cool the roof deck.

These homes were, of course, "heat-wasters," but there was not as much interest in conserving fuel and energy at that time. Plenty of heat escaped into the attics and adequate natural ventilation kept the attic air moving. As a result, roof-snow melted rapidly and did not accumulate. Ice and icicles formed on the eaves and in the gutters. Snow-water penetrations were insignificant and gone before they could cause damage.

In recent years, because of the concern about high fuel costs and the need for energy conservation, building codes and standards have changed. New houses and "modernized" older homes must now meet new standards. The new standards, however, frequently represent only *minimum requirements*. As a result, millions of homes now have warm attics instead of the hot attics in the old "heat-waster" houses. The snow accumulation on roofs of houses with warm attics melts slowly along roof edges causing water pools to back up behind ice dams. The water often remains in this area for weeks, penetrating roof shingles and finding its way into ceilings and wall cavities. This, of course, can create severe damage, such as soaked insulation, stained, swollen and cracked plaster and drywall panels, dampness and rotting in wall cavities and, eventually, stained, blistered and peeling paint. Interior paint damage may show up fairly soon. The blistering and peeling of exterior painted surfaces, however, may not become apparent until summer weather arrives. Water trapped in insulation and wall cavities may then penetrate the wood siding and emerge as blisters under the paint film.

CAN ICE DAMS BE PREVENTED?

Yes, ice dams can be prevented or at least minimized. Although this may not be a simple matter in some houses, the threat of potential damage makes the effort worthwhile. A number of factors can lead to the formation of ice dams, but the fundamental problem is undesirable heat in the attic or immediately under the roof which results in a warm roof surface. *The logical solution to the problem is to try to maintain a cold roof.* (See Figure 1.)

Consider what happens to snow accumulation on *cold surfaces* in those parts of the United States which receive heavy snowfall. There is no massive ice formation on unheated sheds and buildings, on wood piles or on picnic tables. So, the best advice to homeowners is to work toward keeping the outside roof surface temperature as close as possible to the outside air temperature.

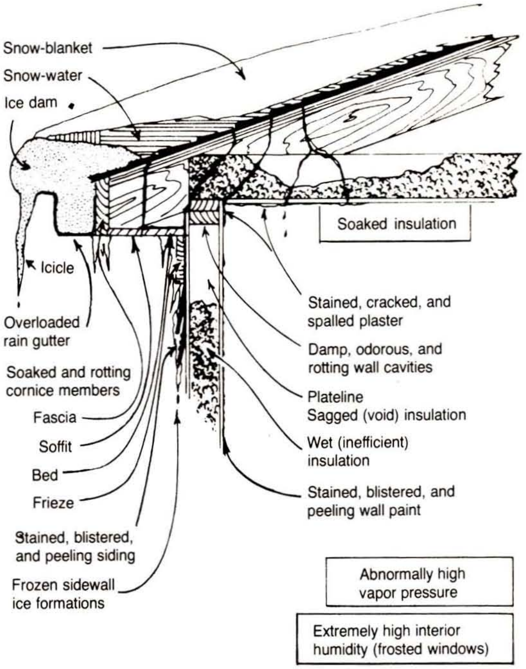


Figure 1. This sketch of the ice dam problem identifies both the ice dam and its damages. Of course, all the damages illustrated may or may not occur at any one instance.

Sketches Courtesy of AGRICULTURAL EXTENSION SERVICE, UNIVERSITY OF MINNESOTA

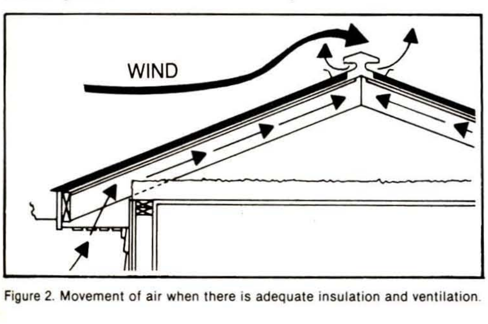


Figure 2. Movement of air when there is adequate insulation and ventilation.

HOW CAN I KEEP THE ROOF COLD?

To accomplish this, it is necessary to minimize the amount of warm air entering the attic and to provide for constant removal of this warm air by continuous ventilation.

The ceilings of rooms immediately under the roof must be insulated *much more* than is customary and all openings which allow warm air to enter the attic must be sealed off. Excellent caulks and sealants are now available to homeowners in easy-to-use forms. There are sealant cartridges for use in "guns" as well as sealants in wound rope or tape form to make it convenient to seal cracks, holes and electrical openings permanently.

But, adequate insulation alone will not prevent ice dam formation. *Proper insulation must be done in conjunction with adequate ventilation.*

HOW CAN I KEEP THE ROOF COLD? (Con't.)

To prevent ice dam formation, there is no such thing as too much ventilation in the attic and under the roof surface. Some utility companies recommend that homes have one square inch of ventilation area for each square foot of ceiling area in those rooms under the roof. Ventilation should be equally distributed between incoming air vents and outlets. The overall objective is to have a brisk flow of outside air entering through the soffit and moving along the ridge rafters. The air exits through a ridge vent near the peak of the house. Figure 2 illustrates the direction and path of the desired air flow.

A variety of devices are available to help achieve the ventilation described. Some companies sell devices known as "air chutes." These can be installed during construction or when insulation is added. Correctly installed, these devices are very helpful in providing the ventilation needed to maintain cool attic and under-roof areas.

WHAT CAN I DO FOR TEMPORARY RELIEF?

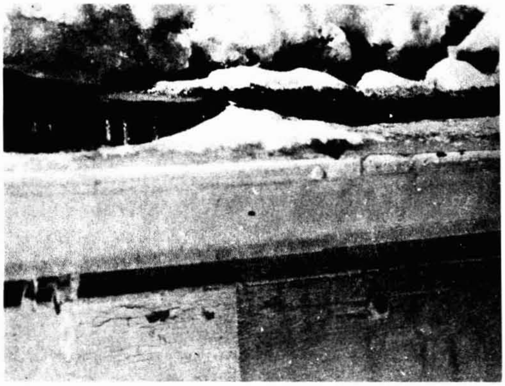
Once heavy snow accumulations are on the roof or ice dams have formed, the homeowner needs immediate emergency measures. Here are some actions that can be taken to provide some relief, even if it is only temporary:

(1) Snow can be removed from the roof with push brooms or roof rakes. But, don't try this unless you can get to the roof safely. *Remember—your personal safety is of greater importance!* Never use a blow torch or try to chop through the ice to the roof surface. These measures could cause more damage than you prevent.

(2) Electric cables can be installed along eaves and in roof valleys to prevent ice dam formations. The melting effectiveness is limited to a few inches from the cable, however, and the irregular type of melting that occurs can sometimes cause secondary ice dams to form further up the roof. Electric cables use a great deal of expensive energy, of course.

(3) Have the roof steamed or hose it with tap water on a warm day. With steaming, there is always the risk of expansion and contraction of the roof deck which can lead to later roof deterioration.

Considering the possibilities of personal injury and roof damage, your best bet is to spend your time and money on proper insulation and ventilation rather than resorting to temporary emergency measures each winter.



Ice dam on roof edge

Snow accumulation on roof

Roof collapse from snow accumulation

Conditions conducive to ice dam formation

WHAT KIND OF DAMAGE IS CAUSED BY ICE DAMS AND SNOW WATER?

Many types of damage, some quite severe, can result from roof ice dam formation. Here are some things that can happen:

(1) Structural damage to roofs, porches, walls, etc., can be caused by the sheer weight of accumulated snow and ice. Supermarkets and even many houses in the Chicago area experienced collapsed roofs due to the heavy snowfalls of the 1978-1979 winter season.

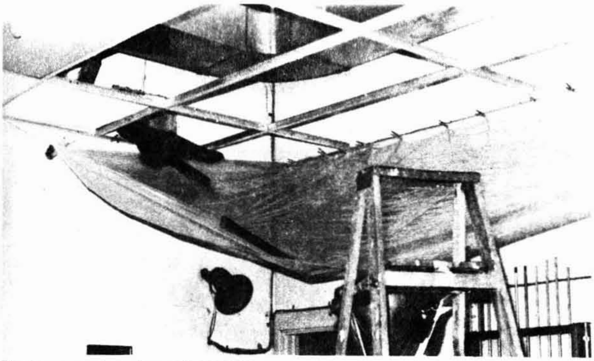
(2) Wet, soaked insulation in ceiling and wall cavities generally results in the loss of insulating properties. In fact, wet insulation can become a *conductor* of heat and cold rather than an *insulator*.

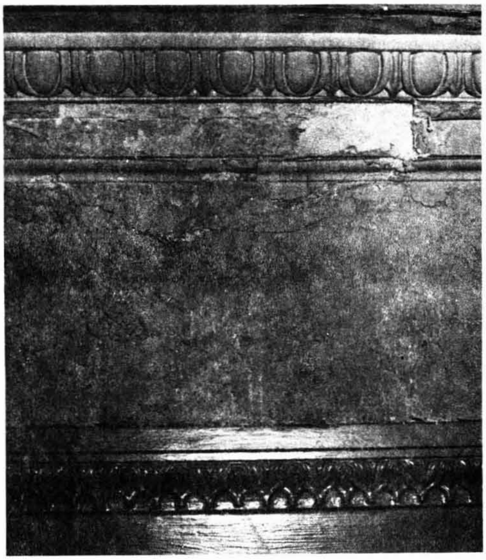
(3) Soaked insulation can result in damp, rotting wall cavities and rotting wood structural members. It also can cause very unpleasant odors.

(4) If plaster ceilings and walls become water-soaked, the interior walls quickly show the unsightly effects. The plaster swells, cracks and crumbles. In extreme cases, the whole ceiling and parts of the wall can fall.

(5) When walls and ceilings are constructed of gypsum board, drywall panels and wood panels, as most modern homes are, water damage may be different from that to plastered areas, but is often just as severe. Drywall panels will swell and become distorted when water-soaked. Even wood paneled walls are damaged when water accumulates behind them. They can swell, buckle and come loose from the wall.

(6) Unless damage is severe enough to require replacement of interior ceiling and wall sections, the most noticeable damage is likely to be to painted surfaces. Blotchy, stained areas will quickly appear. Stains can come from construction materials, insulation, nails, plaster and wall paneling. In addition, the paint is likely to blister, crack and peel. When hot summer weather arrives, look for paint damage on the outside of the house. Water trapped in wall cavities will find its way to areas of lower vapor pressure. This often means it will travel through the exterior wood siding and paint film. The exterior paint can blister, then crack and peel. Stains also can occur on exterior paint.


Replacement of drywall panels

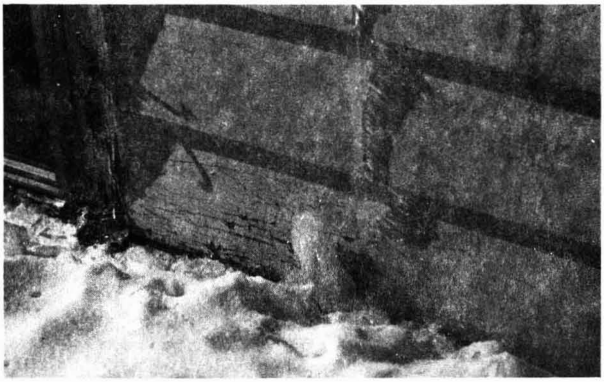

Water damage to plastered wall

HOW CAN THE DAMAGE BE REPAIRED?

If the damage to your walls or ceilings is severe enough to require replacement of some of the panels, you will probably need the help of a professional painting contractor. He can assess the damage and give you accurate cost estimates for repair. Many painting contractors are qualified to do the whole job for you.

To repair sagging drywall on ceilings, it is recommended that 5/8-inch panels be used. The old damaged panels can be removed and replaced or new 5/8-inch drywall can be installed in front of the sagging panels. The thicker 5/8-inch drywall is recommended because greater amounts of insulation are being used today. Otherwise, the weight of the insulation could cause the drywall to sag between the joists in time.

Many years ago, it was common practice to use drywall on the underside of exterior overhangs. When melted snow backed up under the roof shingles into the overhang and froze, the weight often caused the drywall to collapse. If this has happened to your house, you are well-advised to repair these areas using "waterproof" sheetrock or exterior grade plywood panels.


Ice dam and resulting damage

WHAT ABOUT REPAINTING?

Once the structural damage has been repaired and you have determined that wall cavities and areas above ceilings and under floors have been properly "dried out," it is time to repaint. It is important to remember that paint *protects* as well as beautifies. There are a great variety of paint and coatings products available and it's important to choose the correct ones for your particular purpose and apply them properly. Here are some of the problem areas that are likely to need repainting:

Stained Walls and Ceilings...

Most of the stains caused by the water are likely to be amber or brownish streaks or blotches.

If the plaster or gypsum board has not been damaged by the water and only the paint's appearance has been spoiled by stains, repainting may be a sufficient remedy. Since water has caused the stain, you can assume that the stain is at least partially water soluble. So, wash the stained surface carefully with water and detergent or a household cleaner that's intended for paint. Without soaking the surface, remove as much stain as possible. Allow the washed surface to dry thoroughly (48 hours or longer).

Before applying the finish coat of paint, it is wise to use a special "stain-blocking" or "stain-killer" type of primer-sealer. These products are readily available at your paint dealer's store. Primers of this type are fast drying, resinous, *solvent-thinned* coatings— not water-thinned. Some have alcohol as their solvent.

The purpose of using a *solvent-thinned* primer is to prevent further leaching of the staining material into a water-thinned paint. Once the special primer has been applied uniformly, any type of topcoat paint or enamel may be used, including latex paints which contain water. If the stain is thoroughly sealed, it will not penetrate the special primer and discolor the topcoat. Your paint dealer can help you select the right products, readily available in a wide range of colors and sheens.

Discolored Painted Wood...

If painted woodwork, doors or paneling are discolored or stained by water from inside walls or ceilings, they can usually be refinished with a moderate amount of work. If the painted surface is blistered or the paint is peeling or chipping, it may be necessary to remove the paint down to the wood surface to achieve a smooth, attractive finish. Many types of paint and varnish removers are available at your paint dealer. Some of these are in paste form, designed for use on vertical surfaces. Many are water-rinsable which makes clean-up easier. *Be sure to follow label instructions carefully when using paint removers!*

If the painted wood surface has not been badly damaged, but is dulled, discolored or stained, clean the surface thoroughly and apply an enamel undercoat. Allow the undercoat to dry thoroughly, then sand lightly with a very fine sandpaper. Wipe clean and then apply either an alkyd or latex enamel in any color or sheen you like for the finish coat.

If the wood surface has not been painted, but is a finished natural wood, remove the finish if necessary and sand the wood to a smooth surface. You'll find wood stains in a variety of shades, as well as clear topcoat varnishes in several sheens at your paint dealer's. If the damage to stained woodwork is minor, a light sanding, followed by a coat of gloss or semi-gloss clear varnish will greatly improve the appearance.

Ask your paint dealer for product selection advice or hire a reputable painting contractor to do the painting or finishing job for you.

Painting New Plaster...

Many older homes have plastered walls and ceilings. If water has caused the plaster to swell and crumble, or if sections have collapsed, it is likely that new plaster will be needed in some areas. Plaster is a good surface on which to apply paint, but it must be allowed to dry and harden properly before painting. The time required can vary considerably depending on such things as heat, humidity and composition of the plaster.

Normally, most plaster jobs can be safely painted in four weeks if the temperature in the house or building is above 50 degrees Fahrenheit and the relative humidity is not unusually high—say, below 70%. These conditions apply to plaster on a lathed wall (furring strips). If plaster is applied directly to a solid wall such as brick, tile, etc., a longer drying time is necessary before painting. In this case, the water can escape only through the painted plaster—not both sides of the wall, as is the case with a furred wall.

You may want to rent or purchase a moisture meter from your paint dealer. Moisture meters measure, by electrical conductivity, the amount of moisture on or near the surface of a wall. Their dials indicate whether an area is dry, wet or very wet. It is important to make tests with a moisture meter in many areas, both high and low, on the walls. Remember that you are determining only the condition of the wall *surface*—water still inside the plaster will continue to come out.

Perhaps the best method of using a moisture meter is to check the same areas each day for several days. When the readings don't show change, it is a good indication that the plaster is "dry" and has reached a stable condition for satisfactory painting.

If new plaster must be painted before adequate drying time has elapsed, probably the best procedure is to apply just one coat of a high quality latex wall paint. The latex paint will not be affected by any free alkali coming to the surface and the single coat will allow moisture to continue to evaporate through the paint without causing blisters. Later, another coat or two of either latex or alkyd wall paint may be applied.

Once you have determined that your newly-plastered walls are dry enough to paint, you should check them carefully for chalky areas. These can occur when plaster dries too rapidly at high temperatures. Chalk should be removed by vigorous brushing before painting.

Most plaster jobs will have an even, uniform surface. However, if dense areas called "suction spots" are present (from uneven troweling), a second coat of primer may be necessary. Paint applied to surfaces with uneven absorption will have uneven gloss and sometimes uneven color intensity.

Many improved primers and paints are available today. Some companies recommend a solvent-thinned (alkyd type) primer or a high quality latex paint as a first coat on new plaster, followed by either a latex (water-thinned) or an alkyd wall paint. Topcoat paints can be flat, semi-gloss or high-gloss. All of these paints can be found in a full spectrum of pastels and deep tones to give the decorator a practically limitless choice of color combinations. There are also many textured paints which allow the painter to create attractive patterned and grained effects on walls and ceilings. Textured paint is also useful in covering minor defects in wall surfaces.

It is always sound painting practice to read the manufacturer's label instructions and follow directions carefully. Your reputable paint dealer can be very helpful in selecting the correct paint product for your job.

Painting New Drywall (Gypsum Board)...

Drywall which has become badly soaked by water from the inside of the wall will probably need replacement. Once the new gypsum board panels have been installed and the joints properly taped and sanded, painting becomes a pretty straightforward procedure. For the first coat on new gypsum board, a latex primer is recommended. These fast-drying, water-thinned primers prepare the drywall panels for topcoat painting by providing a smooth, sealed surface. Following an evenly applied coat of latex primer, the topcoats can be either latex or alkyd paint in your choice of flat, semi-gloss or gloss sheens. Most wall and ceiling paints for this purpose are latex types because they clean up easily.

Exterior Painting...

As mentioned before, damage to exterior paint may show up with warmer weather. Moisture vapor still trapped in wall cavities will seek an area of lower vapor pressure. With the sunshine's warmth on the exterior walls, you may discover blistering and peeling paint as moisture forces its way through the wood siding and paint film to the outside air.

Once you are sure the moisture has been dried out of the wall cavities and an adequate ventilation system has been installed, you should begin repairing the exterior paint damage. If there are blisters in the paint, or loose and peeling paint, these will have to be removed. Paint damage of this type generally results in the paint coming loose right down to the bare wood.

All exposed wood surfaces should be sanded and spot-primed with a suitable exterior primer. Many paint manufacturers recommend a solvent-thinned alkyd type for this purpose. When the primer is dry, it may be topcoated with either an alkyd or a latex exterior paint. Your dealer can help you choose one that's right for your home.

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Federation of Societies for Coatings Technology
1315 Walnut Street
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National Decorating Products Association
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Government and Industry

Simplification of DOT Paint Terms Urged by NPCA

The National Paint and Coatings Association has called for the Department of Transportation to simplify its description of paint and related materials in two sections of Title 49, Code of Federal Regulations.

In its petition for rulemaking to amend Sections 172.101 and 173.128(a) of the CFR, NPCA recommended that the term "Paint and Related Materials" be substituted for the following terms now required: paint; lacquer; stain; shellac; varnish; liquid aluminum; liquid bronze; liquid gold; liquid filler; liquid lacquer base; or a thinning, reducing, or removing compound therefor, or a liquid drier therefor. NPCA recommended that "Paint and Related Materials" be used unless the Hazardous Materials Table includes a more specific entry identifying the above materials by chemical name, in which event the more specific proper shipping name must be used.

According to NPCA, the designation "Paint and Related Materials" will provide a more accurate description for products manufactured and shipped by its members, as well as reducing the cost to shippers.

In its petition the Association asserted that by adopting the proposal DOT would improve the likelihood that the paint manufacturer will conform to its regulations and noted that simplification would result in fewer mistakes and mismarkings on shipping papers that could lead to possible distortions of the actual hazard descriptions.

Last year the National Classification Board of the Motor Carrier Industry approved a similar NPCA proposal. NPCA plans to make similar recommendations to the railroad industry.

Information on Coatings Performance Is Sought By Georgia Tech

Information on computer-assisted record keeping and analysis of performance data for coatings on steel is sought by the Engineering Experiment Station of Georgia Institute of Technology on behalf of the Federal Highway Administration (FHWA) of the U.S. Department of Transportation.

The FHWA, a major source of information for all 50 state highway departments, is concerned with the kinds of coatings available for highway structural steel and with improved methods for evaluating their performance. One aspect of its research program on coating systems for controlling corrosion involves the use of performance data generated in tests conducted by states, various federal agencies, private industry and other organizations. Such information, especially that derived from controlled service testing, is expected to be helpful in establishing correlations and developing improved performance standards and actual improved long-range costs. The volume of the data expected will require the use of automated data processing.

Information is sought as to highway related and non-highway related sources of coatings performance data on steel, in addition to information about computerized evaluations of coatings performance data per se. Confidentiality of any proprietary information will be strictly observed.

Anyone wishing to supply information on this subject and to obtain copies of the reports resulting from this study should contact: Dr. Charles Ray, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia 30332; telephone (404) 424-9651.

EPA Proposes Guidelines For Effluent Limitations

The Environmental Protection Agency has proposed a zero discharge standard for all direct and indirect effluent discharges of process wastewater from paint manufacturing facilities.

In its January 3, 1980 *Federal Register* notice, EPA proposed to require the complete elimination of discharges of pollutants in the caustic and/or water-wash subcategory both from new and existing sources. The proposed standard is to be achieved by in-plant controls and contract hauling of nonrecyclable wastes.

Included in the January 3, 1980 notice is a list of nine questions on which EPA is seeking public comment. The National Paint and Coatings Association is preparing extensive comments on the proposal; but, as this proposal is only for the paint industry and no other parties will be commenting, NPCA urges industry members to obtain the notice and supporting documents and to submit comments directly to EPA. If adopted as a final rule, this proposal would have a serious impact on small manufacturers. In proposing the effluent prohibition for the paint industry, the EPA relied on the following two documents.

The "Development Document for Proposed Effluent Limitations Guidelines, New Source Performance Standards and Pretreatment Standards for the Paint Formulations Point Source Category" can be obtained by contacting James Berlow, Effluent Guidelines Division (WH-552), EPA, 401 M Street, SW Washington, DC 20460, Attn.: Docket Clerk, Paint; phone (202) 426-2554.

The "Economic Analysis of Proposed Revised Effluent Standards and Limitations for the Paint Manufacturing Industry" can be obtained from John Kukulka, Water Economics Branch (WH-586), EPA (address above); phone (202) 755-7733.


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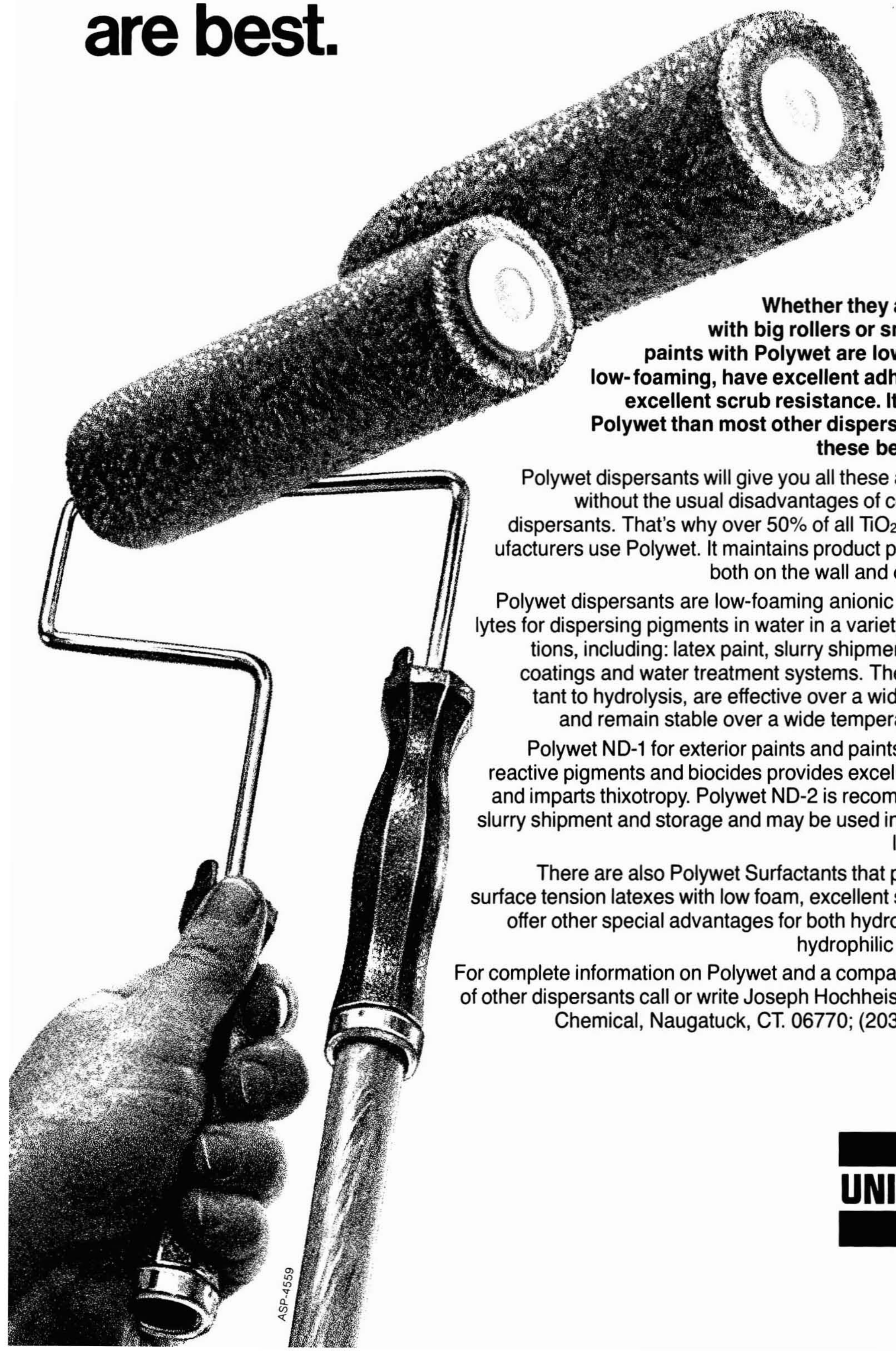
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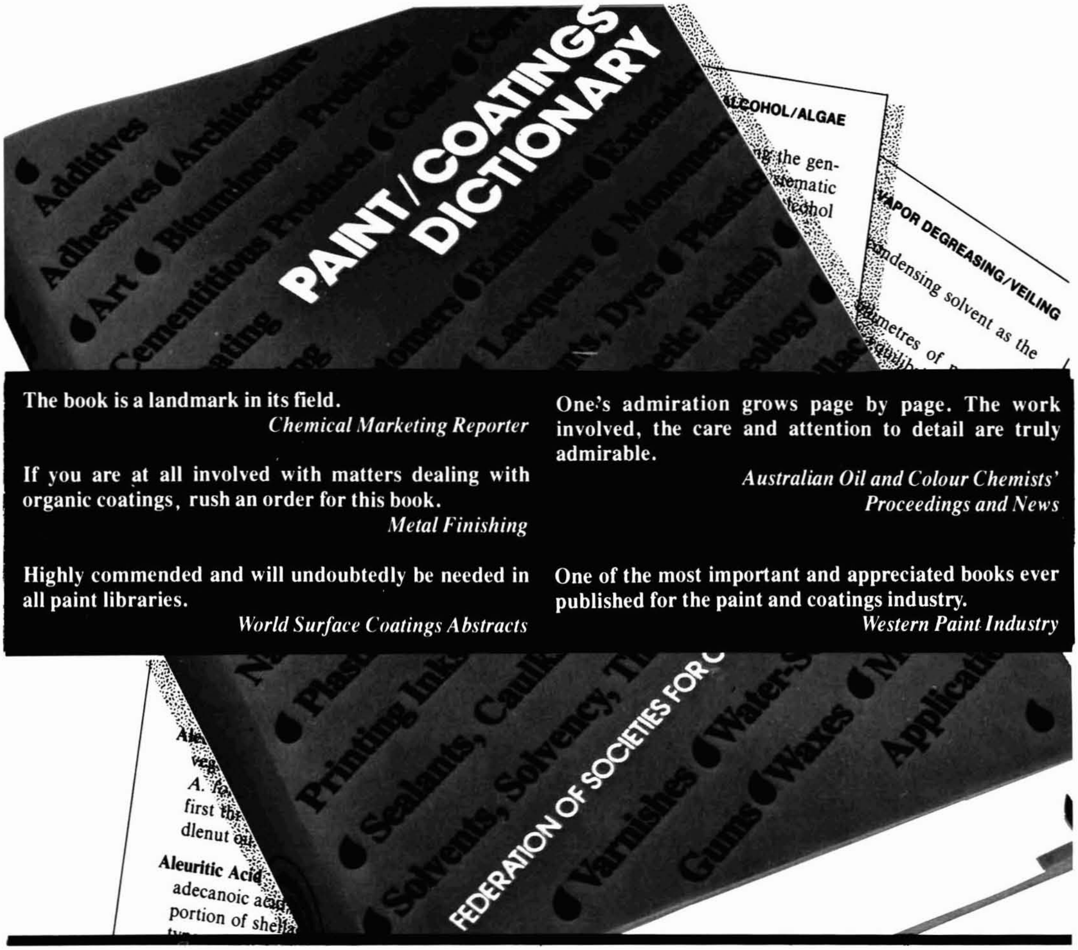

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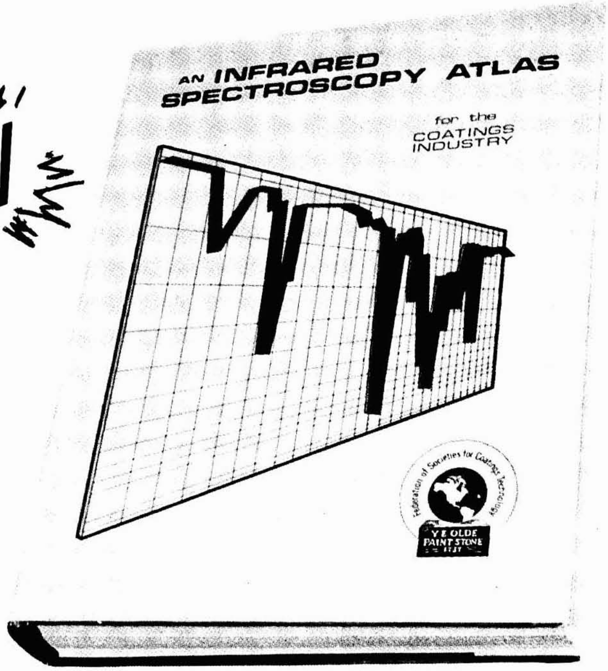

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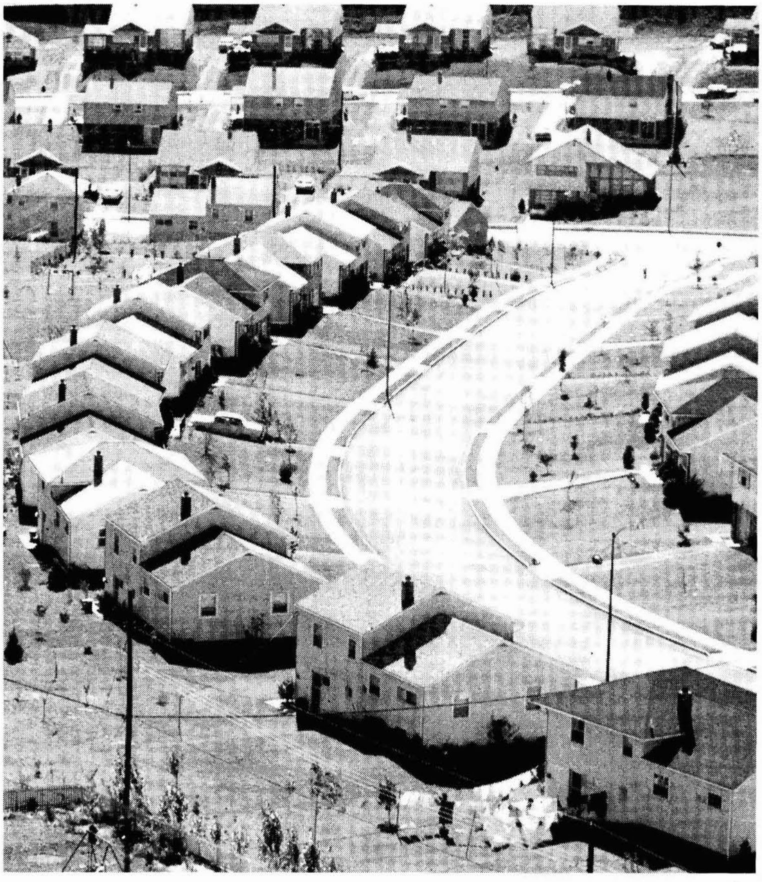

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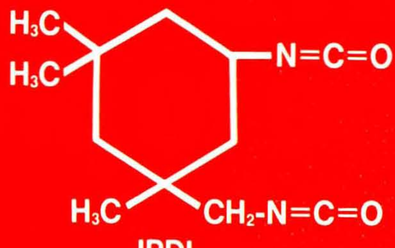

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② IPDI-H3150 IPDI-H2921	Oxyester T 1136 Oxyester V 2922 Oxyester B 1842 Oxyester B 926 Polycaprolactones	Solvent-free elastomers and sealing compounds	Soft and flexible to extremely hard compounds with good tear-resistance, permanent flexibility, and yellowing resistance
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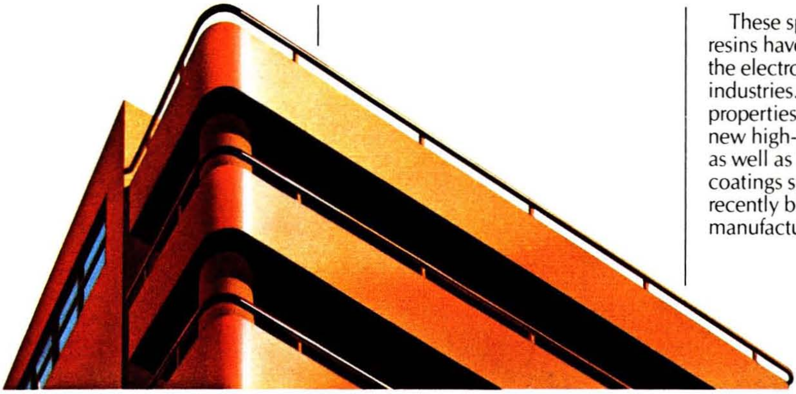

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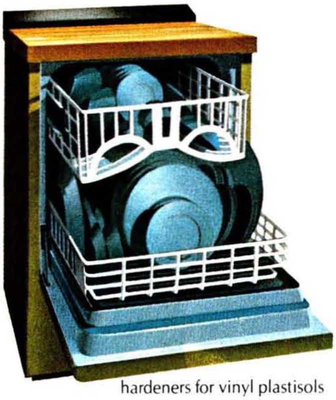

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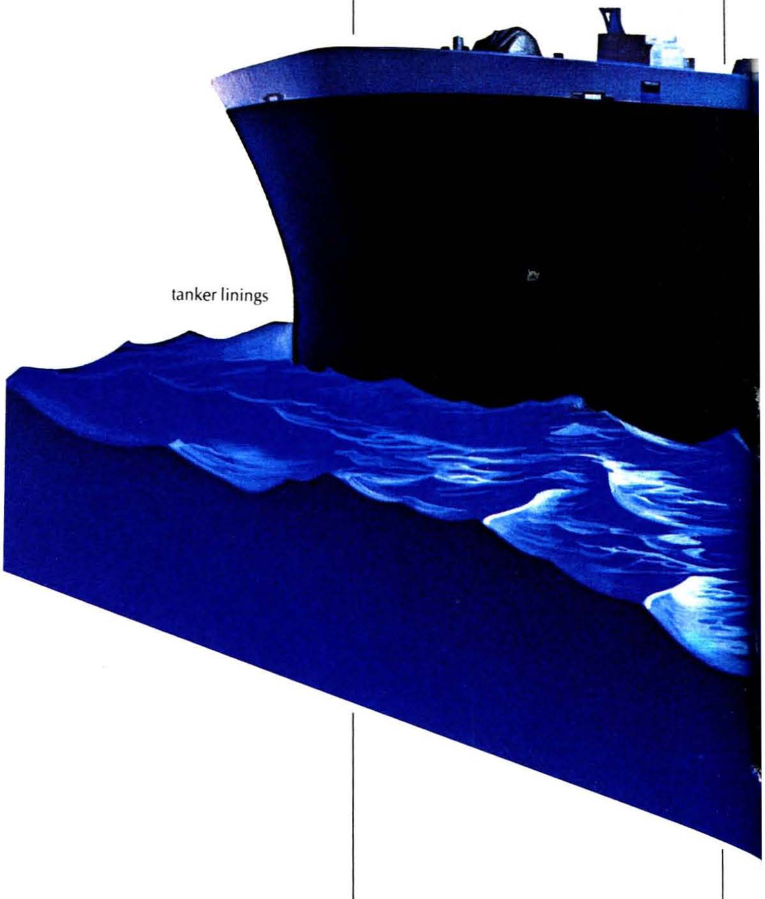

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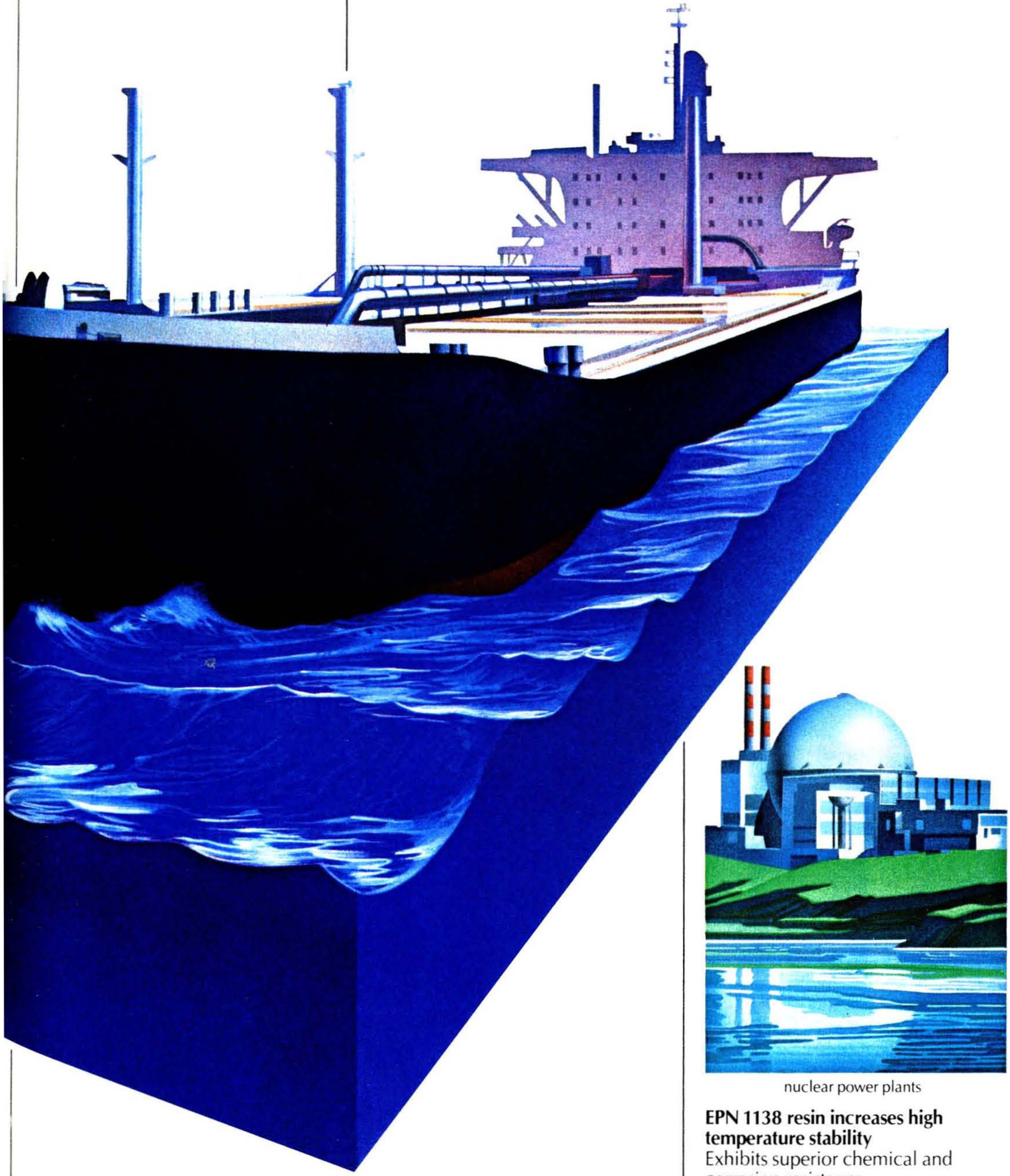

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0500	Liquid	3	3,000 cP	200 cP	high heat resistance
ECN's	Solid	2.7-5.4	35-99°C	3,000 cP	tight crosslink density, chemical resistance, hardness
EPN's	Liquid/Semi – solid	2.2-3.6	1700-3500 cP at 52°C	3,000 cP	FDA-conforms to 175.300
Aracast® hydantoins	Liquid/Solid	2	500 cP/95°C	–	non-aromatic, weatherable non-crystallizing, very low viscosity
Araldite® PT 810	Solid	3	95°C	–	non-aromatic, weatherable
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ECN's	■	■	■		■	■
EPN's	■		■		■	■
Aracast® hydantoins	■	■	■	■	■	■
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SPECTRUM '79

Copper Phthalocyanine (CPC) Pigments In Industrial Water-Borne Systems

Paul G. Schmidt
E.I. du Pont de Nemours & Company, Incorporated*

Copper phthalocyanine pigments in water-reducible paints have been found to be sterically stabilized through secondary bonding forces. The strengths of these bonds were determined by measuring the thermodynamic work of adhesion between the pigment and paint resins. A positive work of adhesion value indicates pigment-polymer bonding, but not necessarily pigment stabilization. A negative value indicates non-bonding conditions and pigment instability. Color stability as "drift" was instrumentally measured and related to pigment-polymer work of adhesion.

INTRODUCTION

This study was undertaken to determine the effect of surface properties on the performance of CPC pigments in industrial water-borne paint systems. It was based on the hypothesis that surface treatments control the dispersion stability of a pigment in a particular end-use system and that this stability is a primary indication of performance.

Pigment dispersions are inherently unstable because dispersed particles collide as a result of Brownian motion. Upon collision, pigment particles can adhere via London/Van der Waals forces to form clusters. This phenomenon is called flocculation.

To prevent flocculation, repulsive forces between particles must exist. Two types of repulsive forces between pigment particles are generally recognized: electrostatic and steric forces. The magnitude of the forces depends greatly on the character of the pigment surface and the nature of the vehicle in which it is dispersed.

Electrostatic Stabilization

It is well known that dispersions can be stabilized by electrostatic repulsive forces in aqueous media. The theory for this phenomenon has been worked out and extensively tested. Very briefly, the theory considers that a charged species is attached to the solid surface forming the Stern[1] layer, *Figure* 1, and that a counterbalancing charge persists in the solution in the diffuse layer around the particle. When two such particles approach, the diffuse layers interact to produce a repulsive force between particles. If this repulsive force is large enough, a potential energy barrier will result, reducing the rate at which particles collide just as a potential energy barrier reduces the reaction rate in chemical reactions. For aqueous dispersions, this barrier is about 10 to 15 times the thermal energy, kT, of a particle.

In the Stern layer, positive ions usually dominate. A higher concentration of negative ions in the adjoining diffuse layer is responsible for the negative electrophoretic migration of the particle. The potential difference between A and O is known as the Zeta potential and it is this potential that determines pigment dispersion stability.

The average Zeta potential required for a given level of colloid stability has been determined by Riddick[2] (*Table* 1). It is seen from this table that maximum agglomeration and precipitation occur in the 0 to −15 millivolt Zeta potential range, and moderate stability is acquired somewhere between −30 and −40 millivolts. Fairly good to excellent stability require −40 to −100 millivolts of charge associated with the pigment.

Using these guidelines, we determined the average Zeta potentials of a series of polar, toner, and treated CPC pigments in water, water-alcohol mixtures characteristic of water-reducible systems, and in various acrylic, polyester and alkyd water-reducible systems.

The results in *Table* 2 show a decrease in Zeta potential with decreasing dielectric strength of the medium (as expected), and a decrease in pigment Zeta potential when water-reducible polymers are present. The latter effect is

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*Experimental Station, CD&P., Wilmington, Del. 19898.

Table 1—Required Average Zeta Potential for Colloid Stability

Stability Characteristics	Avg. Zeta Potential In Millivolts
Maximum agglomeration	0 to +3
Range of strong agglomeration	+5 to −5
Threshold of agglomeration	−10 to −15
Threshold of delicate dispersion	−16 to −30
Moderate stability	−31 to −40
Fairly good stability	−41 to −60
Very good stability	−61 to −80
Extremely good stability	−81 to −100

Table 3—Types of Interatomic Forces

Force	Dissociation Energy (KCAL/MOLE)
Primary (chemical)	
Ionic	140–950
Quasi-chemical	
Hydrogen bond	7
Secondary (physical or Van der Waals)	
Dipole-Dipole (Keesom)	Up to 5
Dipole-Induced Dipole (Debye)	Up to 0.5
Dispersion (London)	2–10

probably the result of resin molecules either penetrating the electric double layer or directly adsorbing onto the pigment surface.

Based on the parameters outlined by Riddick and the information in *Table* 2, it seems reasonable that electrostatic stabilization is not the primary stabilization mechanism for CPC pigment in water-reducible paint systems, since the average Zeta potentials fall only in the −15 millivolt range.

Steric Stabilization

Steric stabilization[3,4] is based on the theory that polymers adsorbed on each pigment particle form barrier layers which interact as particles come together. This interaction is the result of entropic, osmotic, and compressive forces. As two particles approach each other, the adsorbed polymer layers lose configurational freedom resulting in a loss of entropy. As the adsorbed layers overlap and are compressed, osmotic pressure and compressive forces are generated. All of these forces tend to keep the particles apart.

The attractive forces decrease with increased separation between the particles. In solvent systems, these attractive forces become negligibly small in comparison to the kinetic energy of the particle, when interparticle distances exceed 200Å. Therefore, a pigment dispersion should be stabilized if each pigment particle is coated with a layer 100Å thick.[6] Using an effective C—C bond length of 1.22Å (corrected for angular dependence), it was found that a completely stretched C_{18}-chain will be only 22Å long and ineffective in stabilizing dispersions, even if the pigment surfaces were completely covered. Polymeric substances adsorbed at the pigment surface are needed to provide a large enough barrier layer. For pigments of approximately 0.1 μm diameter, a polyester, an alkyd, or an acrylic of a minimum molecular weight of 5000 would be needed, assuming the polymer is completely uncoiled.

But simply coating the particles with a barrier layer of sufficient thickness is not enough. This layer must also be carefully designed to behave like the medium. The most apparent way to do this is to use polymers which are soluble in the medium and which will attract solvent molecules to the surface layer. In this way, the layer is composed partially of the medium itself.[5]

It is also apparent that the layer solution will form a second phase, resulting in flocculation if the molecules attached to the surface are incompatible with other species in the medium. One could even imagine a situation in which the barrier layer would actually result in stronger attraction between the composite particles than would have existed between the individual untreated particles.

Table 2—Average Zeta Potential (mv) for CPC Pigment Types

	Zeta Potentials (mv)			
CPC Pigment	Water	Alc/Water	Water Reducible Vehicles	
Polar	−47	−22	Acrylic	−11
			Polyester	−18
			Alkyd	−14
Toner	−50	−21	Acrylic	−12
			Polyester	−16
			Alkyd	−15
Rosinated	−45	−24	Acrylic	−15
			Polyester	−17
			Alkyd	−13

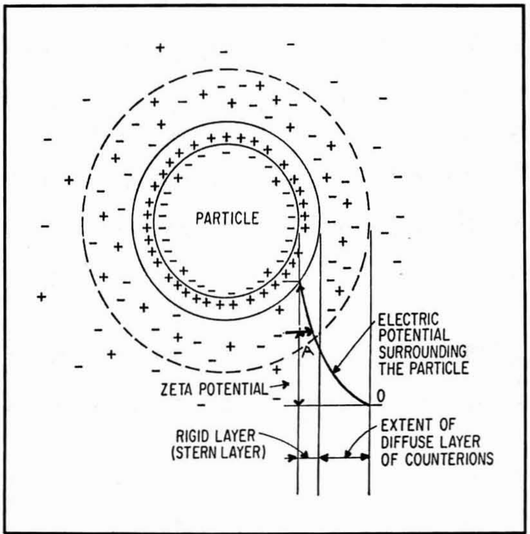

Figure 1—Charged particle

From these considerations the requirements for steric stabilization are:

(1) Bonding a molecular species of sufficient molecular weight to the pigment surface.

(2) Solubility of part of the bonded species in the medium.

(3) Compatibility of the dissolved part of the bonded species in the medium.

In water-reducible paint systems, requirements (2) and (3) are satisfied, since the dispersing polymer is the resin itself and, in most cases, these polymers have molecular weights over 5000. Therefore, the bonding strength of the molecular species at the surface is the key requirement for steric stabilization of the particle in the medium.

The strength of attachment of the molecular species can vary from very strong ionic bonding to weak physical adsorption. The stronger the attachment and the larger the number of attachment points,[7] the greater is the stability.

Types of Bonds

The dissociation energies associated with the various types of bonds are illustrated in *Table* 3. The primary or chemical bonding forces are much more powerful than the secondary or physical forces. A bond with intermediate strength is the hydrogen bond. The physical forces, often referred to as Van der Waals' forces, are now known to consist of three separate effects. The dipole-dipole forces first described by Keesom[8] are those forces arising between molecules which have permanent dipoles, causing a mutual attraction and a mutual alignment of the molecules. The dipole-induced dipole forces first described by Debye[9] are the forces caused by a molecule with a permanent dipole moment inducing a dipole in a neighboring molecule by polarization. The London[10] or dispersion forces, which are by far the most important forces occurring in polymers, are general interactions occurring between any two molecules or atoms which are in close proximity irrespective of their permanent dipoles. Although a molecule may have a net dipole moment of zero because on the average the electron arrangement is symmetrical, at any given instant there will be dipoles arising from the motion of the electrons in the molecule. This motion will cause induced dipoles in phase. The magnitude of the Keesom, Debye, and London forces varies as the inverse sixth power of the distance between molecules or atoms, becoming negligible at distances greater than about 10Å. Although the secondary forces are weak in comparison with the primary forces, they account for the major part of the strength of polymeric materials and in some substances, such as polyethylene or polypropylene, may account for almost all of the observed bulk strength of the material.

It is clear from *Table* 2 that ionic bonding is the best method of attachment, since covalent and metallic bonds cannot be reasonably expected under these conditions. Next in strength are hydrogen bonds, then bonds resulting from London-Van der Waals forces.

Types of CPC Pigment-Water Reducible Polymer Bonds

The type of bond formed between CPC pigments and water-reducible polymers and its relative strength can be estimated by a method proposed by Bolger and Michaels.[11] It is measured by the difference between the isoelectric pH (IEPH) of the pigment and ionization pK of the adsorbed molecule. When the pigment acts as a proton acceptor, the bond strength Δ_a is given by equation (1),

$$\Delta_a = \text{IEPH} - \text{pK}_a(\text{a}) \tag{1}$$

and when the pigment acts as a proton donor, the bond strength Δ_b is given by equation (2).

$$\Delta_b = \text{pK}_a(\text{b}) - \text{IEPH} \tag{2}$$

If Δ_a or Δ_b is positive, the bond is ionic. The larger the value of delta, the stronger the ionic bond. Zero or negative values signify hydrogen bonds and dispersion bonds, respectively. The symbols $\text{pK}_a(\text{a})$, $\text{pK}_a(\text{b})$ represent the ionization constants of the organic acids and bases, respectively. For water-reducible paint systems based on carboxylic acid functionality, the $\text{pK}_a(\text{a})$ is approximately 4. *Table* 4 shows the isoelectric pH's for a series of polar, untreated, and treated CPC pigments. It is seen that the isoelectric pH's range from 2.0 to 4.2 for all pigments and depend only upon the degree of chlorination and acidity of the pigment. Then Δ_a would be in the very slightly positive to negative range. Thus, the stability of CPC pigment in water-reducible paint systems is dependent upon the weak hydrogen and dispersion energy bonds.

Hydrogen-Dispersion Energy Bonds

The thermodynamic work of adhesion provides a method to determine whether these bonds exist for a given pigment-polymer system. This thermodynamic work of adhesion, between two substances, C (coating) and P (pigment), can be expressed by equation (3).

$$W_A = \gamma_C + \gamma_P - \gamma_{CP} \tag{3}$$

Table 4—CPC Iso-Electric pH and Bond Character with Carboxylic Acid Groups pKa = 4.0

CPC Pigment	Iso-Electric pH	Δ
Polar (Flocc. resistance)	2.0	−2.0
Full chlorinated (Greens)	2.5	−1.5
Semi-chlorinated (Crystal stable blues)	3.0	−1.0
Chlorine-free (Blues)	4.3	+0.3

Table 5—CPC Surface Free Energies (Dynes/CM²) and Polarity

CPC Pigments	γD	γH	γO	γH/γO
Polar	45.3	4.3	49.6	0.087
Toner	45.9	1.7	45.9	0.037
Rosinated	40.2	2.0	42.2	0.047

Table 6—Water Reducible Resin Surface Free Energies (Dynes/cm²) and Polarity

Water Reducible Resin	γ^D	γ^H	γ^O	γ^H/γ^O
(A) Acrylic				
I	22.5	2.5	25.0	0.100
II	4.0	20.0	24.0	0.049
III	22.1	12.8	34.9	0.365
IV	1.2	24.3	25.4	0.952
(B) Alkyd				
I	48.6	7.35	56.0	0.131
II	34.6	1.54	36.2	0.043
III	0.9	3.6	4.5	0.791
IV	7.1	8.0	15.0	0.531
(C) Polyester				
I	15.1	0.65	15.8	0.050
II	31.9	19.0	50.9	0.374
III	46.2	1.9	48.1	0.039

The work to separate C and P immersed in a liquid, L, is given by equation (4).

$$W_A = \gamma^o_{CL} + \gamma^o_{PL} - \gamma^o_{CP} \tag{4}$$

where γ^o is the free energy at the respective interfaces. Equation (4) states that the work of adhesion is equal to the sum of the energies of the CL and PL interfaces which must be created minus the energy of the CP interface which is destroyed. If the work of adhesion is negative, separation between C and P will be spontaneous, i.e., there is no bonding. If the work of adhesion is positive, work must be done on the system to create two separate interfaces at the expense of the original one interface, i.e., there is bonding.

The measurement of free energy of a liquid is simple since the free energy of the liquid is equivalent to its surface tension, and the interfacial free energy between two liquids is numerically equivalent to the interfacial tension between these two liquids. The chief obstacle, however, to this thermodynamic treatment of adhesion phenomena between solids, is that there is no easy way for direct measurement of the surface tension of a solid.

Table 7—Work of Adhesion W_A (dynes/cm²) for CPC Pigment Types with Various Water Reducible Resins

	CPC Pigment		
Water Reducible Resin	**Polar**	**Toner**	**Rosinated**
Acrylic			
I	5.2	3.8	4.1
II	6.6	1.2	4.6
III	14.4	8.4	9.6
IV	5.3	−1.9	2.5
Alkyd			
I	18.8	14.7	14.0
II	8.5	6.8	6.6
III	−4.7	−10.6	−6.4
IV	4.7	1.5	1.3
Polyester			
I	6.6	1.2	4.6
II	20.8	14.2	14.6
III	12.0	10.7	9.7

Table 8—Color Stability of W_A', Work on Adhesion

System	Pigment Type	W_A'	Color Stability (144 hr 49°C) Change vs Control
Acrylic I	Polar	+5.2	Equal
	Toner	+3.8	Equal
	Treated	+4.1	Equal
Acrylic II	Polar	+6.6	Equal
	Toner	+1.2	Equal
	Treated	+4.6	Equal
Acrylic IV	Polar	+5.3	2% Weak
	Toner	−1.9	5% Weak
	Treated	+2.7	1.5% Weak
Alkyd III	Polar	−4.7	5% Weak
	Toner	−10.6	20% Weak
	Treated	−6.4	10% Weak

Fowkes[12] has published an approach to this problem. If it is assumed that the free energy of a liquid or solid surface is composed of its hydrogen bonding and dispersion energy forces, and that these forces are additive, then the total surface free energy of a solid or liquid γ^o can be described by equation (5), where the *d*

$$\gamma^o = \gamma^d + \gamma^h \tag{5}$$

superscript refers to the Keesom, Debye, and London forces and the superscript *h* refers to hydrogen bonding forces. The magnitude of each of these components of surface free energy can be evaluated by a derivation from the Young equation

$$1 + \cos\Theta = \frac{2\sqrt{\gamma^d_L}\ \sqrt{\gamma^d_S}}{\gamma^o_L} + \frac{2\ \sqrt{\gamma^h_L}\ \sqrt{\gamma^h_S}}{\gamma^o_L} \tag{6}$$

where Θ is the contact angle of liquid, L, with components γ^d_L and γ^h_L in contact with a solid with components of surface energy γ^d_S and γ^h_S. Thus, it is only necessary to measure the contact angle of two liquids against the solid surface and to know the hydrogen bonding and dispersion force components of the liquids[13] in order to calculate the hydrogen bonding and dispersion force components of the solids. These properties have been published for many liquids. By using two liquids, simultaneous linear equations are obtained and solved for the dispersion and hydrogen bonding components of the solid surface.

Fowkes has also shown that the interfacial free energy between two substances, C and B (γ_{CB}), can be described by a relationship of the following form:

$$\gamma_{CP} = \gamma_C + \gamma_P - 2\ \sqrt{\gamma^d_C\ \gamma^d_P} - 2\ \sqrt{\gamma^h_C\ \gamma^h_P} \tag{7}$$

Having determined the values of the free energy components of the solid surfaces by equation (6), one can then calculate a theoretical interfacial free energy between the solids or between each solid and a liquid by equation (7). The total surface free energy of each surface (C and P) is found by equation (5). These values can then be inserted in equation (1) or equation (2) to determine the thermodynamic work of adhesion of C to P, either alone or in the presence of a liquid, remembering that C and P will bond in the presence of the liquid if the work of adhesion is positive.

METHODS OF MEASUREMENT

The contact angles on resin films and pigments pellets were measured. Liquids used for measurement were water and methylene iodide. The components of surface energy for these two liquids are:[13]

	γ_L^d	γ_L^h	γ_L^o
Water . . .	21.8	51.0	72.8
CH_2I_2 . . .	48.5	2.3	50.8

Substituting these values in equation (6) and simplifying leads to the expressions of equations (8a) and (8b).

$$\gamma_s^d = [4.253\,(1 + \cos \Theta_m) - 1.295\,(1 + \cos \Theta_w]^2 \qquad (8a)$$

$$\gamma_s^h = [5.102\,(1 + \cos \Theta_w) - 0.653\,\gamma^d]^2 \qquad (8b)$$

Thus, from the contact angles of water and methylene iodide on pigment and resin, one can determine the bulk surface-free energies of the pigments and resin polymers along with their hydrogen bonding and dispersion energy components.

The pigment surface-free energies were determined by measuring the contact angles on the CPC pigment pressed into pellets under pressures of 80,000 psi. The pellet surface was protected from the stainless steel plunger by means of a 1-mil Kapton® film. The calculated free energies were essentially independent of pressure and the Kapton insert. The resin surface-free energies were measured by contact angles on paints drawn down onto slides, air dried for 24 hr, and washed with distilled water for 30 sec to remove polar exudate. Contact angle measurements were made in triplicate.

It should be noted that these free energy values are really approximations for Hildebrand and Scott's[14] cohesive energy densities-solubility parameters, and for Zisman's[15] critical surface tension. It is also an attempt to use the bulk properties of pigment and coating to predict molecular interactions. *Table* 5 illustrates the hydrogen bonding and dispersion free energies determined for CPC pigments evaluated.

CPC Pigment Surface-free Energies

Measurements of the hydrogen bonding (γ^h) and the dispersion-free energy (γ^d) components of CPC pigments showed three categories of pigment: Polar (flocculation resistant) Pigments, which are the highest energy, highest hydrogen bonding energy CPC pigments; Toner (untreated) Pigments, which have a dispersion energy similar to the polar pigments but substantially less hydrogen bonding energy; and Treated CPC Pigments, which have the lowest free energy of all the CPC pigments.

It has been also demonstrated that many of the multivalent ions associated with the treated CPC's are sufficiently soluble in the water-alcohol solvents characteristic of industrial water-borne paints to precipitate resin. The amount of precipitate, or the degree of the effect, depends upon the time-temperature profile of the paint, which is determined by the cation concentration and acid number of the polymer. The acid number determines the number of sites that must be reacted to precipitate the polymer. Higher acid number polymers, like most acrylics, would have longer periods of time before the effect is observed, while this effect would be observed in shorter periods of time with the lower acid number alkyds and polyesters. The net result of the above phenomena is that only polar and toner CPC's can be safely employed in a given industrial paint system.

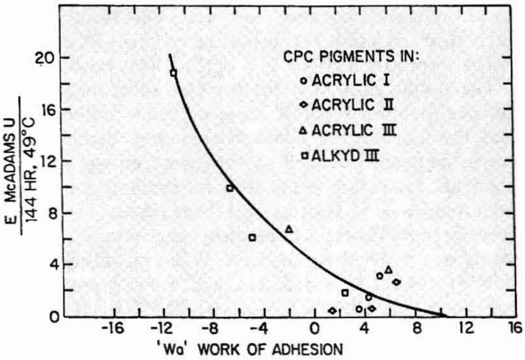

Figure 2—ΔE McAdam units vs Work of Adhesion

Industrial Water-Borne Resin Surface-Free Energies

The measurements of the hydrogen bonding (γ^h) and the dispersion-free energy (γ^d) components of the industrial water-borne systems evaluated are shown in *Table* 6. Briefly, it shows:

(1) The surface energies associated with these polymers cover a wider range than do the CPC pigments.

(2) There is no one set of energies that can be distinguished as characteristic of an acrylic, alkyd or polyester—although it was found that acrylics generally have lower total energies.

(3) The surface energies of these polymers with similar total energy can still be distinguished by various hydrogen bonding to dispersion energy ratios.

RESULTS

The basic hypothesis of this work has been that CPC pigment performance should be related to the degree of stabilization of the pigment in the system. This stability for sterically stabilized systems is related to the pigment/polymer bond adhesion, which is measured by the work of adhesion W_a.

A positive value of W_a indicates bonding but not necessarily pigment stabilization and optimum paint performance. A negative value of W_a, however, indicates non-bonding conditions and—independent of the other factors—poor performance.

The results of such calculations, equation (4), are illustrated in *Table* 7 for some of the industrial water-borne systems evaluated. γ_{CL}^{o} and γ_{PL}^{o} were calculated from equation (4), using the γ_{L}^{h} and γ_{L}^{d} of each resin's respective alcohol.

The results show that the work of adhesion (W_a) is positive for most types of water-reducible systems and that the polar-higher hydrogen bonding, higher total energy pigments, as well as the lowest energy treated pigments (assuming no cation interaction) might be preferred for some systems over toner grades. There are, however, combinations of pigments and water-reducible resins which do show negative W_a's and where CPC stability should be a problem, e.g., toner pigments in Acrylic IV and all CPC's in Alkyd III (*Table* 7).

To verify these predictions, paints were prepared with CPC polar, toner, and resinated pigments in Acrylic I, II, IV, and Alkyd III. Color stability as drift was measured on finished panels after aging the paints at 48°C for 144 hr (*Table* 8). The results not only show significant color drift in systems where the Work of Adhesion is negative but increasing drift with decreasing Work of Adhesion values, *Figure* 2. Where the Work of Adhesion is positive, the results show no color drift as in Acrylic I and II, and a small color drift, 1.5 to 2%, in Acrylic IV. This latter result is within the expectation limits of the assumptions.

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United Kingdom Orders of FSCT Educational Literature

Mr. Ray Tennant, of the Birmingham Society, will act as a source of Federation educational literature (Color-matching Aptitude Test Set; Infrared Spectroscopy; Paint/Coatings Dictionary) for United Kingdom customers. Anyone interested in receiving these items is urged to contact Mr. Tennant. His address is: Carrs Paints Limited, Westminster Works, Alvechurch Road, Birmingham B31 3PG, England.

An Improved Drawdown Blade

Dwight A. Holtzen

E.I. du Pont de Nemours & Company, Incorporated*

Nonuniformity of paint drawdown film thickness results in considerable error when determining scattering coefficients of prime hiding pigments. Simple modification of drawdown blades routinely used in paint laboratories results in improved uniformity and reduces thickness variation by approximately 30%. Redesigned blades minimize pressure, viscosity, and rate effects.

INTRODUCTION

Methods to determine the efficiency of a coating to make an underlying pattern indistinguishable are usually based on reflectance measurements of a less than opaque film over a patterned chart. Black and white checkerboard cards are commonly used. With a less than 0.05 cm coating applied, film thickness uniformity is assumed over the entire drawdown area.

The method commonly used to determine scattering coefficients involved the use of equations developed by Kubelka and Munk.[1,2] Scattering coefficients can easily be determined by equation (1) where the thickness X is defined as X = (paint weight) (wt % TiO_2) / (paint area).

$$SX = f(R_w, R_b, R_o) \tag{1}$$

It becomes readily apparent that the thickness of the film must remain uniform over the entire drawdown area or, alternately, that the pigment content be determined over the same area that the reflectance measurement is being made. The latter method is somewhat cumbersome in that a considerable amount of calibration data are necessary because of interferences of extenders, resins, and other paint components. The simplest alternative is to provide a method for the production of very uniform films.

With commercially available drawdown devices, shown in *Figure* 1(A), it was found that considerable nonuniformity exists over the length of drawdown,[3] resulting in a relatively high error in the determination of scattering coefficients. Ross and Bruhlman[4] have determined that a standard deviation (δ) of approximately 2.9% exists for scattering coefficient (S) determination based on a single measurement. Considerable averaging is necessary to reduce the error below this level.

Flow underneath a drawdown is highly dependent on many interacting factors. Among these are blade geometry, pressure developed, and system viscosity. The purpose of this paper is to show how a simple change in geometry of the drawdown blade will allow the production of highly uniform films by minimizing variations due to pressure and viscosity effects. Only laminar flow

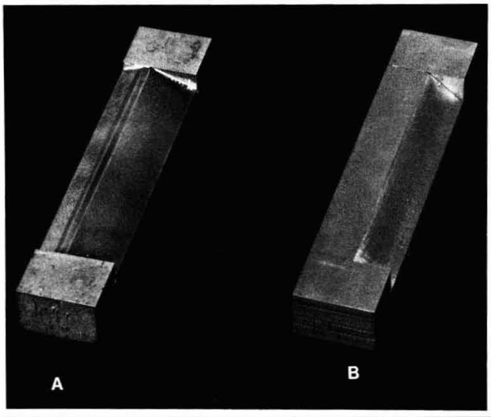

Figure 1—Commercial drawdown Blade A and improved Blade B

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*Chemicals, Dyes, and Pigments Dept., Wilmington, Del. 19898.

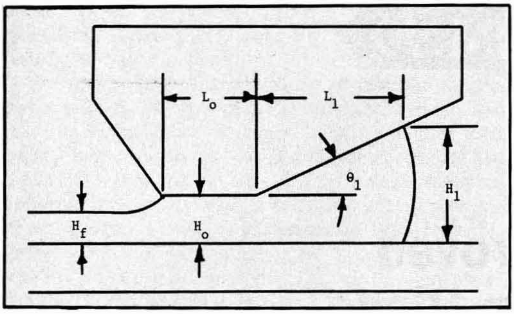

Figure 2—Cross-section of typical drawdown blade

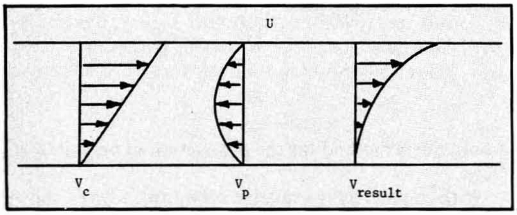

Figure 3—Velocity profile in constant thickness (L_o) section. V_c, couette flow; V_p, pressure flow; V_r, resulting flow

models are considered since the Reynolds' number is small.

Figure 2 shows a cross-sectional view of the commercially available drawdown blade. Usually, blades have a tapered entrance channel, a constant thickness section, and a tapered exit section. What has been found is that blades currently available on the market do not control the ratio of the constant thickness channel, L, to that of the clearance, H. Of the 26 blades measured, L_o/H_o averaged 29.9 with an estimated standard deviation of 21. By selecting the proper ratio of L_o to H_o more uniform drawdowns can be made. Simple, fluid flow models were used for analysis and the blade is considered in two sections: pressures developed in the tapered channel H, and loss of pressure effects in the constant thickness channel L. If pressure effects are ignored, flow is given by equation (2) where V is velocity relative to the substrate and W the width of the blade. This is the familiar couette flow equation, also referred to as drag flow, that relates flow generated between infinitely long parallel plates to clearance and relative velocity.

$$Q_c = 0.5\ U\ H_o\ W \tag{2}$$

It is generally accepted that the resulting film thickness will be one half that of the clearance. It has, however, been found that pressures are developed in the channel, L_1, and pressure flow can be adequately represented by equation (3) where μ is the viscosity.

$$Q_p = W\ H_o^3 P/(\mu/L_1) \tag{3}$$

Thus, the total quantitative output of a blade is not only a function of the clearance H_o but also of the viscosity, pressure, and amount of paint that is being

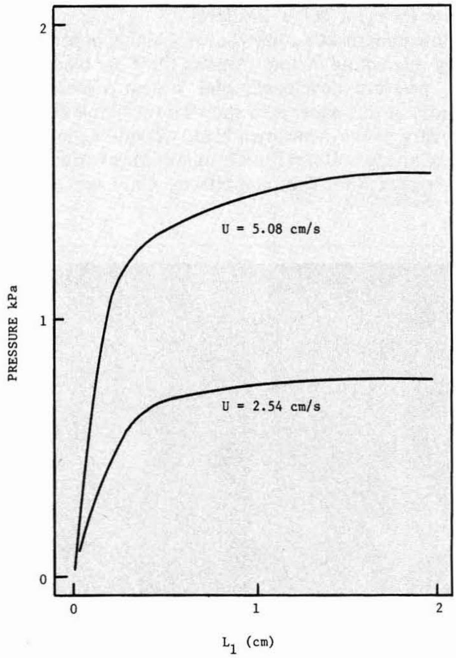

Figure 4—Pressure developed under two velocity conditions. H_o = 0.0127 cm, W = cm, μ = 1 Pa's

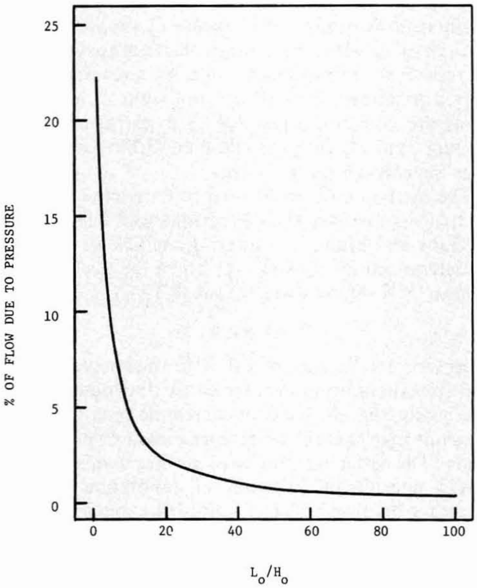

Figure 5—Pressure contribution to flow for the following conditions: H_o = 0.0127 cm. W - 7.62 cm, μ = 1 Pa's

retained in front of the constant channel area. The total output is simply the summation of the drag flow output and of the pressure output given by equation (4).

$$Q_t = Q_c + Q_p \qquad (4)$$

Considering only the velocity profiles through the constant section, L_o, it is readily apparent that the couette flow contribution opposes the pressure flow velocity profile resulting in thicker films. This is shown schematically in *Figure* 3. In order to estimate the pressure effects, a constant volumetric output was assumed. Pressure was calculated from an equation presented by McKelvey[5] and is given by equation (5).

$$P = \frac{\dfrac{W\,H_o\,U}{1 + (H_o/H_l)} - Q}{\dfrac{W\,H_o^3}{12\mu L_l} \quad \dfrac{2}{(H_o/H_l) + (H_o/H_l)}\,2} \qquad (5)$$

As shown in *Figure* 4, when the drawdown blade is flooded with paint, a relatively constant pressure is developed. However, as the head of paint is depleted underneath the channel, a sharp dropoff in pressure is predicted. Also, the drawdown rate greatly affects the pressures. It was assumed that the viscosity remained constant. However, this is not always the case and viscosity effects should be incorporated. When the pressure flow Q_p is combined with that of the volumetric output calculated from couette flow Q_c only, an optimum value of L_o/H_o can be determined, as is shown in *Figure* 5. At length to clearance ratios near 20, one would expect to find a maximum variation in film thickness of approximately 3%. When the ratio increases to 100, less than 1% flow is contributed by pressure and thus one expects considerably more uniform films from any paint of any viscosity. Thickness is also independent of the amount of paint pooled under the leading edge of the blade.

Table 1—Drawdown[a] Uniformity vs. Aspect Ratio (L_o/H_o),
(Test Blade Shown in Figure 1)

Blade	H_o	L_o/H_o	X-ray Counts X10^{-2} =
(A)	0.0127 cm	40	18.40 − 0.129 (D) R = 0.8
(B)	0.0127 cm	100	18.85 + 0.007 (D) R = .2

(a) U = 2.54/cm/s, D in 7.6 cm intervals, D_{max} = 38 cm.

Table 2—Drawdown Uniformity vs. L_o/H_o and PVC

(N = 96)

Paint PVC	68.1		64		51	
L_o/H_o	40	100	40	100	40	100
Avg. counts	6.771 ..	7.521	6.848 ..	7.346	9.237 ..	9.938
Std. dev.	0.146 ..	0.089	0.146 ..	0.122	0.235 ..	0.103

Table 3—Drawdown Uniformity vs. Rate

(PVC Emulsion Paint)

	2.54 cm/s		10 cm/s	
Blade clearance (CM)	0.0066	0.0127	0.0066	0.0127
L_o/H_o	40	100	40	100
Average counts X10^{-3}	8.41	9.27	9.04	9.16
Std. dev.	0.23	0.14	0.18	0.11

L_o/H_o = 40, 10 cm/s vs. 2.54 cm/s
Students t = 4.20 (t_{crit} = 2.85), LSD = 0.25
L_o/H_o = 100, 10 cm/s vs. 2.5 cm/s
Students t = 2.08 (t_{crit} = 2.85), LSD = 0.15

RESULTS

To test this concept, two blades were manufactured with a clearance of 0.0127 cm (5 mils). These blades are shown in *Figure* 6. *Table* 1 shows thickness variation with respect to position with a 55 PVC, 86 KU emulsion paint.* Film thickness is invariant with the higher L_o/H_o

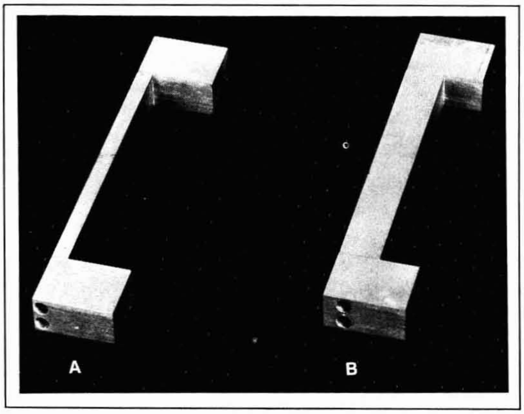

Figure 6—Test blades with different L_o/H_o values; A: 40, B: 100

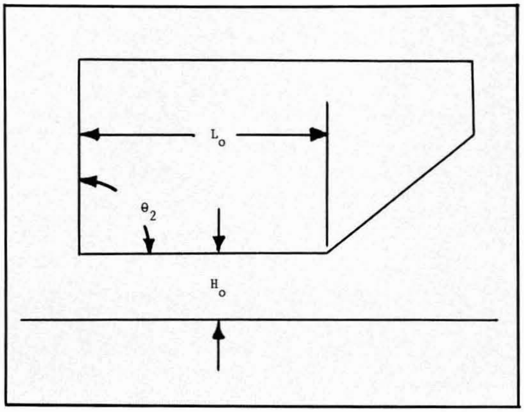

Figure 7—Improved drawdown blade, $O_2 \leq 90°$, $L_o/H_o \geq 100$

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*Thickness Measurement Method: The titanium dioxide content is directly proportional to film thickness and was measured with a Texas Nuclear 9200 portable x-ray fluorescence analyzer.

The Analyzer could also be used to determine pigment content at the same location where reflectance is being measured, however, a considerable amount of calibration is necessary.

ratio blade. With different PVC paints at constant velocity, an approximate 30% reduction in error is noticed between the two blades shown in *Figure* 6. The data are shown in *Table* 2. *Table* 3 shows the effect of the drawdown velocity on film thickness uniformity. Blades used in this test were those shown in *Figure* 6. The lower ratio channel (L_o/H_o, Blade A) resulted in less uniform films at both drawdown velocities. As determined by the student's test, the average thickness of the film at high velocity was greater than at low velocity. Two distinct sets of film thicknesses resulted with Blade A. As L_o/H_o was increased to 100 (Blade B), more uniform films were produced and film thickness was independent of velocity.

An improved blade that will reduce the error most significantly is shown in *Figure* 7 and in *Figure* 1 (B). The L_o/H_o ratio should be at least equal to 100 and the trailing edge angle (θ_2) be $\geq 90°$ to avoid surface discontinuities because of surface tension effects.

CONCLUSION

As has been demonstrated, a very simple modification of the existing drawdown devices will result in considerably more uniform thickness films. This modification reduces the effects of viscosity, pressure, and blade velocity. It has been demonstrated that the precision of thickness can be improved by as much as 30% by this technique.

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(5) McKelvey, J.M., "Polymer Processing," John Wiley & Sons, NY, 1962, p 251.

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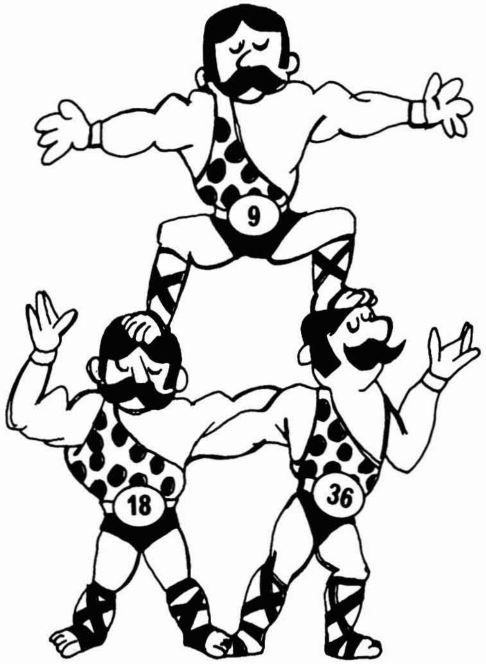
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New Formulating Parameters In the Switch From Bag to Slurry Clay

T.G. Brown, W.S. Stoy, and B.P. Scibek

Engelhard Mineral and Chemicals Corporation*

Latex flats made by converting to total slurry pigments offer savings primarily because of increased production rates. Dispersant levels should be carefully reduced in this switch.

Delaminated and hydrous kaolin slurries can replace dry calcined clay in higher PVC light and dark tint bases. Delaminated slurries exhibit superior hiding and tinting strength, particularly in light tint systems. Both types of slurries provide better enamel holdout and stain resistance. Burnish and scrub resistance of calcined clays can be compensated for by the adjustment of flatting agents. The 65% PVC high kaolin paints develop maximum opacity and tinting strength, better than the 55% PVC series, with no appreciable sacrifice in film integrity.

INTRODUCTION

Increasing costs continue their pervasive influence on all phases of paint manufacture. With trade sales profits below expectations, management seeks new ways to reduce costs. Increased productivity and lower raw material cost are two ways to increase profit without affecting quality. Slurry pigment handling provides both benefits and this has been a major trend of the last decade.

Titanium dioxide slurries have been followed by slurries of the two extenders amenable to aqueous dispersion, the kaolins and carbonates. Partial or complete conversion of water-borne paint to slurry pigments is possible. Cost comparison of actual conversions indicate that the major savings accrue, not from lower delivered or off loading costs or from lesser energy savings, but from throughput increases. Nominal cost reductions are these:

(1) A slurry tank car can be unloaded through a 4-in. pipe in about 2 hr with less manpower than is needed for bagged pigment handling.

(2) Kaolin slurry provides 55% more weight of clay for the same volume of dry bulk, and, counting normal isles and warehouse spaces for bagged product, even more storage space is saved.

(3) During makedown, there is no dusting or pigment loss.

(4) Dispersion energy input is reduced by perhaps .50¢ per ton of kaolin[1] because only simple mixing of predispersed slurries is needed, rather than the intensive grinding associated with dry pigments.

None of these savings, however, compare to the potential increases in productivity ranging from 25% for large producers to as much as 100% for one smaller manufacturer.

Conversion to slurry pigments has forced rethinking of basic premises used by the formulator. In the same manner as automotive engineers have been mandated by federal energy rules to redesign already optimized engines, so formulators have been restricted to a slim list of pigments in slurry form.

While there are at least 70 dry titanium dioxide pigments, many of them distinctive, the 20 slurry versions actually represent two types. Slurry users usually select only the enamel grade for simplicity of storage. There is generally one type of carbonate slurry, the #2 fine particle variety. Several grades of kaolins exist in slurry form;

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*Paints & Printing Inks Div., Menlo Park, Edison, N.J. 08817

Table 1—Comparison of Typical Properties

	Fine Particle Hydrous Kaolin (FPHK)	Medium Particle Delaminated Kaolin (MPDK)	Medium Particle Calcined Kaolin (MPCK)
Particle size, μ	0.55	0.85	1.50
% Finer than 2μ	92	83	67
Shape	Thin plates	Delaminated plates	Irregular microporous structures
Oil absorption (ASTM)	38	40	50
Brightness, %	90	87	90
pH	6.3	6.5	5.0
Slurry solids, %	70.0	68.0	
Slurry viscosity, cps	300	370	

however, tankage limitations again restrict purchases to one choice in most cases. Formulators still incorporate dry add-in extenders (pre-dispersed as a slurry under a separate mixer unless these are stir-in flatting agents), but frequently just one per latex formulation on a very selective basis. Each dry extender adds another increment of dispersion time, to be avoided for maximum throughput and savings.

Kaolin Comparisons

Faced with the responsibility of reformulating his product line into one which uses pigments available in slurry form, the formulator is frequently confronted with choosing a hydrous or delaminated kaolin slurry as a replacement for calcined clay. A new compromise in performance properties is required. Therefore, this study reexamines latex flat formulations in the light of slurry replacement for the most widely used grade of calcined clay (currently available only in dry form).

The three kaolins have been tested at three loadings (1.25, 1.75, and 2.25 lb/gal) and at two PVC's (55 and 65) as detailed in the experimental section. Titanium dioxide levels simulate those of deep and light tint base products. The binder is a fine particle vinyl/acrylic emulsion copolymer. The range of PVC's represents commercial medium-to-low cost interior wall paints which still offer good performance. Because these formulations contain more extender per gallon, they clarify the effect of the clay contribution.

Kaolin Selection

Two types of kaolin have emerged as leading slurry contenders for the paint industry. These are a fine particle hydrous kaolin (FPHK) and a medium particle delaminated kaolin (MPDK), as listed in *Table* 1. Similar to each other in moderate oil absorption, they are available at 68–70% slurry solids and have been widely employed in slurry conversion processes. Much finer in particle size than any other extenders of comparable cost, they offer excellent film packing characteristics that lead to significant TiO_2 conservation.

Use of slurry automatically forces the consolidation and elimination of other grades of hydrous and calcined kaolins, although some continue to be added on a dry basis. Among these is a medium particle calcined product

Table 2—Suggested Dry and Slurry Modes of Addition (lb/100 gal)

	Total Dry Pigments	Slurry TiO_2	Slurry TiO_2 and Kaolin	Total Slurry
Water	150.0	130.0	69.5	100.0
KTPP	1.0	1.0	1.0	1.0
Dispersant	6.6	3.9	3.3	2.8
Wetting agent	3.0	3.0	3.0	3.0
Defoamer	1.0	1.0	1.0	1.0
Buffer	2.0	2.0	2.0	2.0
Biocide	1.0	1.0	1.0	1.0
Coalescing agent	4.5	4.5	4.5	4.5
Ethylene glycol	25.0	25.0	25.0	25.0
Thickener	2.5	2.5	2.5	2.5
Water	87.3	26.0	25.0	56.0
TiO_2	125.0	—	—	—
ASP 352 (MPDK)	100.0	100.0	—	—
$CaCO_3$	150.0	150.0	150.0	—
Silica	50.0	50.0	50.0	50.0
		Grind at high speed; then add at reduced speed		
TiO_2 slurry (76.3%)	—	163.8	163.8	163.8
ASP 352 slurry (68%)	—	—	145.7	145.7
$CaCO_3$ slurry (72.7%)	—	—	—	206.2
		Disperse for 5–10 min; letdown with		
Vinyl acrylic copolymer	168.0	168.0	168.0	168.0
Defoamer	2.0	2.0	2.0	2.0
2% Thickener solution	125.0	125.0	125.0	125.0
Water	127.0	172.3	190.0	69.4
	1130.9	1131.0	1132.3	1128.9

Table 3—Test Formulation - lb/100 Gal

	55% PVC		65% PVC	
Water	107		116	
Colloid 681F	2		2	
Igepal® C0630	2		2	
AMP® 95	2		2	
Merbac® 35	1		1	
Tamol® 731	4		4	
Ethylene glycol } premix	25		25	
Natrosol® 250HR μ } premix	3		3	
Enamel grade TiO_2	98	(75)[a]	98	(75)
Kaolin slurry	250	(175)	250	(175)
#2 Calcium carbonate (2.5μ) slurry	214	(150)	321	(225)
Diatomaceous silica (8μ)	25	(25)	25	(25)
Colloid 681F	1		1	
Amsco® 3077	264		206	
2% Natrosol 250 HR	75		50	
Water	60		70	
	1133		1176	

(a) ( )=dry pigment

Colloids 681F is a registered trademark of Colloids, Inc.; Igepal, GAF Corp.; AMP, International Minerals & Chemicals Corp.; Merbac, Merck & Co.; Tamol, Rohm and Haas Co.; Natrolsol, Hercules Incorporated; Amsco, Amsco Div., Union Oil Co. of Calif.

(MPCK). Coarser, but more porous than the kaolin pigments available in slurry, MPCK is higher in oil absorption. Because of the attendant film porosity, it has traditionally offered a surface roughness or flatting effect combined with opacity. MPCK may be retained as a dry component to overcome picture framing.

The last quarter century has documented the invaluable role of calcined kaolins in emulsion paints[2] and the number of grades has justifiably proliferated for special needs.[3] Calcined products are not available in slurry form because of suspension and rheological problems that have proven difficult to overcome.

Reformulating with Slurry

All slurries contain a careful balance of dispersants, biocides, and other additives designed for maximum compatibility with each other and other paint ingredients.

While the formulator is aware of these factors, experience has been that he sometimes overlooks the additive effect of the slurry introduced dispersants. An item to consider in the conversion to slurry is that the original dispersant level in the formulation needed to disperse dry ingredients should be reduced since extra dispersant is supplied in each of the slurries.

Best paint performance properties are obtained when the pigments in the system are at optimum dispersion. To ensure that all pigments (from slurry or dry add-on) are properly deflocculated, the formulator should determine total dispersant demand.

The following method is used to establish dispersant levels. The pigment grind portion is titrated to minimum viscosity, with the primary dispersant as titrant. On a laboratory scale, water and secondary additives are charged under a Cowles type mixer. Withholding the thickener and primary dispersants, slurries and dry pigments or extenders are individually added. The mill base solids are adjusted to 60–65% solids with water. Small volume increments (less than 1.0 ml) of primary dispersant are added and the viscosity of the pigment grind determined after each addition until a minimum is reached. To avoid errors in recording data and to immediately recognize this minimum, viscosity is plotted against dispersant volume as the test progresses.

Order of addition for slurry modified systems is similar to the dry process. Water and additives, including 50–60% of the thickener requirements are charged, followed by the slurries and any dry flatting agent. Following the minimal mixing time, the mill base is let down with the latex vehicle, defoamer as needed, and the remaining cellulosic as a 2–3% solution, to adjust viscosity.

Typical and progressive changes from dry pigment ingredients to slurry are shown in latex flat formulations in *Table* 2. The first column lists dry pigments. The second column is converted to slurry TiO_2 only, the third adds kaolin slurry, and the fourth employs calcium carbonate as the third slurry. The dispersant levels are gradually decreased, compensating for dispersants brought in by each slurry. Much less free water is available as additional slurries are introduced. This must be carefully split into two portions, one for the initial mixing stage, one for viscosity adjustment and washdown.

The absence of sufficient free available water in some water-poor formulations can cause excessive competition in water demand between the thickeners and the various slurries. This starvation can lead to undue thickening at any point during the sequential addition of ingredients. The formulator must take care to maintain a careful water balance at all times.

High solids coatings can also aggravate the problem. Employment of higher solids latices provides a desirable latitude.

EXPERIMENTAL

Formulae are calculated according to the pattern shown for the 55% and 65% PVC paints in *Table* 3. Enamel grades TiO_2 levels are fixed at 0.75 lb/gal (deep tint) or 1.50 lb (light tint). Kaolin levels are 1.25, 1.75, or 2.25 lb/gal. A constant 0.25 lb of flatting agent is always present. Calcium carbonate is the variable, replacement component. Extender plots on the graphs refer to kaolin alone.

Paints have been prepared by incorporating slurries in the order listed (Cowles dissolver, $2\frac{1}{2}$ in. blade, moderate speed), then adding dry flatting agent, and post mixing for 10 min.

Opacity measurements of dried paint films (6 mil Bird applicator) on drawdown charts and black glass follow the essential procedures of ASTM D2805-70 and ASTM Bulletin 181. Tinting strengths are determined on medium gray paints (the LAB scale on a Gardner XL20 unit) that have been prepared by using 4 oz of universal carbon black colorant per gallon of latex vehicle.

Sheen is rated at 85° on 3 mil drawdowns. Enamel holdout is based on 60° readings of 2 mil alkyd semigloss drawdowns over 3 mil paint films. Washability tests

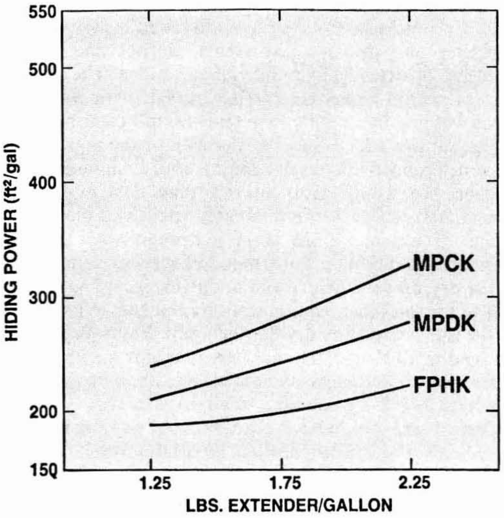

Figure 1—Hiding power vs extender loading at 55% PVC and 0.75 lb TiO_2

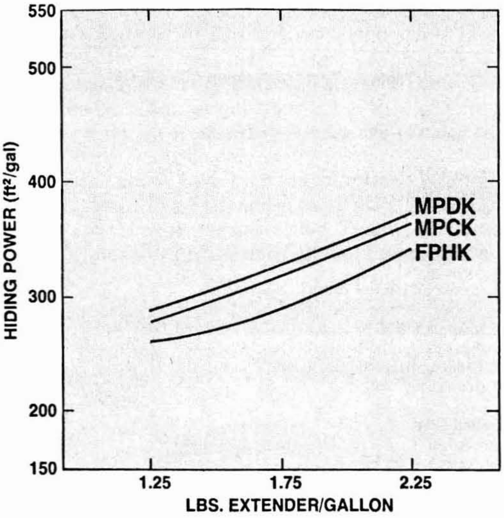

Figure 2—Hiding power vs extender loading at 65% PVC and 0.75 lb TiO_2

conform to method 6142 of Federal Standard 141. Scrub resistance has been run on one week aged films (7 mil Gardner) with a Gardner Heavy Duty Wear Tester, modified shim and silica media, modeled after ASTM D2486-74.

Light Scattering

Both hydrous and calcined kaolins have been renowned for their contribution to light scattering in coatings. Attributed in part to fineness of particle size and spacing or reinforcement of TiO_2 particles, the primary effects are increased opacity and tinting strength.

In the mixed pigment, multi-extender, varied binder systems that constitute latex flats, many interactions are hidden. Results tend to be attributed to only one ingredient. Dry hiding is frequently associated with the extender or pigment component in the formulation that is highest in oil absorption: in truth, this may be a component which is indeed high in demand, but is still only part of the total absorption. The reputed dry hiding of calcined kaolins in high extender/flatting agent systems can be a case in point, since opacity is really dependent upon special packing arrangements of all the pigments at high PVC.

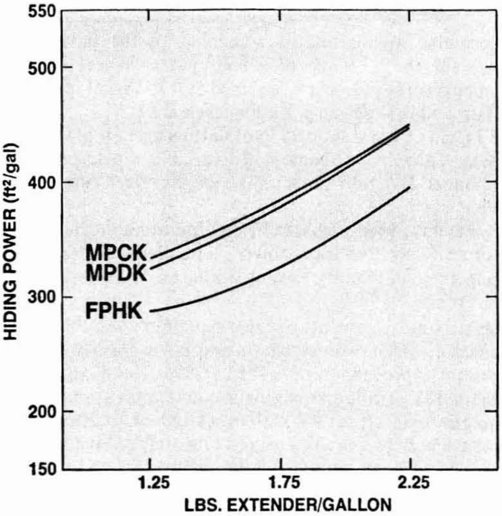

Figure 3—Hiding power vs extender loading at 55% PVC and 1.5 lb TiO_2

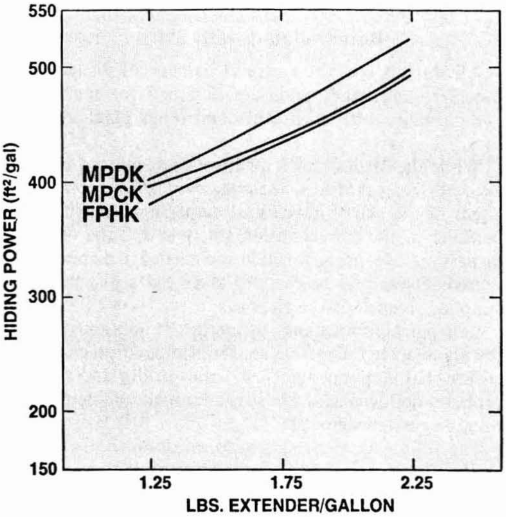

Figure 4—Hiding power vs extender loading at 65% PVC and 1.5 lb TiO_2

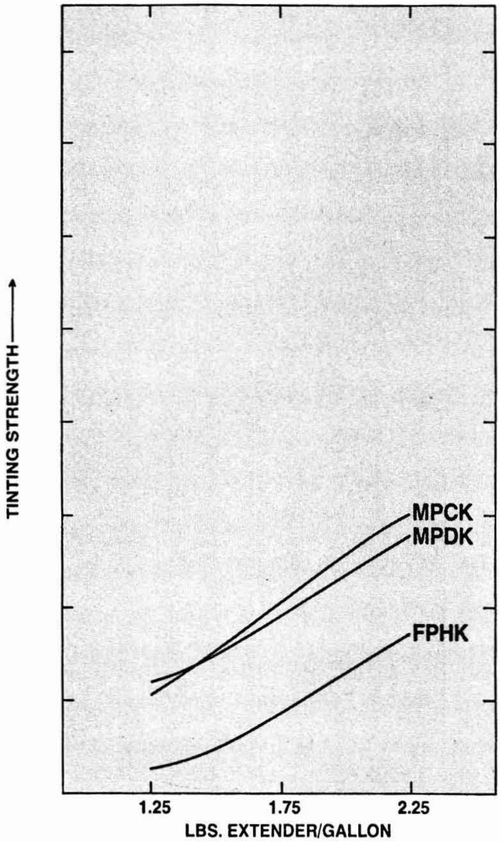

Figure 5—Tinting strength vs extender loading at 55% PVC and 0.75 lb TiO_2

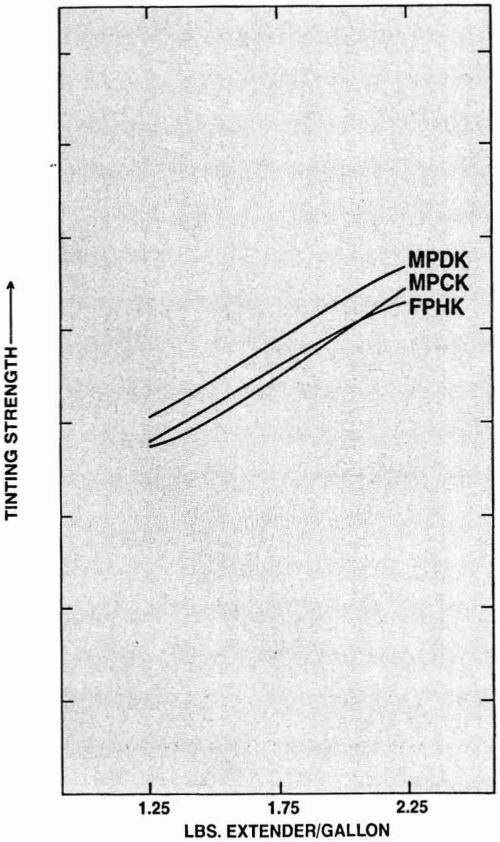

Figure 6—Tinting strength vs extender loading at 65% PVC and 0.75 lb TiO_2

In the present experimental data, *Figure* 1 plots the apparent 10% hiding improvement noted for the calcined over the delaminated product at 55% PVC in a deep tint. This low TiO_2, lower PVC situation is the only one in which this calcined superiority is noticeable. Without much contribution by the TiO_2, at levels near CPVC, each kaolin provides light scattering, but the calcined clay has the vehicle demand to give the added boost of dry hiding.

High kaolin loadings gradually increase relative opacities for these white paints and slightly broaden differences between clays. The delaminated kaolin is consistently superior to the fine particle hydrous product, more effectively spacing and reinforcing the limited amount of TiO_2. Under more crowded conditions of 65% PVC (with TiO_2 still at the lower 0.75 lb/gal and the same kaolin to TiO_2 ratios of 1.7 to 3.0), all paints have much increased hiding power. Thus there is a slight superiority for the delaminated as related to the calcined clay (*Figure* 2).

At the same 55% PVC and its less crowded pigment universe, but with double the TiO_2 (150 lb/100 gal), hiding power curves shift again (*Figure* 3). The delaminated and calcined products are totally indistinguishable. Ratios of kaolin to TiO_2 range between 0.9 and 1.5, with presumably enough thin delaminated plates per pound of kaolin to insure an optimal number of interfaces and light scattering.

The 65% PVC, high TiO_2 paint versions (*Figure* 4) all respond again to the advantages of dry hiding regardless of type of clay. Hiding values are about 20% higher and the differences among clays are 7% or less. However, all delaminated kaolin test paints are more clearly superior to the calcined versions than in the low TiO_2 situation. Again, the extra delaminated platelets make the difference.

All four sets of data reveal a gradual rise in hiding with increased kaolin levels; there are no cross-overs or appreciable changes. Considering that all light and deep tint bases are shown here in the untinted form, many show promising hiding. The delaminated kaolin is clearly the preferred slurry alternate to the dry calcined clay.

Tinting Strength

Gray tinted analogs of these same paints are plotted in the next four figures. Tinting strengths are directly related to opacities in terms of light scattering, but are more closely associated with surface particle reflectance than with total film thickness.

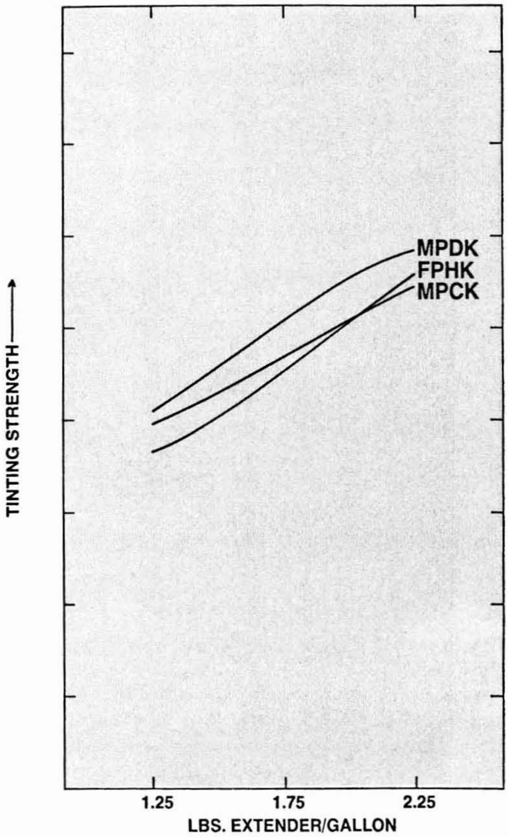

Figure 7—Tinting strength vs extender loading at 55% PVC and 1.5 lb TiO_2

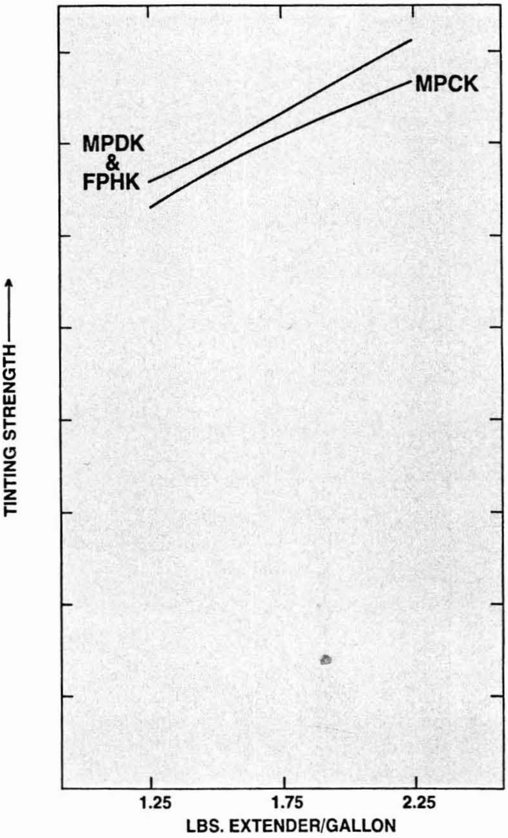

Figure 8—Tinting strength vs extender loading at 65% PVC and 1.5 lb TiO_2

A lighter (higher) reflectivity indicates better tinting strength for the given kaolin.

In deep tone gray flats (low TiO_2) at the lower 55% PVC, calcined and delaminated products are indistinguishable (*Figure* 5). At the higher PVC and lower TiO_2 level (*Figure* 6), the delaminated kaolin is superior in strength to the other clays.

When the TiO_2 level is doubled, all grays are lighter and the delaminated kaolin continues to be superior in strength to the others at 55% PVC (*Figure* 7). At 65% PVC (*Figure* 8), it is still superior to the calcined clay, but is matched by the fine hydrous kaolin.

In general, the more crowded conditions of higher PVC increase tinting strength and opacity and reduce differences among products. Calcined and delaminated grades are fairly similar in light scattering capabilities, but the delaminated has the edge in higher TiO_2 systems. In tinted paints, where the number of particles per pound may be the most significant factor, finer particle hydrous and delaminated kaolins perform quite well against the calcined versions.

Higher hiding and tinting strength at higher kaolin loadings simply reflect carbonate replacement and this normally anticipated advantage.

Sheen (85° Gloss)

Figures 9–12 restate the most direct and obvious of relationships: finer particle kaolins provide higher sheen. The fine hydrous kaolin at all PVC's and loadings develops the greatest sheen, notably at the highest loading of the higher 65% PVC (*Figure* 12). The standard calcined clay employed in this study is always lower in sheen.

Once again, higher TiO_2 levels accentuate sheen differences of the kaolins. Even the calcined systems are not quite as low in sheen, possibly indicating a different pigment packing for these denser films. Hence, to reduce angular sheen, both TiO_2 and clay levels should be manipulated.

In commercial products produced from slurry extenders, sheen control via flatting agents, rather than slurries, is the practice. It is conceded that the selection of a single diatomaceous silica level of 0.25 lb in this series of test paints is arbitrary, but necessary for experimental simplification. Some of the higher sheen effects noted in these formulations, particularly in the case of the fine hydrous kaolin grades, could be reduced by greater amounts of diatomaceous or amorphous silicas (and even coarse

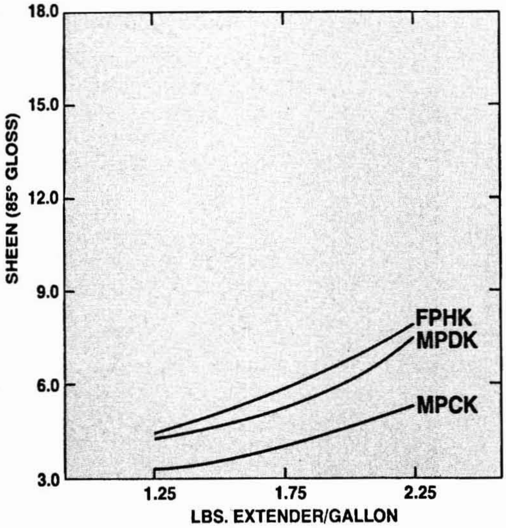

Figure 9—Sheen vs extender loading at 55% PVC and 0.75 lb TiO_2

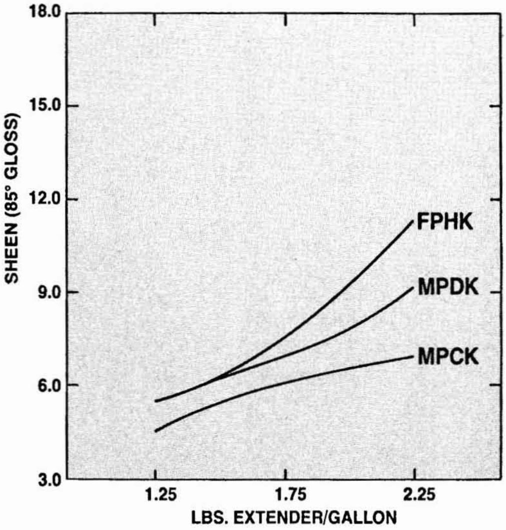

Figure 10—Sheen vs extender loading at 65% PVC and 0.75 lb TiO_2

carbonates or calcined clays.) Commercial paints conventionally use between 0.25 and 0.50 lb, sometimes even 0.80 lb, of these sheen reducing extenders.

Not reflected in the machine numbers are the subtle optical differentiations that are apparent to the eye: the pleasant eggshell appearance imparted by delaminated kaolin or the texture of the calcined clay product. Loadings of these extenders can vary broadly without causing sharp, rapid changes in sheen that may be anticipated by the use of coarser or higher oil absorption flatting agents.

Enamel Holdout

This relative measure of film porosity is plotted in *Figures* 13–16. At all PVC levels, enamel holdout is far superior for both the hydrous and delaminated clays, as anticipated. Overall, the hydrous grade is slightly superior in surface packing and resistance to enamel strike-in compared with the delaminated grade. Both, at the lower 55% PVC (*Figure* 13 and 15), show no loss in enamel holdout as their loadings increase to the maximum. Again, at 65% PVC (*Figures* 14 and 16), both have

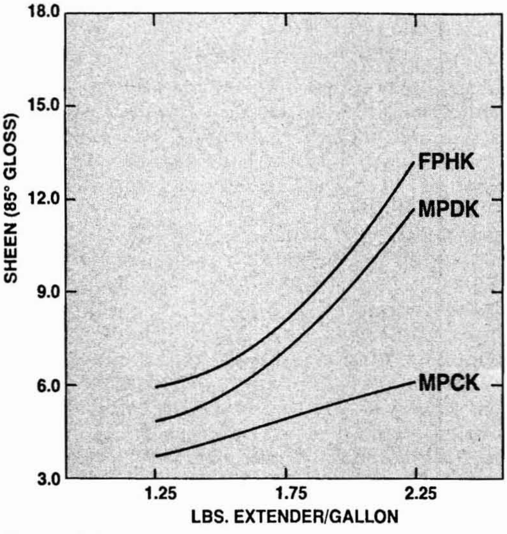

Figure 11—Sheen vs extender loading at 55% PVC and 1.5 lb TiO_2

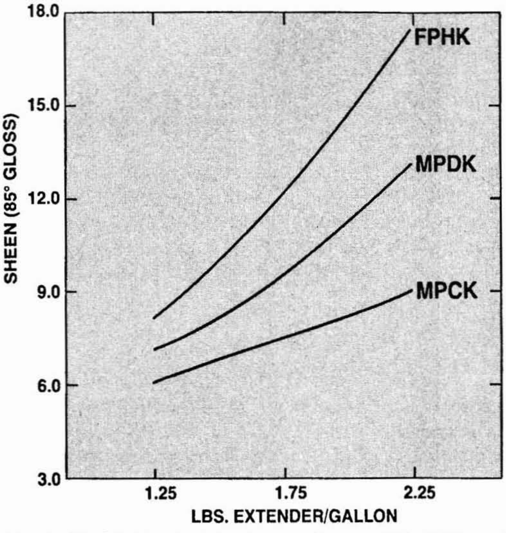

Figure 12—Sheen vs extender loading at 65% PVC and 1.5 lb TiO_2

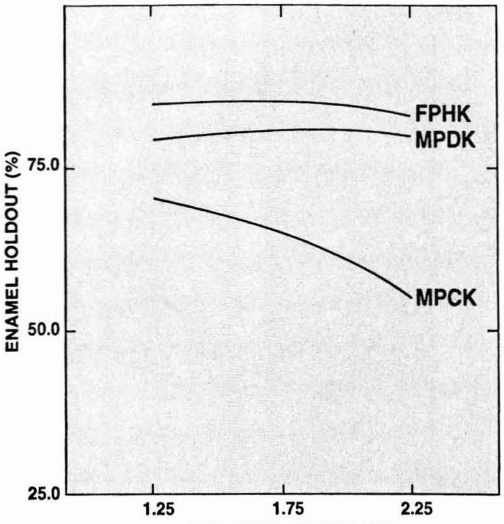

Figure 13—Enamel holdout vs extender loading at 55% PVC and 0.75 lb TiO_2

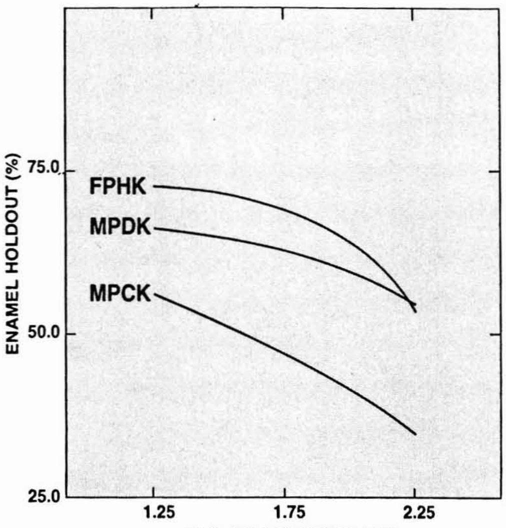

Figure 14—Enamel holdout vs extender loading at 65% PVC and 0.75 lb TiO_2

reasonable holdout at the lower loadings but show some drop off. The calcined clay is distinctly poorer in all cases, reflecting its microporous structure. Finer particle calcined clays would be expected to accentuate this difference.

Change in TiO_2 levels appears not to affect any of these relationships.

Scrub Resistance

The calcined grade demonstrates its superior abrasion resistance in 55% PVC paints (*Figures* 17 and 19). Differences are minimized at 65% PVC (*Figures* 18 and 20). The fine hydrous clay is always intermediate in performance; change in TiO_2 level has no real effect.

Test procedures for scrub resistance levels frequently tend to be more subjective and arbitrary than many other paint film tests. To obtain this data, some adjustment in scrub media between silica and nonionic surfactant was required to bring results within a reasonable range. Nonetheless, the relative differences at 55% PVC and between 55% and 65% paints are valid.

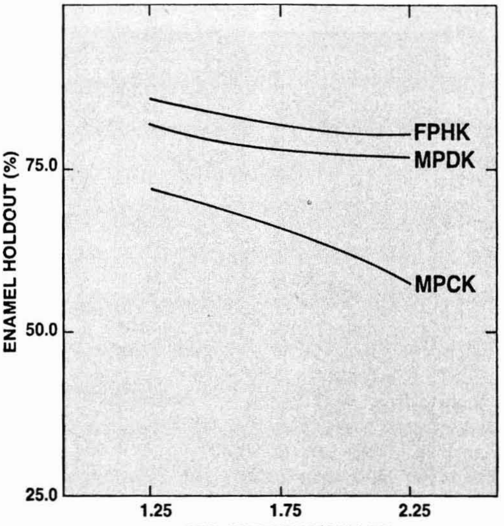

Figure 15—Enamel holdout vs extender loading at 55% PVC and 1.5 lb TiO_2

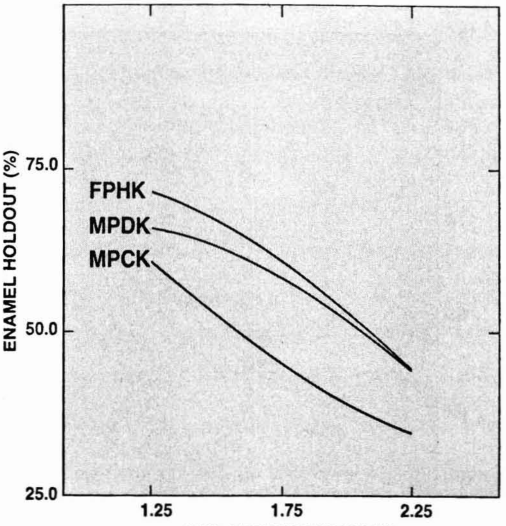

Figure 16—Enamel holdout vs extender loading at 65% PVC and 1.5 lb TiO_2

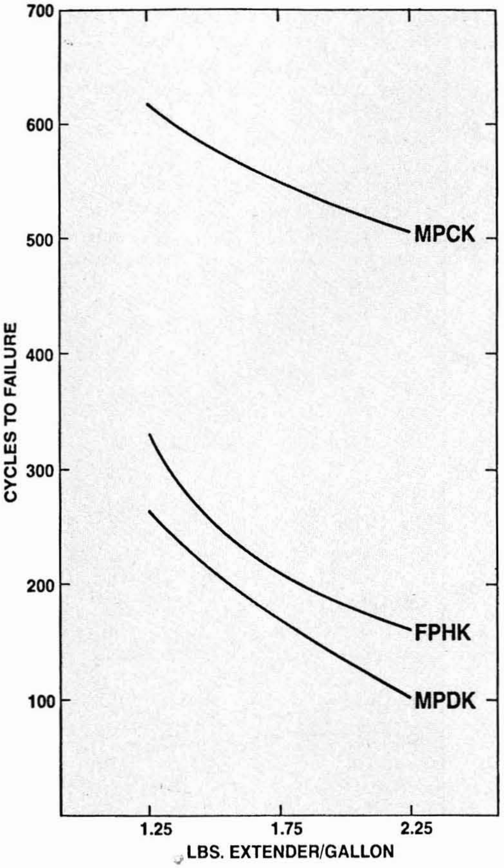

Figure 17—Scrubability vs extender loading at 55% PVC and 0.75 lb TiO_2

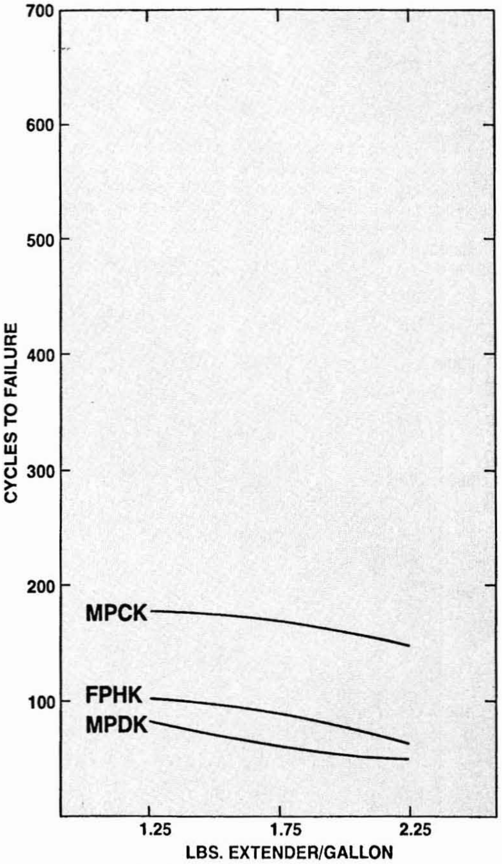

Figure 18—Scrubability vs extender loading at 65% PVC and 0.75 lb TiO_2

Washability (Stain Removal)

Stain removal and burnish resistance are two interrelated properties that, in the last two decades, have slowly assumed a more ascendant role than scrub resistance. Tests indicate little staining for any of these paints, perhaps in general evidence of film tightness and binder quality.

The 55% PVC paints are the most resistive to staining. The fine hydrous and delaminated clays are only very slightly superior to the calcined grade. Staining is slightly more apparent at 65% PVC, with the calcined type again slightly inferior. Higher TiO_2 loadings decrease staining slightly at both PVC's, possibly reflecting the use of the finer particle and better packing enamel grade TiO_2.

Differences in polishing or sheen increase are more evident. The calcined clay extender paints polish less by an average of 5 gloss units. The finer hydrous kaolin polishes more at lower PVC; at the higher PVC, it is very slightly inferior to the calcined grade (this is the only real PVC effect noted).

Higher TiO_2 loaded paints burnish a little more than low TiO_2 paints, an effect of increased fine particle size distribution.

Delaminated kaolins are traditionally lower both in cost and water demand than their calcined counterparts. Comparisons of 55% and 65% PVC paints in terms of these physical properties suggest that most calcined kaolin bearing interior flats can be successfully reformulated with slightly higher levels of delaminated extender. PVC can be increased slightly with concomitant further improvement in light scattering but with no loss of film integrity or increase in cost.

PVC, Film Integrity, And Commercial Success

The subtleties of CPVC relationships have not been emphasized to this point, since, in some measure, any CPVC estimates are subject to test method assumptions and variables. Calculated CPVC values based on oil absorptions[4] suggest that the 55% PVC formulations reported here are very slightly above CPVC, perhaps by 1–4%. The 65% PVC formulations are proportionately

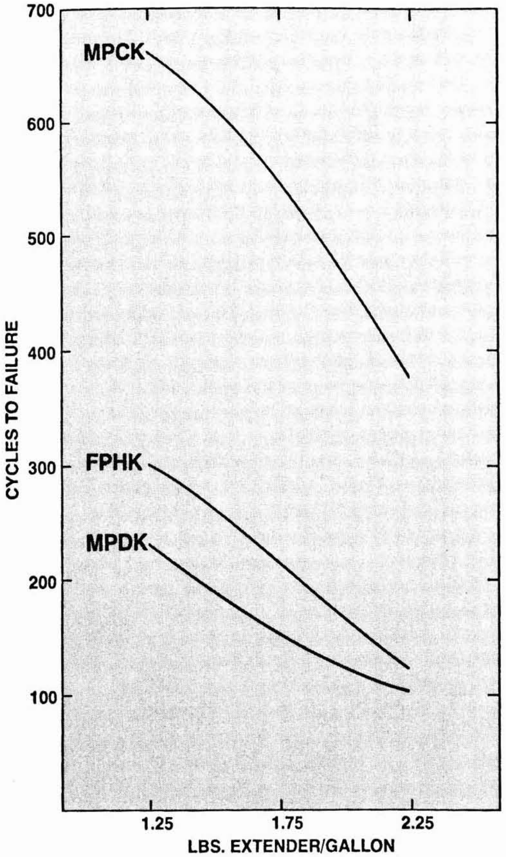

Figure 19—Scrubability vs extender loading at 55% PVC and 1.5 lb TiO_2

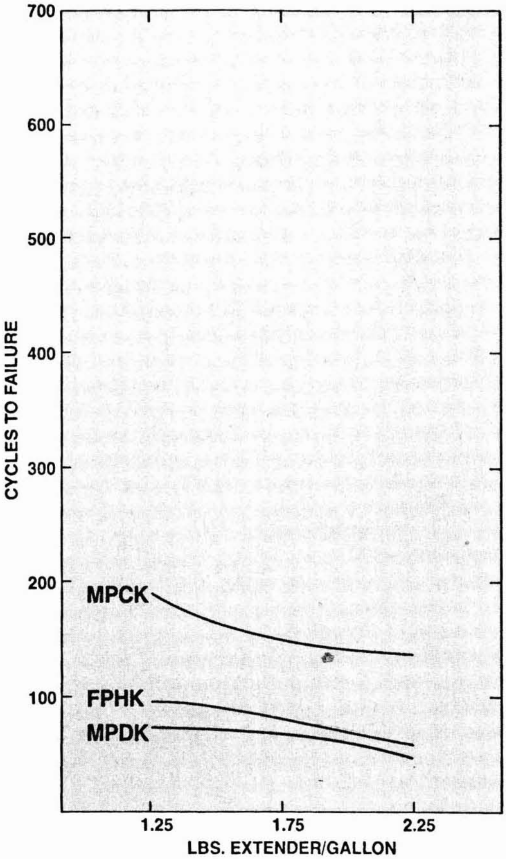

Figure 20—Scrubability vs extender loading at 65% PVC and 1.5 lb TiO_2

further above their calculated CPVC levels by 7–12%. However, these oil absorption CPVC's ignore the binding power of the fine particle vinyl acrylic vehicle. Adding the binder index effect,[5] paints formulated at the 55% PVC level probably fall below the CPVC. The practical tests of enamel holdout, scrub resistance, and washability on the 55% PVC paints seem to substantiate film tightness and integrity expected in paints below CPVC, while those at 65% PVC exemplify films above critical.

Paints containing calcined clay, particularly those at the higher 1.75–2.25 lb levels, have the lowest calculated CPVC values.

In recent years, more trade sales flats have moved into this 55–65% PVC zone, sometimes even successfully towards 70%. Failures occur when poorly packing, high vehicle demand pigments and extenders are held by inadequately binding vehicles.

The press has discussed the declining quality of interior flats and correlated this with increasing raw material costs and consumer resistance. To quantify these concerns, the top line flats and flat enamels of a number of major brands have been analyzed recently.

The TiO_2 levels average above 2 lb/gal. Aluminum silicates of the kaolin variety are present in all samples with some general evidence of silica of one type or another as flatting aids. Barium sulfate is detectable in at least one case, but little or no carbonate is apparent, certainly none in the flat enamels. The PVC average is close to 45% but one notable flat exception is at least 61%.

Medium line brands are by contrast higher in PVC, averaging 55–60%. TiO_2 levels, although still close to two pounds, are slightly lower than for the above samples. There is heavier reliance on lower binder demand aluminum silicates, carbonates, and silicas. The vehicles range from acrylic to acetate to styrene.

CONCLUSION

From a consumer point of view, the results of this present study suggest that the performance of a 55% to 65% PVC candidate can be optimized in terms of hiding and durability, with significant savings in raw material costs. This is a firm indication that money can still be saved without compromising quality. Formulating principles, particularly those relating to the interactions between extenders and TiO_2, must be reexamined.

Test data presented here suggest that delaminated or fine hydrous clay slurries can successfully replace dry calcined kaolin in the slurry conversion of high PVC interior flats. Opacity and tinting strength of calcined product are easily matched or exceeded by PVC adjustment. Enamel holdout and washability are readily improved. Scrub and burnish resistance can be maintained by careful modification with flatting agents.

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Natural Occurrence and Volatility Of Benzene, Toluene, and Xylene In Petroleum Thinners

William H. Ellis and Charles D. McLaughlin
Chevron Research Company*

Benzene, toluene, and xylene are of increasing concern to regulatory agencies because of potential acute and chronic health effects. Gas chromatographic analyses of fractions from laboratory fractional distillations showed that occurrence of an aromatic compound in a solvent depends upon its percentage in the original crude oil, the solvent distillation range, and distillation efficiency. Evaporation experiments and analyses of vapor and liquid in equilibrium showed that volatility is sometimes influenced by molecular interactions.

Special analytical techniques were required to determine benzene, toluene, and xylene concentrations in mixtures with other hydrocarbons.

INTRODUCTION

It is perhaps unfortunate that toxic and hazardous solvents have desirable properties; otherwise, human exposure to them would be less likely. Benzene, toluene, and xylene, for example, are valuable chemicals in their proper place. In the air we breathe may not be a proper place,. but safe limits have not been adequately established. This subject is being considered now by several governmental agencies. A chronology of regulatory activities is given in Appendix A.

It is not always apparent from a regulation, however, what commercial products may be affected. The purpose of this paper is to shed more light on the subject of where benzene, toluene, and xylene are likely to be found in industrial solvents and how they evaporate from hydrocarbon mixtures.

The toxicity of aromatic hydrocarbons, especially benzene, has long been known, and chemists have generally treated them with respect. There appears to be sufficient evidence that chronic exposure to benzene may produce toxic effects to the blood forming cells of the bone marrow.

DISTILLATE THINNER MANUFACTURE

Most petroleum thinners are manufactured by direct distillation from crude oil. A refinery "crude unit" is a continuous still. Fresh crude is preheated and fed into the "flash zone" located at the lower portion of the cylindrical distillation column. Low-boiling materials vaporize and migrate upward. Residual, high-boiling materials are drawn off at the bottom. A temperature gradient is established between the flash zone and the column top, and side cuts of various boiling ranges are collected. Some of these can be thinners such as VM&P naphtha or mineral spirits. Sometimes a broad-boiling distillate is collected and redistilled into narrow-boiling thinner fractions.

After distillation, the thinners are usually treated with chemicals, adsorbents, or hydrogen to improve color, odor, and chemical stability.

"Rule 66" Thinners

The original Rule 66 prompted many solvent manufacturers to find ways to decrease the aromatic contents of their distillate thinners to comply with the law. The aromatic content of mineral spirits, typically 15% aromatics before legislation, had to be reduced when the maximum legal limit of 8% was imposed. This reduction required an additional refining step, but could be accomplished in several ways: hydrogenation, extraction, or blending with synthetic isoparaffins. Although all of these method have been used, hydrogenation is undoubtedly the most satisfactory. The aromatics, which react more rapidly in smog chamber tests, are converted to less photochemically reactive cycloparaffins; and the manufacturing yield of product is improved.

Hydrogenation is carried out with a catalyst at moderate (for refinery processes) temperatures and

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*P.O. Box 97, El Segundo, Calif. 90245.

Table 1—Benzene, Toluene, and Xylene Contents of Various Crude Oils

	Volume, %		
Crude	Benzene	Toluene	Xylene
Sanga Sanga (Indonesia)	1.48	4.35	4.50
North Slope	0.25	0.60	0.65
Elk Hills, Stevens	0.19	0.65	1.13
West Texas Sweet	0.18	0.58	0.91
Iranian Light	0.18	0.65	1.00
Iranian Heavy	0.13	0.45	0.73
Saudi Arabian Light	0.10	0.40	0.64
Saudi Arabian Medium	0.06	0.30	0.62
Saudi Arabian Heavy	0.04	0.19	0.43
San Joaquin Valley Mix	0.09	0.29	0.45
California Coastal Mix	0.08	0.18	0.26
Santa Maria	0.03	0.11	0.34
Sumatran Light	0.12	0.04	0.27

pressures. The degree of hydrogenation can be controlled by adjusting conditions, but it is frequently easier and more efficient to hydrogenate almost completely and, subsequently, blend the product with untreated stock to achieve the proper aromatic content.

Isoparaffin Thinners

Isoparaffins are distillate thinners made from a synthetic feed stream. The feed is made by polymerizing catalytic cracker by-product olefins and paraffins. The polymerization process, which uses an acid catalyst, is called "alkylation." The products are essentially 100% isoparaffins with no measurable aromatic species. Isoparaffins are commonly marketed as odorless mineral spirits.

Commercial Distillate Product Line

The processes described are used to manufacture, with perhaps some variation among suppliers, the following typical product line:

Product	Boiling Range °C
Rubber solvent	40–150
Rotogravure solvent	93–107
Lacquer diluent	90–120
VM&P naphtha	120–150
Mineral spirits	155–205
Odorless mineral spirits	175–205
140 Solvent	180–215
Kerosene	175–265

Other thinners may be blended from these basic items to tailor solvency and volatility to precise limits. Volatility is adjusted by blending stocks with different boiling ranges. Solvency depends upon the proportions of n-paraffins, isoparaffins, cycloparaffins, and aromatics—the four molecular types naturally occurring in crude oil distillates. In practice, stocks high in aromatics, whose manufacture will be discussed in a later section, are used to increase solvency. The use of aromatics, of course, has been severely restricted in recent years by air pollution laws and is now getting serious attention because of toxicity concerns. The toxicity question addresses both the type and the amount of aromatics. Benzene is now considered the most toxic, but toluene and xylene are targeted for more study.

NATURAL OCCURRENCE OF AROMATICS IN CRUDE OIL

Benzene, toluene, and xylene occur naturally in crude oil and are therefore present in some distillate thinners. One factor determining the concentration of a given aromatic in a solvent is its amount in the original crude.

Table 2—Azeotropes of Benzene and Toluene with Saturated Hydrocarbons[1]

		Benzene (B.P. = 80.1°C)		Toluene (B.P. = 100.6°C)	
Azeotroping Compound	Boiling Point, °C	Benzene, Wt %	Azeotrope Boiling Point, °C	Toluene, Wt %	Azeotrope Boiling Point, °C
Cycloparaffins					
Cyclohexane	80.7	52	77.6		
Methylcyclopentane	72.0	16	71.7		
Ethylcyclopentane	103.6			7	103
1,1,3-Trimethylcyclopentane	104.9			16	104
1,2,3-Trimethylcyclopentane	110.4			39	108
1,2,4-Trimethylcyclopentane	109.3			39	107
Isoparaffins					
2,2-Dimethylpentane	79.2	46	75.9		
2,3-Dimethylpentane	89.8	80	79.2		
2,4-Dimethylpentane	80.5	48.3	75		
2,5-Dimethylhexane	109.4			35	107
2-Methylheptane	117.6			82	110
2,3,4-Trimethylpentane	113.4			60	110

Table 3—Thinner Base Stock Physical Properties

Gravity, °API	61.7	
Gravity, Specific, 15.6°C/15.6°C	0.7324	
Density, Lb/Gal., 15.6°C	6.10	
Aniline Point, °C (°F)	62	(143)
Aromatics, Volume, %		
Benzene	0.0693	
Toluene	0.485	
m-Xylene	0.921	
Distillation, ASTM D-86, °C (F)		
Initial Boiling	48	(118)
5% Recovered	77	(170)
10% Recovered	86	(186)
50% Recovered	124	(256)
70% Recovered	142	(288)
90% Recovered	162	(323)
95% Recovered	169	(335)
Dry Point	174	(345)
End Point	177	(350)

The volume percentages of benzene, toluene, and xylene in a variety of crudes are shown in *Table* 1; differences are significant. Benzene contents, for example, vary from 0.03% in Santa Maria (Calif.) crude to 1.48% in Sanga Sanga (Indonesian).

With few exceptions, the relative amount of one aromatic will suggest the relative amounts of the other two. Usually, the toluene content of a crude will be several times higher than its benzene content and somewhat lower than its xylene content.

Density variations in crude oils from the same geographical area may or may not affect aromatic concentrations in distillate thinners. Although the Saudi Arabian "light" crude oil, for example, has more of each aromatic than the Saudi Arabian "heavy", it also yields more nonaromatic hydrocarbons in the thinner boiling range. Total yield of a particular thinner will usually vary, however, with crude oil density; a lighter crude oil normally contains more solvent.

Another factor affecting the amount of an aromatic in a distillate thinner is the broadness of the thinner distillation range. If the distillation range is broad, a large volume of saturated hydrocarbon compounds will be distilled and collected with the aromatic; and the aromatic percentage in the distillate will be low.

DISTILLATION BEHAVIOR

Molecular Interaction Effects

Molecular interactions affect the distillation of aromatics, especially benzene, from crude oil. The exact distillation temperature depends upon the chemical nature of the whole mixture. Azeotropes are probably the most commonly considered manifestation of molecular interaction, but nonideal behavior can occur even when azeotropes don't.

Some azeotropes of benzene and toluene are listed in *Table* 2.[1] They apparently form most readily with cycloparaffins and isoparaffins. No boiling point azeotropes of benzene or toluene with n-paraffins are shown in the latest American Chemical Society monograph on azeotropes.[1] The only azeotrope of xylene listed is one with n-nonane, and the deviation from ideality is very slight.

Experimental Concentration Effects

Regulations designed to control exposure to toxic or photochemically reactive compounds such as benzene, toluene, or xylene often neglect to indicate products that may contain them. The potential occurrence of specific aromatics in commercial thinners was explored experimentally by distilling a sample of thinner base stock in the laboratory and analyzing the fractions. The analytical methods are described in Appendix C (page 72). To simplify the experiments, only the metaxylene isomer, in addition to benzene and toluene, was traced. Metaxylene is usually the predominant isomer in commercial xylene, and its behavior approximates that of mixed xylenes. Ortho- and paraxylene, which occurred in low concentrations, were ignored. Properties of the starting material, including pertinent aromatic contents, are shown in *Table* 3. Possible products that might be made from this base stock range from lacquer diluent to mineral spirits.

The base stock distillation curve is shown in *Figure* 1. The distillation unit was a 4 ft. × 2 in. column packed with Penn State perforated stainless steel saddles. Total sample volume was eight liters, and 2.5% fractions were

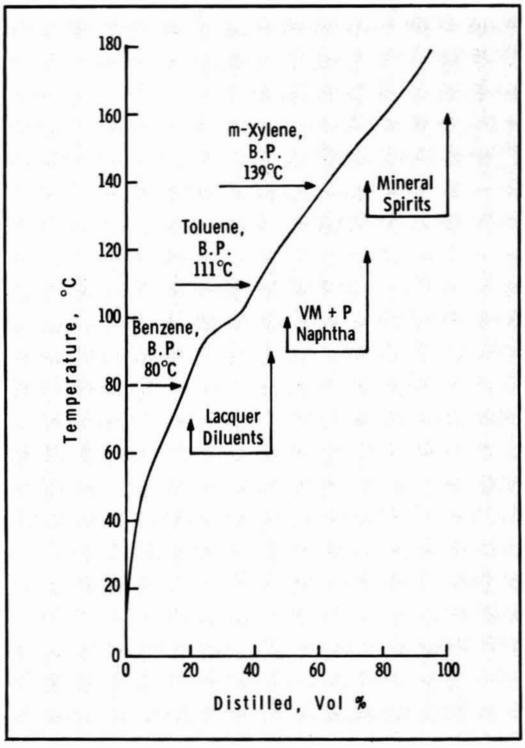


Figure 1—Distillation of thinner base stock

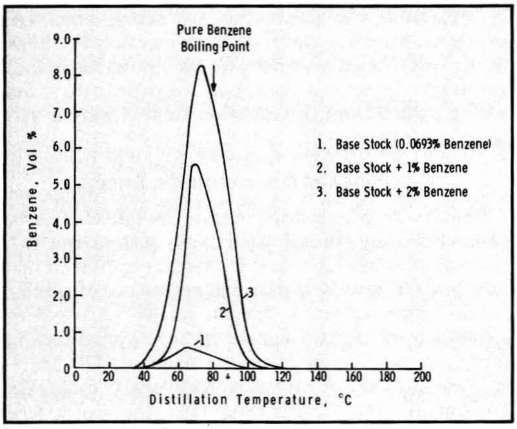


Figure 2—Volume % benzene in distillation fractions vs distillation temperature

collected and analyzed for the three aromatics. The reflux ratio was 10:1. Under these conditions, distillation efficiency was 10–15 theoretical plates. The distillation was repeated with 1% and again with 2% each benzene, toluene, and m-xylene added to the base stock.

Typical portions corresponding to various coatings solvents and boiling points of the three pure aromatics are also indicated in *Figure* 1. Benzene should be expected to occur in the lacquer diluent, together with toluene. m-Xylene should occur in the VM&P naphtha, and none of the three aromatics should be present in the mineral spirits. (Aromatics in mineral spirits usually have nine to eleven carbon atoms.)

Actually, each aromatic occurs in distillate fractions over a range of boiling points because it has significant volatility before the exact boiling point is reached, and there is some residual material that vaporizes after the boiling point is passed. In addition, the volatility (as discussed in a later section) is affected by interactions with other compounds.

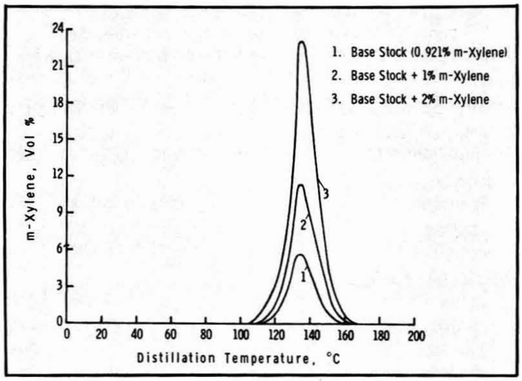


Figure 4—Volume % m-xylene in distillation fractions vs distillation temperature

Concentrations of benzene in the distillate at various temperatures are shown in *Figure* 2. Curves are given for the base stock and for its two blends with added benzene. Fractions from the base stock will contain more than 0.1% benzene by volume at distillation temperatures between 43°C and 93°C. With 1% benzene added, the range increases to 43°C to 105°C, and with 2% benzene added, the range is 37°C to 113°C. Thus, as the percentage of benzene in the feed stock increases, the range of products containing benzene may increase.

A phenomenon also apparent in *Figure* 2 is the shift of the benzene maximum as the concentration changes. As the percentage of benzene in the feed increases, the temperature at which the maximum benzene occurs increases, approaching the boiling point of pure benzene. In this case, the change is about 4°C for each of the two 1% increments added. This follows a general pattern we have observed for other systems.[2] As the concentration of a minor component in a nonideal system decreases, its activity coefficient increases; and the component becomes more volatile.

Similar distillation data for toluene and m-xylene are shown in *Figures* 3 and 4, respectively. Again, the

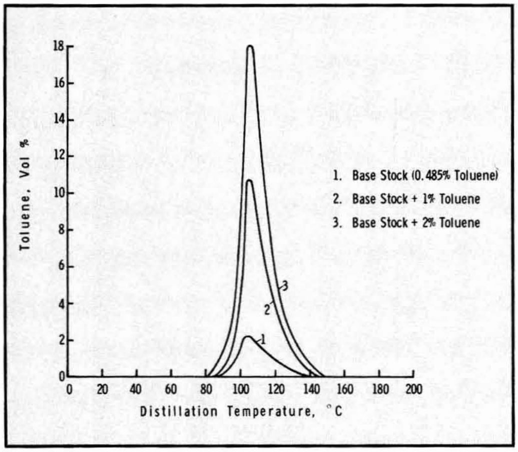


Figure 3—Volume % toluene in distillation fractions vs distillation temperature

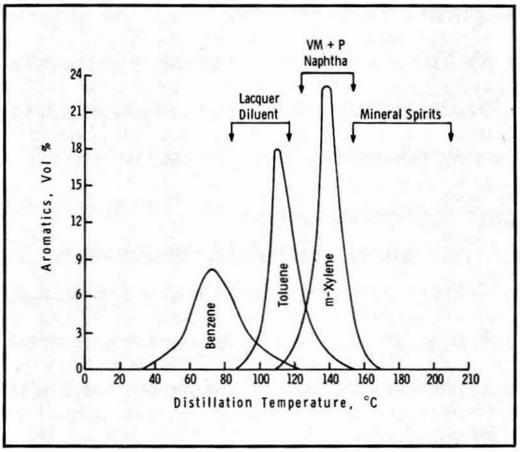


Figure 5—Aromatics can overlap in distillation fractions (Base stock + 2 vol % each added benzene, toluene, and m-xylene)

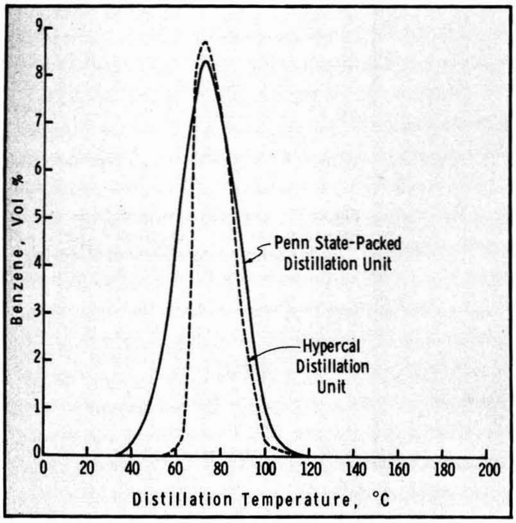


Figure 6—Fractionation efficiency varies with distillation technique (Base stock + 2 vol % added benzene)

individual aromatics occur in fractions over a range of temperatures; as the percentage of the aromatic in the feed increases, the temperature range broadens. However, the maximum toluene and xylene concentration in these experiments occur at temperatures only slightly lower than their pure boiling points; the shift in temperature with concentration in the feed observed for benzene is not as apparent with toluene and m-xylene.

Sharpness of Distillation Separation

The sharpness of separation of the three aromatics is shown in *Figure* 5. The base stock contained 2% each of added benzene, toluene, and m-xylene. There is significant overlap. A lacquer diluent made from this base stock under these distillation conditions would contain all three aromatics, but primarily toluene. The VM&P naphtha would contain some toluene and much m-xylene, and the mineral spirits would contain only a trace of m-xylene.

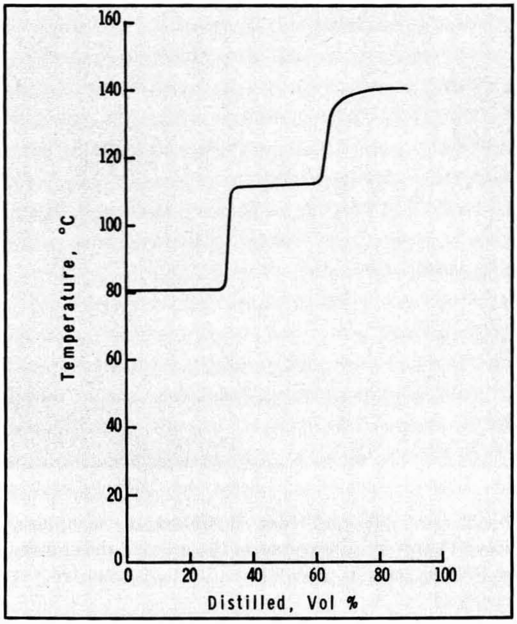


Figure 7—Distillation of aromatic mixture 1/3 each by volume benzene, toluene, m-xylene

Fractionation Efficiency Effect

Sharpness of separation, i.e., the amount of overlap, of two compounds in distillation fractions can be improved by increasing the distillation equipment efficiency. The effect of fractionation efficiency is illustrated in *Figure* 6. The 6 ft Podbielniak Hypercal unit is much more efficient than the Penn State column used for the distillations described previously. The sample in both cases contained 2% added benzene. The benzene occurs in distillation fractions from the Hypercal column over a much narrower distillation range, and its maximum concentration is greater. Thus, the Hypercal column is better able to separate compounds.

There is a variation among refinery units, also.

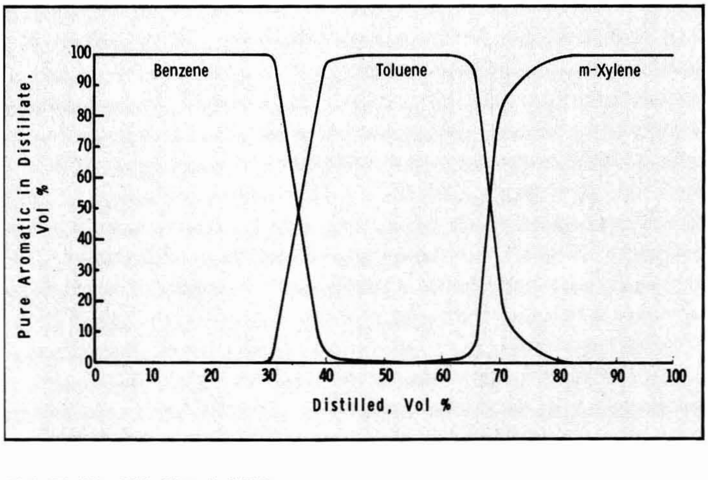


Figure 8—Laboratory hypercal distillation produces pure aromatics from blend of equal volumes of benzene, toluene, and m-xylene

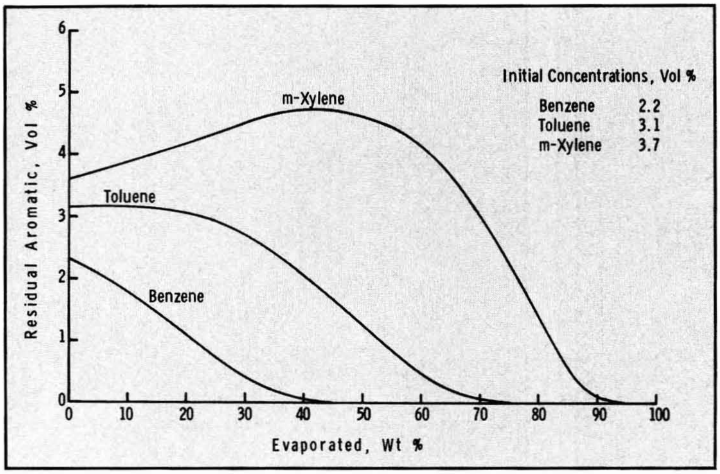


Figure 9—Aromatic concentrations vary as solvent evaporates (Base stock + 2 vol % each added benzene, toluene, and m-xylene)

Distillation efficiency and sharpness of separation depend upon the dimensions of the column, the number of trays or type of packing, reflux ratio, and feed or boilup rate.[3,4]

AROMATIC SOLVENT MANUFACTURE

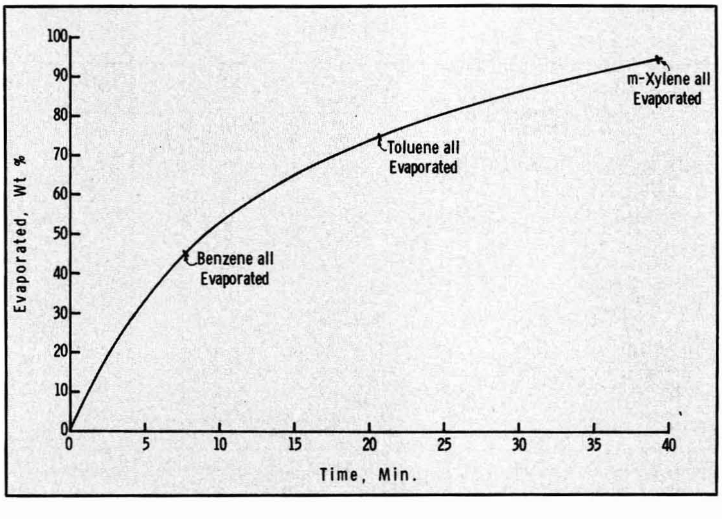
Aromatic solvents are manufactured rather than simply separated from crude distillates. The concentration of naturally-occurring aromatics is too low to make separation economically attractive. The generic process for aromatics manufacture is "catalytic reforming," and there are various proprietary variations that go by other names.

A catalytic reformer uses a catalyst to dehydrogenate cycloparaffins at relatively high temperatures and pressures. In the process, some of the paraffins are isomerized to cycloparaffins and subsequently dehydrogenated. The feed may be tailored to yield only specific aromatics; it is common practice to feed a low-boiling distillate to produce a mixture of benzene and toluene, or a higher boiling distillate may be used to produce only xylene. Some paraffins are unchanged and must be separated later.

Purification of the aromatics is usually accomplished with any one of a variety of extraction processes. Separation of the aromatics from each other is usually done by distillation. One exception is the difficult separation of the three xylene isomers and ethylbenzene; their boiling points are similar. Orthoxylene and ethylbenzene can be distilled from isomer mixtures with very efficient columns, but meta- and paraxylene have very close boiling points (138.8°C and 138.5°C, respectively) and must be separated by a more sophisticated method such as freezing. For solvent use, xylene isomers are used as a mixture; and their separation is not necessary.

Low-boiling pure aromatics can be easily separated by laboratory distillation, as shown by the data in *Figure* 7.

Figure 10—Evaporation of thinner base stock with 2% each added benzene, toluene, and m-xylene (Chevron Research Evapocorder at 25°C)



A sample of equal volumes of benzene, toluene and m-xylene was distilled in the Hypercal unit. The temperature plateaus are at the pure compound boiling points, indicating no significant molecular interactions and sharp fractionation. Analysis of the distillation fractions (*Figure* 8) confirms this conclusion; except in narrow overlap areas, the fractions are quite pure individual aromatics.

VAPORIZATION OF AROMATICS FROM SOLVENTS

A toxicity hazard depends upon the concentration of a vaporized compound in the ambient air as well as on its inherent toxicity. Partial pressure (vapor concentration) depends upon the liquid concentration, the pure component vapor pressure, and molecular interaction.

Ideal and Nonideal Mixtures

In the simplest case, the partial pressure of a component in a mixture follows Raoult's Law:

$$p_i = x_i p_i^\circ \qquad (1)$$

p_i = partial pressure component i
x_i = mole fraction of component i
p_i° = vapor pressure of pure component i

In most real cases, it is necessary to introduce an activity coefficient to handle deviations from the ideal system described by Raoult's Law:

$$p_i = \gamma_i x_i p_i \qquad (2)$$

γ_i = activity coefficient of component i

If the activity coefficient is high, i.e., greater than 1, that component will have a partial pressure higher than Raoult's Law predicts, and the compound will evaporate faster than would normally be expected. This situation occurs very commonly and is characteristic of most "nonideal" systems. Raoult's Law also says that decreasing the concentration in the liquid phase will give a lower partial pressure and a lower concentration of a component in the vapor phase.

With these phenomena in mind, a sample of the base stock plus 2% each of benzene, toluene, and m-xylene was evaporated from an evaporating dish and the residual liquid was analyzed at intervals. Data are shown in *Figure* 9. Benzene in the liquid phase decreased sharply and was all evaporated with the first 45% of the sample. Benzene concentration was highest in the first vapor increment. Toluene concentration in the liquid remained fairly constant until about 20% of the sample was evaporated; it then decreased as the benzene had. At 75% evaporated, the toluene was all vaporized. m-Xylene in the residual liquid actually increased as the lighter components evaporated, reaching a maximum concentration at about 42% evaporated. At that point, its partial pressure would be at its highest. Measurable concentrations of m-xylene remained until almost 95% of the sample had evaporated. As evaporation proceeds, the evaporation rate diminishes, as shown in *Figure* 10. (Data were obtained with an evaporation balance, the Chevron Research Evapocorder).[5] Each successive evaporating increment requires a longer time. This is characteristic of petroleum distillates, which are mixtures of many compounds. The most volatile materials evaporate early, leaving the less volatile ones behind; and the evaporation rate decreases. Vapor pressure of the mixture decreases in proportion. A pure compound evaporation curve is a straight line, as shown by the data in *Figure* 11.

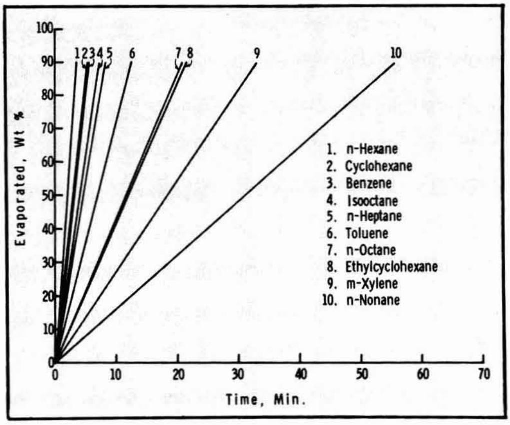


Figure 11—Evaporation rates for pure hydrocarbons (Chevron Research Evapocorder at 25°C)

In similar experiments with benzene added to gasoline, Runion[6] found that benzene concentration in the hydrocarbon vapor increased as the very volatile components evaporated away and then decreased as total volatility decreased. However, benzene concentration in the air remained relatively constant until about 55% of a gasoline sample had evaporated; it then decreased as the liquid benzene concentration decreased.

Volatilities of Binary Blends

Boiling point azeotropes are commonly recognized indications of nonideal behavior, but azeotropes also form at ambient evaporation temperatures.[2] Furthermore, nonideal behavior can occur without the formation of an azeotrope, i.e., an activity coefficient can be greater (or less) than 1; but an azeotrope will form only if component volatilities are similar. The vapor pressures and evaporation data in *Table* 4 and *Figure* 11 show that components of some binary blends, such as benzene and

Table 4—Vapor Pressures at 25°C of Pure Compounds[7 8]

Compound	Vapor Pressure, Torr, 25°C
Benzene	95
Toluene	30
m-Xylene	9
n-Hexane	160
n-Heptane	46
n-Octane	15
n-Nonane	5
Isooctane	48
Cyclohexane	104
Ethylcyclohexane	14
2,2,5-Trimethylhexane	17

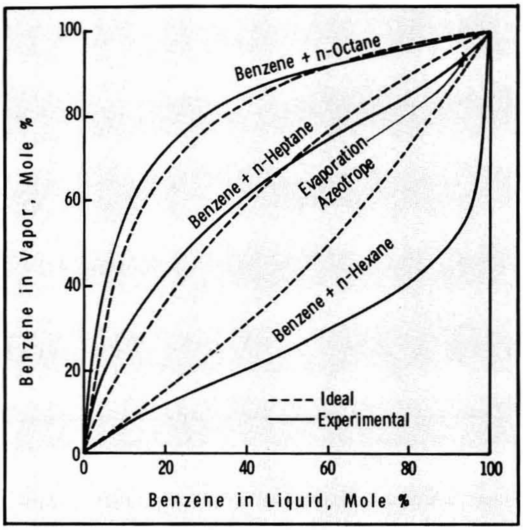


Figure 12—Benzene forms nonideal blends with n-paraffins

cyclohexane have similar volatilities and might form azeotropes.

Volatility behavior of three binary blends containing benzene are illustrated in *Figure* 12. The second component of each combination is a normal paraffin. The figure shows the composition of vapor in equilibrium with liquids of various percentages of the two components. The solid lines are experimental data; the dotted lines are ideal relationships predicted by Raoult's Law.

Benzene and n-octane deviate only slightly from predicted compositions. At low concentrations of benzene in the liquid, the benzene is slightly more volatile than expected; at higher concentrations of benzene, behavior is nearly ideal. With n-heptane, benzene is also slightly more volatile than expected at low concentrations. At high concentrations, however, the benzene is less volatile than predicted and forms an evaporation azeotrope at 97% benzene and 3% n-heptane. At this extreme composition, though, the azeotrope has little practical significance. The azeotrope can be recognized because the composition of the liquid and the vapor are identical. The blend of benzene and n-hexane deviates markedly from ideality even though no azeotrope is formed. The benzene concentration is much lower than it

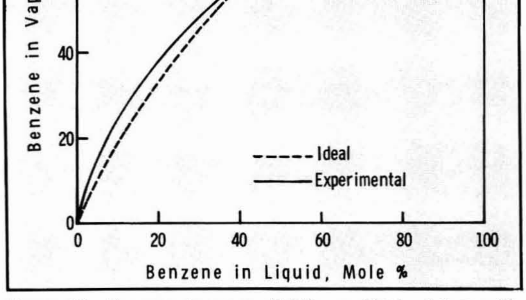


Figure 13—Benzene forms a slightly nonideal mixture with isooctane

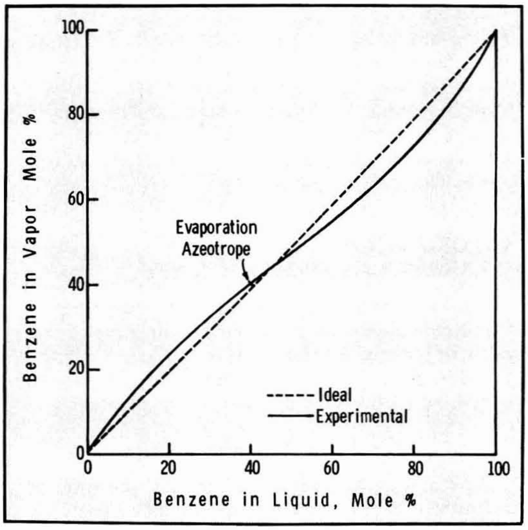


Figure 14—Benzene forms a slightly nonideal mixture and an azeotrope with cyclohexane

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WILLIAM H. ELLIS is a Senior Research Associate with Chevron Research Company, El Segundo, Calif., and is responsible for solvents research and technical service. He has obtained a number of patents and published many papers. He is a Stanford University Graduate and a member of the American Chemical Society, the American Association for the Advancement of Science, Sigma Xi, the Air Pollution Control Association, and the National Paint and Coatings Association. He is currently the President-Elect of the Federation of Societies for Coatings Technology.

DR. CHARLES D. McLAUGHLIN is presently a research chemist at Chevron Research Company in the Thinners and Solvents Laboratories in El Segundo, Calif. In 1968, he received the B.S. Degree in chemistry from the University of Akron and the Ph.D. Degree in analytical organic chemistry from Northwestern University in 1976. Since joining Chevron Research Company, he has been interested in the fundamental properties and analytical methods development for hydrocarbon solvents.

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would be in an ideal system at almost all concentrations. This means that the n-hexane is more volatile than expected and the percentage of benzene in the vapor mixture will be proportionately lower.

Benzene-isooctane blends (*Figure* 13) behave in a manner similar to the n-heptane-benzene blends. The system is slightly nonideal and forms an evaporation azeotrope at 98% benzene, a level having no practical significance. Thus, the normal and branched paraffin form similar, slightly nonideal mixtures with benzene.

Benzene and cyclohexane comprise a somewhat nonideal system, as shown in *Figure* 14. The evaporation azeotrope contains 40% benzene and 60% cyclohexane. A blend of this composition would evaporate and behave as a pure compound because evaporating vapor would have exactly the same composition as the liquid, and the component ratio would not change in either phase. Evaporation azeotropes always have a higher vapor pressure and evaporate faster than either component;[2] in this case, the evaporation rate is about 10% faster than that of benzene or cyclohexane, which are similar, and the cyclohexane increases slightly the vaporization of benzene. The nonideality of this mixture is not really greater than that of other examples tested. The azeotrope forms because the cyclohexane and benzene vapor pressures (*Table* 4) are very similar.

Additional experiments with toluene and m-xylene in combination with saturated hydrocarbons of comparable relative volatilities showed similar behavior patterns. Toluene with n-octane and xylene with n-nonane behavior resembled that of benzene with n-heptane, for example. All binary combinations of the three pure aromatics exhibited ideal behavior.

Thus, azeotrope formation and molecular interactions affect evaporation of aromatics from hydrocarbon solvents to a measurable but relatively insignificant degree. The primary concern remains the percentage of aromatic in the original solvent, which in turn depends upon the aromatic content of the original crude oil and the manufacturing process efficiency.

SUMMARY AND CONCLUSIONS

Benzene, toluene, and m-xylene exhibit essentially ideal volatility behavior in blends with each other. The three aromatics start to distill from saturated hydrocarbon mixtures at temperatures slightly below their pure boiling points. The distillation temperature of benzene decreases as its liquid concentration decreases.

The occurrence and concentration of a particular aromatic in a distillate thinner depends partially upon: its concentration in the original crude oil; the width of the boiling range; and fractionation efficiency of the distillation unit.

A significant amount of a particular aromatic is unlikely to occur in a distillate thinner whose boiling range is not near the boiling point of the aromatic, e.g., mineral spirits will rarely contain benzene.

With few exceptions, benzene, toluene, and m-xylene form slightly nonideal mixtures with saturated hydrocarbons. An exception is n-hexane plus benzene, which forms a markedly nonideal blend but no evaporation azeotrope.

Evaporation azeotropes form with an aromatic and a saturated hydrocarbon when their volatilities (vapor pressures or evaporation rates) are similar.

ACKNOWLEDGMENT

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APPENDIX A

LEGISLATIVE RESTRICTIONS FOR BENZENE

Before legal restrictions on the benzene concentration in ambient air emerged, its toxicity was recognized by the American Conference of Governmental Industrial Hygienists (ACGIH). ACGIH established a threshold limit value (TLV) of 100 ppm maximum for an 8-hr, time-weighted average in 1946. Levels were decreased to 50, 35, and 10 ppm in 1947, 1948, and 1970, respectively.[16]

On May 3, 1977, the Occupational Safety and Health Administration (OSHA) issued an emergency order, effective May 21, 1977, limiting worker exposure to 1 ppm maximum averaged over an 8-hr period. The action followed discovery that eight former rubber plant workers had died of leukemia; this was five times the rate that would be expected in the normal population. The 1 ppm level was explained by OSHA as the lowest level achievable with present day technology and analytical methods. Liquids containing less than 1% benzene were exempt from control measures. Before the temporary standard took effect, however, it was delayed by a legal injunction obtained by the American Petroleum Institute. The AFL-CIO also challenged the plan, but on the basis that it was too lenient.

On May 27, 1977, the Environmental Protection Agency (EPA) classified benzene as a "hazardous air pollutant" under the Clean Air Act. The law required EPA to issue proposed emission standards within six months, hold hearings, and issue final standards within six months after the final proposal.

On February 10, 1978, a permanent standard of 1 ppm benzene maximum over an 8-hr exposure period was issued by OSHA, but it did not exempt liquids containing low concentrations of benzene, as the temporary standard had. (Gasoline was exempted, however). Instead, the agency established an "action level" of 0.5 ppm benzene in the ambient air; below this level, monitoring and medical surveillance were not required. The standard was to take effect March 13, 1978.

On March 12, 1978, the American Petroleum Institute and the National Petroleum Refiners Association obtained an injunction from the U. S. Court of Appeals to block implementation of the OSHA rule until a hearing could be held before the court. Simultaneously, OSHA was making revisions in the proposed standard and planned to exempt liquids containing less than 0.5% benzene for three years and 0.1% after that.

On May 19, 1978, the Consumer Product Safety Commission (CPSC) proposed a ban on all consumer products except gasoline that contained more than 0.1% benzene. The effective date was to be established after hearings were held.

On October 5, 1978, the 5th U. S. Circuit Court of Appeals in New Orleans struck down the whole OSHA proposal on the basis that the measurable benefits bore no reasonable relationship to the cost of implementation, which was estimated at $500 million.

On October 13, 1978, the Consumer Product Safety Commission extended the time for promulgation or withdrawal of a rule until April 16, 1979. Meanwhile, the Commission hired Battelle Columbus Laboratories to prepare an analysis of the ban on consumer products containing 0.1% or more of benzene. Their final report was issued December 21, 1978.

On January 3, 1979, OSHA petitioned the U. S. Supreme Court to review the decision of the New Orleans appeals court.

On February 23, 1979, The U. S. Supreme Court agreed to review the OSHA case.

On April 16, 1979, the CPSC extended the time period for final action on benzene restriction to April 16, 1980.

Meanwhile, the EPA has also delayed final rule proposals.

APPENDIX B

SUMMARY OF TOXIC EFFECTS

Toxicologically, overexposure to benzene, toluene and xylene vapor may result in signs and symptoms of central nervous system depression. Such effects may be displayed by headache, dizziness, loss of appetite, weakness and loss of coordination. Affected persons usually experience complete recovery when removed from the exposure area.[9-14] In addition to the above signs and symptoms, ingestion of these solvents may result in their being aspirated into the lungs and chemical pneumonitis may develop.

There is good evidence indicating an association between chronic exposure to benzene and hematotoxic effects in man. Several studies have revealed an increased incidence of pancytopenia,[17-21] aplastic anemia,[22-23] and acute myleoblastic leukemia[24-29] and its variants in persons chronically exposed to benzene.

Although the OSHA exposure standard for benzene is currently under judicial review, it is now 10 ppm for an 8-hr work day, 40-hr work week. The American Conference of Governmental Hygienists (ACGIH) benzene threshold limit value is also 10 ppm. Likewise, the OSHA and ACGIH values for xylene are both 100 ppm; however, for toluene the OSHA standard is 200 ppm while the ACGIH TLV is 100 ppm.

Table C-1—Analytical Conditions

Gas Chromatograph: Hewlett Packard 5830A Series Equipped with Dual FID Detectors and a Time Programmable Backflush Valve System.

Instrument Settings:
Oven: 100°C Isothermal
Injector + Detector: 250°C
Helium Flow: 20 ml/Min

CUTS 1-15
(0→37-1/2% Distilled)

Column: 15% 90% Tetracyanoethylated Pentaerythritol 10% Bis (2-Ethylhexyl) Tetrachlorophthalate on 80-100 Mesh Anakrom-SD

Size: 3m x 3.2mm

Typical Cycle Time: 20 Min.

CUTS 16-34
(37-1/2→85% Distilled)

Column 1: 9.1% SP-2100 on 60-80 Mesh Chromosorb W

Size: 0.8m x 3.2mm

Column 2: 20% 1,2,3-Tris (2-Cyanoethoethoxy Propane on 80-100 Mesh Chromosorb P

Size: 4.6m x 3.2mm

Typical Cycle Time: 35 Min.

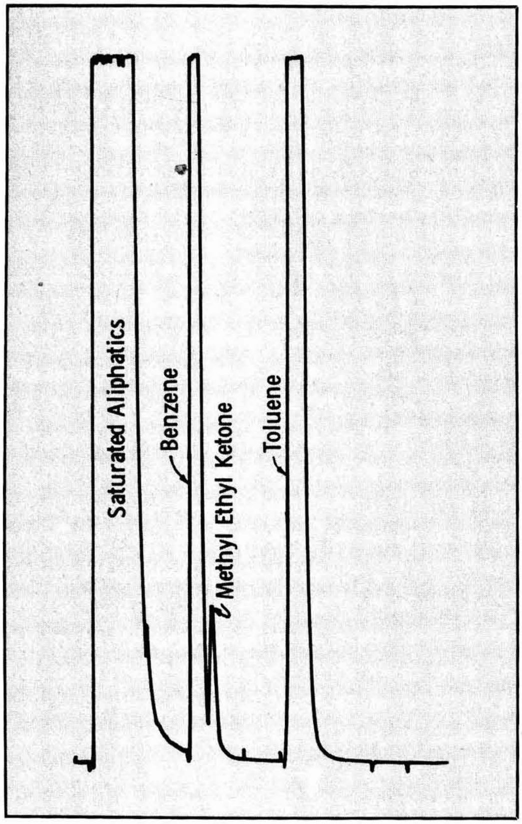

Figure C-1—Typical chromatogram for cuts 1-15

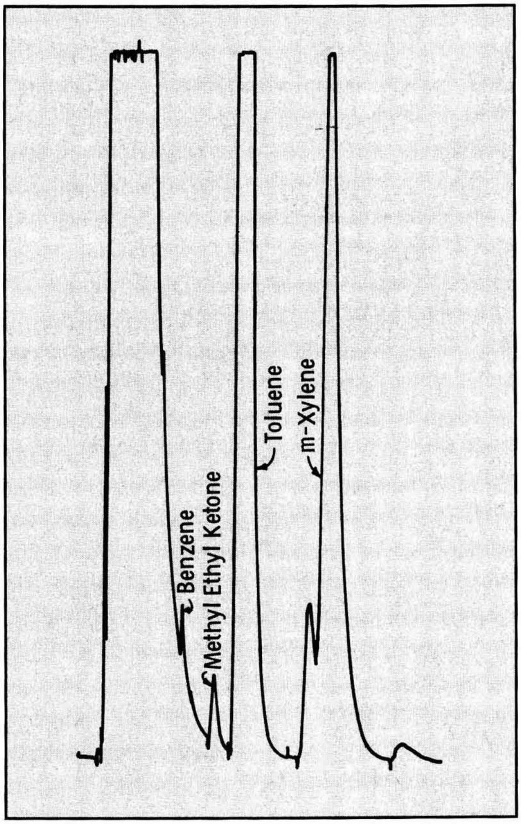

Figure C-2—Typical chromatogram for cuts 16-34

APPENDIX C

LABORATORY ANALYTICAL PROCEDURES

Separation of benzene, toluene, and m-xylene from each other and from all other interfering saturated hydrocarbons in a wide boiling range distillate requires a sophisticated analytical procedure. Two basic sets of gas chromatography conditions were used (*Table* C-1), each selected to optimize the analysis of a specific sample.

To obtain quantitative data in the ppm range, methyl ethyl ketone (MEK) was added as an internal standard to each sample. All samples were made up and stored in glass vials with aluminum foil lined caps.

Benzene and toluene were the two main components of interest in the early part of the distillation. Both of these compounds, along with MEK, are cleanly resolved, as shown in *Figure* C-1, by use of the pentaerythritol column.

After approximately 37.5% of the stock had distilled, higher boiling aliphatic hydrocarbons began to obscure the benzene and MEK peaks. The columns were switched at this point and the two column series shown in *Table* C-1 was used. This second set of analytical conditions is a slightly modified ASTM D-3606 procedure.

The two columns are separated by a back flush valve that permits isolation of the first column from the second. In practice, one determines the time necessary for all compounds of interest (benzene, toluene, and m-xylene) to pass through the first column and onto the second column. As soon as that happens, the back flush valve is activated, thereby reversing gas flow in the first column. All higher-boiling compounds than m-xylene are flushed off the first column and, consequently, they do not contaminate the second column nor obscure individual peaks in the chromatogram.

Figure C-2 shows a chromatogram for sample distilling over at 50% recovered. Higher boiling samples retain this general pattern.

Analysis of vapor compositions for the azeotropic data was accomplished by using a septum-capped bottle. The bottle was maintained in a constant temperature water bath. A gas-tight syringe was used to draw out a vapor sample after the vapor and liquid compositions had come to equilibrium.

Energy Considerations in Stripping Paint From Hooks and Racks

Carol J. Madigan
Whirlpool Corporation*

Hooks and racks used to transport parts through industrial paint systems require periodic cleaning to remove accumulated paint. A common paint stripping method is the molten salt bath system. While this is an effective method, there are several drawbacks. Energy and chemical requirements are high. This paper reviews the evaluation of the alternate methods considered for replacement of a molten salt bath system at a large appliance manufacturing facility. Alternate paint stripping methods evaluated are: hot strippers, cold strippers, mechanical abrasion, incineration, paint burn-off, pyrolysis, and fluidized sand bed. Factors considered in the evaluation are: stripping effectiveness, operating time, energy requirements, chemical requirements, and associated environmental, health and safety factors. Energy requirements as well as the energy forms used are important considerations when evaluating a system for future applications, and these considerations are discussed. The basis of the evaluation is a large appliance manufacturing facility where 550 racks are stripped per day, an average of approximately 230 kilograms of paint stripped per day. The results of this study indicate that the paint burn-off, pyrolysis, and fluidized sand systems are acceptable for replacement of the molten salt bath system.

Introduction

Hooks and racks used to transport parts through industrial paint systems require periodic cleaning to remove accumulated paint. A common effective paint stripping method is the molten salt bath system. This thermochemical process involves a rapid reaction between paint organics and caustic salts at a temperature of 510° C. [1,2] Racks are lowered into the molten caustic salts for 10–20 min. The reaction is so rapid that organic material does not completely break down to carbon dioxide and water; thus, odorous intermediate organic products are emitted. Evaluation of a molten salt bath system at a large appliance manufacturing facility indicated that both energy and chemical requirements are high. For these reasons, an evaluation of alternate paint stripping methods was initiated.

This paper will review this evaluation of alternate paint stripping methods. Alternate paint stripping methods evaluated are: hot strippers; cold strippers; mechanical abrasion; incineration; paint burn-off; pyrolysis; and fluidized sand bed.

Factors considered in the evaluation are: stripping effectiveness; operating time; energy requirements; chemical requirements; and associated environmental, health and safety factors.

The energy requirements, as well as the energy forms used, are important considerations when evaluating a system for future applications, because of relative costs and availabilities. The information presented in this paper includes the results from pilot tests and operational data from existing installations. As a foundation for comparing the various processes studied, the evaluation was based on the paint stripping requirements of the appliance manufacturing facility previously mentioned. At this plant, the paint stripping requirements are 550 racks per day, an average of approximately 230 kilograms of paint stripped per day.

Hot and Cold Strippers

Hot strippers are generally alkaline solutions that are maintained at a rolling boil (120–130° C).[3,4,5] The mode of action for the alkaline solutions is to swell and lift off the paint. Fresh chemical additions are required to keep the solution in an active state, as indicated by regular titration to determine activity. Periodically, the solution must be desludged to remove the paint contaminants. The spent solution requires neutralization and solids separation with proper disposal.

Cold strippers are generally organic solvents or acid activated solutions used at room temperature.[3,4,5] Cold strippers break the bond between the metal and paint, thus causing the dislodged paint to settle on the bottom of the tank. Paint solids must be screened out periodically to prevent over-contamination of the tank. Cold strippers are subject to evaporation loss which can be controlled by a water or wax seal; however, periodic fresh additions are required to make up losses due to evaporation and carry-over.

Chemical requirements for hot and cold strippers are high; yearly cost is estimated to be $65,000–70,000. Proper ventilation and careful handling are required to insure acceptable health safety. Spent solutions require proper disposal methods.

Stripping effectiveness of hot and cold strippers depends on the particular solution used and on the type of paint finish; pilot test results indicated that stripping

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Presented at the American Chemical Society Annual Meeting, Sept. 10–15, 1978, in Miami, Fla.

*Clyde Div., 119 Birdseye St., Clyde, Ohio 43410.

Table 1—Energy Information

Based on 550 Hooks/Day

Process	Energy Form	Energy Requirement Per Year	Energy Cost [a] Per Year
Molten salt bath	gas, propane [b]	15,300 X 10^6 Btu	\$30,600
Incineration	gas, propane	16,800 X 10^6 Btu	\$33,600
Burn-off	gas, propane	4,800 X 10^6 Btu	\$ 9,600
Pyrolysis	gas, propane, oil	1,920 X 10^6 Btu	\$ 3,840
Fluidized sand bed:			\$10,105
Reactor	electricity	185 X 10^3 Kwhr	
Afterburner	gas, propane	2,740 X 10^6 Btu	

(a) Energy Costs: \$2.00 10^6 Btu; \$0.025 Kwhr
(b) Molten salt bath design using electricity is available.

of some paint finishes was not adequate. The system would be time consuming and would require a three shift operation at the plant considered.

Hot and cold strippers were not given further consideration for this application. These strippers appear to be best suited for low paint stripping requirements, highly porous paint types, and in-line systems.

Mechanical Abrasion

Methods of mechanical abrasion include sand blast, steel shot blast, water blast, and an abrasive wheel.[1,6] A suitable system to meet the stripping requirements was not found.

Incineration

Incineration thermally oxidizes the paint organics to intermediate organic products at an operating temperature of 480–510° C. Air is circulated through the incinerator to provide an oxidizing environment and to help control the temperature during combustion. Since intermediate organic products are generated during incineration, an afterburner operating at a temperature of 790–815° C is required for air pollution control.

A batch of 50 racks is loaded on a skid, placed in the incinerator, and processed for 30 min per load. It is common to add scrap cardboard or wooden pallets to the incinerator load to increase the potential for ignition and to decrease the stripping cycle time. Following incineration, a high pressure rinse is required for removal of the inorganic residue. This would be a single shift operation for the plant used as a basis.

Table 2—Summary of Processes Evaluation Based on 550 Hooks/Day

Process	Effectiveness	Operating Time Hrs/Week	Energy Cost Per Year	Chemical Cost Per Year	Maintenance Cost Per Year
Hot stripper	Not acceptable for some paint types	120	Unknown	\$65,000- \$70,000	\$5,000
Cold stripper	Not acceptable for some paint types	120	—	\$70,000	\$5,000
Molten salt bath	Acceptable	40	\$30,576	\$50,000- \$70,000	\$2,000
Incineration	Acceptable	40	\$34,000	—	\$3,000
Paint burn-off	Acceptable	25	\$9,600	—	\$2,500
Pyrolysis	Acceptable	40	\$3,840	—	\$6,000
Fluidized sand bed (one reactor)	Acceptable	95	\$10,092	—	\$8,000

Process	Residue Removal	Air Pollution	Water Pollution	Solid Disposal	Health	Safety
Hot Stripper	High pressure rinse	Organic gases	Tank dump Rinse water	Paint solids	Vapors	Chemicals can be harmful
Cold stripper	High pressure rinse	Organic gases	Tank dump Rinse water	Paint solids	Vapors	Chemicals can be harmful
Molten salt bath	Rinse	Particulates organic gases	Rinse water	Bath sludge	Unknown	Salt overflow Fires
Incineration	High pressure rinse	Controlled in afterburner	Rinse water	Rinse water solids	Acceptable	Acceptable
Paint burn-off	High pressure rinse	Controlled at source	Rinse water	Rinse water solids	Acceptable	Intense heat Paint sparks
Pyrolysis	High pressure rinse	Controlled in rich fume reactor	Rinse water	Rinse water solids	Acceptable	Acceptable
Fluidized sand bed	High pressure rinse	Controlled in afterburner	Rinse water	Rinse water solids	Acceptable	Acceptable

The incinerator and afterburner use gas or propane as an energy source and the total energy usage is an average of 7×10^6 Btu per hour. The peak gas demand in the incinerator occurs during the rack flaming period of the cycle when it is necessary to supply additional air to maintain the temperature range and oxygen supply. In addition to paint stripping, this system may also be used to destroy organic plant wastes, such as waste oils, solvents, and paint sludge. There are no apparent adverse health or safety factors associated with this process.

Paint Burn-Off

A paint burn-off unit actually ignites the paint and rapidly burns the organic material at an operating temperature of 540–650° C.[7] A conveyor carries the racks through the burn-off unit and a high pressure rinse which is required to remove the inorganic residue. As the racks pass through the burn-off unit, a high temperature flue gas at a high velocity from a restricted ceramic nozzle is directed toward the racks to ignite the paint. Complete combustion must take place within the unit to insure acceptable paint stripping and suitable air pollution control at the source. With the proper line speed and operating temperature, complete combustion should take place within the unit; even so, some unit designs include an afterburner to prevent air pollution. To insure safety, the system must be designed to confine the intense heat and burning paint.

The line speed for this application would be 0.6 meter per min and the racks are placed continuously 0.3 meter apart. This would be a single shift operation.

Gas or propane are the energy sources. The energy capacity of the unit is rated at 7.0×10^6 Btu per hour; however, the unit modulates to control the temperature and the actual gas consumption rate is estimated to be 4.0×10^6 Btu per hour.

Periodic replacement of filters must be included in the maintenance costs. The air filters should be replaced weekly and absolute filters are replaced twice a year.

Pyrolysis

In the pyrolysis process, the paint hydrocarbons are volatilized to produce fumes rich in organic compounds at an operating temperature of 470–500° C in the absence of oxygen. The high organic fume is burned in an oxidizing reactor at a temperature of 790–870° C and a retention time of 0.5 sec to insure 99% hydrocarbon conversion. The organic fume is a significant energy source for the reactor. A batch of 75–100 racks is loaded in a basket and two baskets are placed in the pyrolysis unit for a two hour cycle. This would be a single shift operation. Following pyrolysis, an inorganic residue remains on the racks and a high pressure rinse is required.

The energy source for the pyrolysis unit and rich fume reactor is gas, propane, or oil. The pyrolysis unit requires peak energy consumption in the beginning of the cycle to obtain the operating temperature, and less energy to maintain the temperature. The rich fume reactor requires peak energy usage to obtain the operating temperature; then the organic fume supplies the energy source and, at the end of the cycle, auxiliary fuel is required as the organic fume decreases. The energy usage per two hour cycle is calculated to be 2.0×10^6 Btu for this application.

The pyrolysis unit appears to be a versatile system that can have additional applications for the degradation of organic material. It has been suggested that it can be used for disposal of waste paint sludge, waste oils, and solvents.

Fluidized Sand Bed

In a fluidized sand bed, paint organics are thermally degraded to intermediate organic products by a combination of pyrolysis and partial oxidation at a temperature of 480–510° C.[8,9] To maintain a fluidized state, a low air flow suspends the aluminum oxide media which transfers heat from the heat source to the racks. An afterburner at an operating temperature of 790–870° C is required to oxidize the intermediate organic products to carbon dioxide and water.

Approximately 25 racks are loaded in a basket and submerged in the heated fluidized sand bed reactor for a 40 min cycle time. For the application discussed, 22 cycles are required per day. This would be a three shift operation. A high pressurized rinse is required to remove the inorganic residue remaining on the hooks.

The energy source for the sand bed reactor is electricity, and, for the afterburner, it is gas or propane. The system can be shut off when not in use, and the sand bed reactor would require about 2.5 hr to warm up after a weekend. To maintain the temperature in the sand bed reactor, an hourly average of 35 kilowatts is required and the afterburner requires 0.6×10^6 Btu per hour.

It may be feasible to use the fluidized sand bed reactor for disposal of organic plant wastes. Pilot tests would be required for the individual installation.

There is some loss of media due to carry-over during the transportation of racks to the rinse unit. Replacement costs of 10% of the media yearly should be included in the maintenance costs.

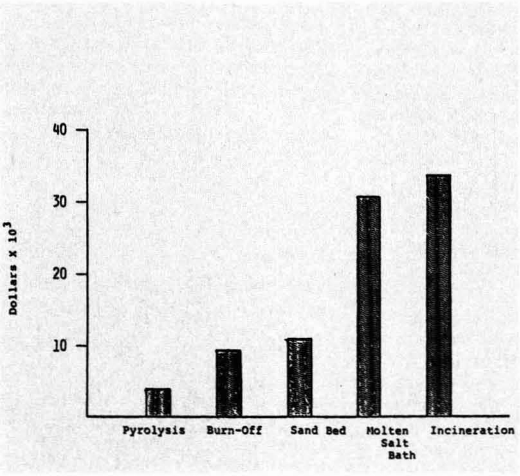

Figure 1—Yearly energy costs (550 hooks per day)

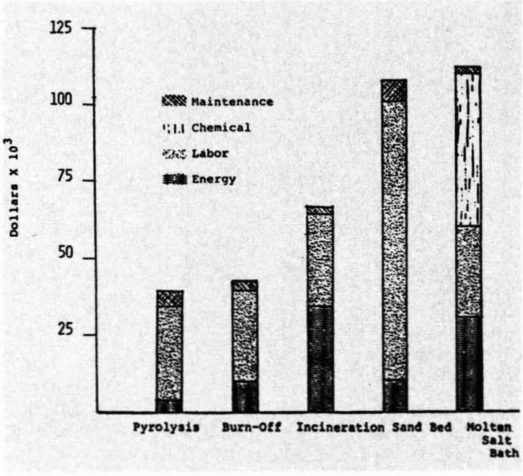

Figure 2—Yearly operational costs (550 hooks per day)

Energy Considerations

The energy forms, requirements, and costs are important considerations in the evaluation of the alternate paint stripping methods for future application. *Table* 1 presents the energy information for the feasible methods.

The energy requirements for the molten salt bath and incineration processes are relatively high, the paint burn-off and fluidized sand bed requirements are moderately low, while the pyrolysis requirement is relatively low. In selecting a suitable paint stripping method for future applications, the future relative availability of the energy forms must be evaluated for the individual location. Paint burn-off requires gas or propane, while pyrolysis can use gas, propane, or fuel oil. The sand bed reactor is electric and this may be attractive for some locations, as long as gas or propane is available for the afterburner. Feasibility of heat recovery should be evaluated for the individual application as a potential of reducing energy costs and conserving energy.

Energy costs can significantly affect the total operational costs. *Figure* 1 is a bar diagram that illustrates the relative energy costs for the feasible processes. *Figure* 2 demonstrates the importance of energy considerations relative to other operational costs. This figure also demonstrates the high labor requirements for the fluidized sand bed process and the high chemical requirements of the molten salt bath system.

Summary

Paint stripping methods reviewed in this paper are molten salt bath, hot strippers, mechanical abrasion, incineration, paint burn-off, pyrolysis and fluidized sand bed. The evaluation is based on 550 racks stripped per day at a large appliance manufacturing facility. The factors considered are stripping effectiveness, operating time, chemical requirements, energy requirements and associated environmental, health and safety factors. *Table* 2 summarizes the factors discussed in this report.

Results indicate that the paint burn-off, pyrolysis, and fluidized sand bed systems are acceptable for replacement of the molten salt bath at the appliance manufacturing facility.

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(7) *Product Finishing*, No. 2, 68 (1976).

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Society Meetings

Birmingham — Jan. 10

W.D. Jones and Dr. D. Price spoke on "COAL—THE FEEDSTOCK FOR THE CHEMICAL INDUSTRY."

In this presentation, Mr. Jones explained that coal could be expected to replace other energy sources in the future. Describing the variable compositions of coal, he reported that the average composition showed it to be a highly condensed carbon ring structure with a small amount of paraffinic hydrocarbon, a paucity of hydrogen, pherolic oxygen, and ring structure nitrogen. He continued with a discussion of the various processes involved with liquifying coal.

Mr. Jones indicated that the point where the liquification of coal is more economical than refining oil is rapidly approaching. Complete degradation of coal could give a wide range of chemicals, he stated. For example, the synthesis process gives aliphatic hydrocarbons and alcohols; and the synthol synthesis at low pressure gives gasoline. Mr. Jones concluded by saying that it is possible to make most chemicals from coal, but the present economics of the situation is questionable.

Dr. Price contributed to the presentation with his answers to members' questions.

Q. How are we going to mine the amount of coal required?

A. By newer techniques of strip mining.

Q. What about other routes, such as from sugar cane?

A. The alcohol route from biodegradation of vegetable matter, such as sugar cane, is a practical proposition. After all, this vegetable matter is the forerunner of fossil fuels.

B.J. ADDENBROOKE, *Secretary*

Chicago — Jan. 7

John Vandeberg, of DeSoto, Inc., spoke on the Society project, the publication of "AN INFRARED SPECTROSCOPY ATLAS FOR THE COATINGS INDUSTRY."

J. Richard Mathieson, of Dow Chemical Co., gave a presentation on "MOTIVATING PRODUCTION PERSONNEL."

J.L. PETTY, *Secretary*

Golden Gate — Nov. 19

Frank Zurlo, of Byk-Mallinckrodt, discussed "THE USE OF THE DYNOMETER."

Mr. Zurlo described the dynometer as a sedimentation analysis instrument which allows a paint or ink company to determine settling characteristics of the coatings system in process immediately after production.

Mr. Zurlo concluded by stating that the dynometer can be used as a formulating tool to determine optimum levels of wetting and suspending agents to achieve desired anti-settling characteristics.

DON MAZZONE, *Secretary*

Golden Gate — Jan. 14

President Ted Favata presented Ken Probst with a Past-President's pin, in appreciation for his service to the Society.

Barry Adler, Chairman of the Scholarship Committee, reported that three scholarships of either $500 or $650 will be awarded to entry college level students, or students graduating in June 1980. Students who intend to major in subjects pertaining to the paint industry will be eligible for the awards.

William J. Stewart, of Tenneco Chemicals, Inc., spoke on "LATEX PAINT SPOILAGE AND PLANT HOUSEKEEPING."

Mr. Stewart discussed the difference between bacteria and enzymes. He also emphasized the need for meticulous housekeeping with the factory in order to prevent contamination of finished paint products. Failure to take the proper precautions within the factory and to keep the levels of preservative at an acceptable level can cause degrading of the cellulosic thickener, which ultimately will cause viscosity loss, gassing, and paint spoilage, he warned.

Through a slide presentation, several examples of areas within the factory which can be sources of contamination were shown. Dirty transfer pipes and tanks, old hoses, and accumulated pigment dust on dispersion bridges and around dispersion tubs were just a few of the examples cited.

Mr. Stewart pointed out that, when it becomes evident that there is a bacteria contamination problem, the immediate action to be taken is to get professional help from one of the many companies that are in the preservative business.

DON L. MAZZONE, *Secretary*

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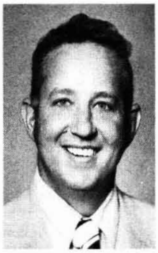


JAMES A. McCORMICK

Finance

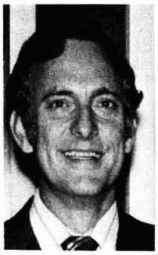
Nominating

most recently served as the 1978-1979 President of the Federation. Mr. McCormick has served as Treasurer of the Baltimore Society, and was Host Chairman of the Federation's 1976 Annual Meeting. He is also a Past-President of the Baltimore Coatings Association. A member of the Federation's Board of Directors, Mr. McCormick is a Past-Chairman of its Public Relations Committee. He is Vice-President of Inland Leidy.

WILLIAM F. HOLMES

Membership

is Technical Director of DeSoto, Inc., in Garland Texas. After graduating from Texas Tech with a Degree in Chemical Engineering, he was employed by E.I. du Pont de Nemours & Co. At DeSoto, Mr. Holmes has filled a variety of positions in engineering, quality control, production, and laboratory capacities. Formerly a Representative of the Dallas Society, he has been a member of the Federation Board of Directors for the past three years.



HERBERT L. FENBURR

Investment

retired in 1976 after more than 38 years of service with Hanna Chemical Coatings Co. A Past-President of the Federation (1967–68), his previous Federation activities include Chairmanship of the Program and Meetings Committees. In addition to serving as Past-President and Council Representative of the C-D-I-C Society, Dr. Fenburr is a Past-President of the Paint Research Institute. Currently a Trustee of the PRI, he is serving his second term as Chairman of this committee.

THOMAS GINSBERG

Delegate

National Association of Corrosion Engineers

is a Project Leader at the Bound Brook Technical Center of the Union Carbide Corp. His undergraduate and graduate studies were performed at the University of Buenos Aires, Argentina. Mr. Ginsberg, the author of several patents and publications, has been associated with the paint industry in a variety of assignments covering the spectrum of coatings technology. He is a member of the New York Society, the National Association of Corrosion Engineers, and the Scientific Research Society of America.

PERCY E. PIERCE

Delegate

International Union of Pure and Applied Chemistry

is Manager of Physical/Analytical Research at PPG Industries, Inc., Coatings and Resins Div. in Allison Park, Pa. He received a B.S. Degree in Chemistry from Case Institute of Technology and the M.S. and Ph.D. Degrees from Yale University. Dr. Pierce was Assistant Professor of Chemistry at Case from 1958-63. From 1963-69, he was engaged in fundamental research at the Glidden-Durkee Div., SCM Corp. In 1969, Dr. Pierce joined PPG Industries to conduct research on the physical chemistry of organic coatings.

COMMITTEE CHAIRMEN

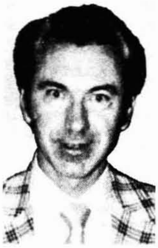
HELEN SKOWRONSKA

Technical Information Systems

received the B.A. Degree in Chemistry, the M.S. Degree in Biochemistry, and the B.S. Degree in Library Science from Case-Western Reserve University in Cleveland, Ohio. Miss Skowronska was employed as Technical Librarian at Sherwin-Williams Co. from 1952–79. A Past-President of the Cleveland Society, she has served on the Technical Information Systems Committee since 1971. Miss Skowronska is also a member of the Editorial Review Board of the JOURNAL OF COATINGS TECHNOLOGY.

COLIN D. PENNY

Technical Advisory



is a Past-President of the Baltimore Society. While attending Bristol College of Technology, he began work as a Laboratory Technician. In 1956, Mr. Penny was employed as a Paint Chemist for the Toronto Laboratories of Canadian Industries Ltd. After two years, he joined W.J. Lynch Co. of Rhode Island as a Chief Chemist. Mr. Penny continued in this position at the American Paint Co. of Washington, D.C., where he was employed for eight years. In 1969, he became the founder and co-owner of Columbia Coatings Co., in Maryland. Mr. Penny presently serves as President of Hampton Paint Mfg. Co., Inc., Hampton, Va., a position held since 1973.

JOHN A. GORDON, JR

Educational

is Director of Paint Short Courses at the University of Missouri-Rolla. Mr. Gordon was formerly employed as Manager of Polymer Technical Services, AMSCO Div., of Union Oil Co. He received the B.A. Degree in Chemistry from San Diego State College in 1936. Past-President of the Los Angeles Society, he has served as Chairman of its Environmental Control, Program, Membership, and Publicity Committees. In addition, Mr. Gordon has served on the Federation's Finance, Environmental Control, and Program Committees. He is currently a member of the Publication Committee.

THEODORE PROVDER

Delegate National Paint and Coatings Association Scientific Committee

is Senior Scientist of the Polymer Research and Computer Science Group of the Polymer and Coatings Research Dept., Glidden Coatings and Resins Div., of the SCM Corp. He received his B.S. Degree in Chemistry from the University of Miami, Fla. in 1961 and the Ph.D. Degree in Physical Chemistry from the University of Wisconsin in 1965. A Fellow of the American Institute of Chemists, Dr. Provder is a member of the Cleveland Society. His Society activities have included participating as a member of the Education and Program Committees and serving as Chairman of the Planning Committee. Dr. Provder has also served as a member of the Federation's Technical Advisory Committee.

Los Angeles Jan. 9

William J. Stewart, of Tenneco Chemicals, Inc., spoke on "THE MANUFACTURING OF WATER-BASED COATINGS."

Mr. Stewart warned of problems which may be encountered when water-based coatings are manufactured. Without proper protection from bacteria, yeasts, and fungi, for example, paint spoilage will occur.

In his presentation, Mr. Stewart focused on the most common problem, bacteria. He explained that when mercury was available for use, it was general in its application; therefore, spoilage was not difficult to combat. However, the organics used today are more complex, because they are more specific. In addition to problems which result from the loss of viscosity, gas formation is also noted. This is usually caused when marginal control is achieved due to inadequate levels of preservative, he said. Mr. Stewart stated that the correct level of preservative should be maintained, because problems caused by burst cans, ruined carpets, etc., far outweigh the small cost savings of lower levels.

Mr. Stewart noted that some thickeners are more resistant to bacteria than others, but all still need a preservative. In addition, bacteria must be destroyed before it produces enzymes. These enzymes can be detected by taking some of the paint which may be spoiled and adding thickener solution. If, after standing overnight in a warm place, the viscosity is water-thin, enzymes are present.

Mr. Stewart suggested some practices for combating bacteria, such as maintaining a clean plant, using industrial vacuums for dust control, and ensuring that equipment is washed and dried carefully. Disinfectants, such as formaldehyde and ammonia, help in the sterilization process. Also, high pressure nozzles effectively clean equipment while using a minimum of water.

ROMER JOHNSON, *Secretary*

Montreal Jan. 6

Robert Rauch, of Tioxide of Canada Ltd., and Joe Fiocco, of Canadian Titanium Pigments Ltd., spoke on "TiO_2 GRADE RATIONALIZATION."

Mr. Rauch discussed the basic behavior differences between a flat grade TiO_2 (83%) and an enamel grade TiO_2 (95% TiO_2). He related the findings of studies which were performed on latex paints containing three pigments: TiO_2, clay, and $CaCO_3$. Thirteen paints were made with different pigmentation, with total volume fraction always adding up to one. The different pigment ratios were obtained by a statistical method, he said. These paints were then evaluated for contrast ratio, porosity, and scrubability and the theoretical CPVC was calculated.

The conclusions related by Mr. Rauch were that, at similar PVC/CPVC ratio and equal cost, enamel grades offer superior opacity, but less film integrity. He also pointed out that good porosity results are only attainable with enamel grades. Mr. Rauch concluded by reporting that, with scrubability used to define film integrity, high dry hide TiO_2 can offer substantial savings.

Mr. Fiocco continued the presentation with an explanation of the practical approach to formulate away from flat enamel grades using an enamel grade pigment. He defined the concepts of PVC (pigment volume concentration), CPVC (critical pigment volume concentration), and EPVC (effective pigment volume concentration).

According to Mr. Fiocco, the practical approach was to prepare the standard latex paint containing the flat grade TiO_2 and two paints with the enamel grade. One of these paints was prepared at the same PVC, but with slightly lower TiO_2 content, to compensate for the difference in the TiO_2 content of the two pigments; the second enamel grade paint was formulated at a higher PVC. The differences in volume were compensated by fine particle size clay to maintain the EPVC, he continued. Consequently, the two enamel grade latex paints were blended to equal performance in tinting strength.

Mr. Fiocco illustrated his findings with slides showing that the obtained match with the enamel grade pigment exhibited very similar properties to that of the latex paint containing the flat grade TiO_2. The properties evaluated were opacity, tinting strength, scrub, and porosity, he reported.

Q. Your study did not show cost comparisons. Do you feel that cost saving can be obtained when switching from a flat grade to an enamel grade?

A. Yes, cost savings can be obtained and they are generally four to five cents a gallon, but could be as high as 25 cents a gallon depending on the formulation.

R.H. KUHNEN, *Secretary*

Officers of the New England Society for the year 1979–1980. Left to right: Vice-President—Gil Sullivan, of Independent Packaging; Secretary—John E. Fitzwater, of Polyvinyl Chemical Ind.; President—George Mulvey, of M & M Paint Manufacturing Co.; Society Representative—Charles Aronson, of Beacon Paint Works; and Treasurer—Robert G. Modrak, of Benjamin Moore & Co.

New York Nov. 13

Al Heitkamp, of Cargill Research Dept., spoke on "FORMULATION AND APPLICATION OF INDUSTRIAL LOW-SOLVENT SYSTEMS FOR THE 1980's."

Mr. Heitkamp reported that, in water-reducible coatings, the preferred cross-linkers are methylated melamines since methylated ureas do not react with the carboxyl groups on the backbone polymers. He stated that the preferred amine for air-dry coatings is ammonia; for force-dry coatings, triethyl amine is recommended; and the preferred amine for baking coatings is dimethyl ethanolamine or 2-AMP. The pH should be adjusted to 8.0–8.5 and maintained at this level by adjustment as required, he said.

According to Mr. Heitkamp, viscosity dilution curves show that, as some water-reducible systems are thinned with water, they pass through a colloidal state in which the viscosity can level off, or even increase on further dilution.

For the selection of pigments, he suggested employing those without surface treatment, or those which are not alkali sensitive. He also recommended selecting synthetic grades, as opposed to natural grades; selecting anti-corrosive pigments with the lowest possible water solubility; and avoiding extenders high in salt or in impurities.

Mr. Heitkamp related that the formulation for high solids systems is relatively simple. Blocked acid catalysts can be included in one-package systems. For good sprayability, experiments indicate that coatings must be reduced to a surface tension specification rather than one for viscosity, he said. The surface tension should be reduced below 36–38 dynes/cm.

DON BRODY, *Secretary*

New York Jan. 8

Ruth K. Harmon-Stangs, of Drew Chemical Corp., spoke on "FOAM FORMATION."

Aided by a film on the causes and mechanisms of foam formation, Mrs. Harmon-Stangs discussed the three generic types of defoamers currently used in latex paints and water-borne coatings, silica, silicone, and organic. She presented test results of various defoamer types in latex and water-borne systems.

Q. The approaches to foam control you have presented seem to be largely trial-and-error. Can you give us any scientific principles to follow?

A. No, because your industry's approach to formulation is not consistently based on physical principles such as measurements of surface tension, interfacial tension, etc. If it was, we could, perhaps, develop some scientific guidelines.

DON BRODY, *Secretary*

Philadelphia Jan. 10

During a joint meeting with the Philadelphia PCA, Robert Hallenbeck, of the Manufacturers Association of the Delaware Valley, spoke on "PRODUCT LIABILITY AND THE DANGERS FACING COATINGS PRODUCERS."

MATTHEW J. HANRAHAN, *Secretary*

Western New York Jan. 10

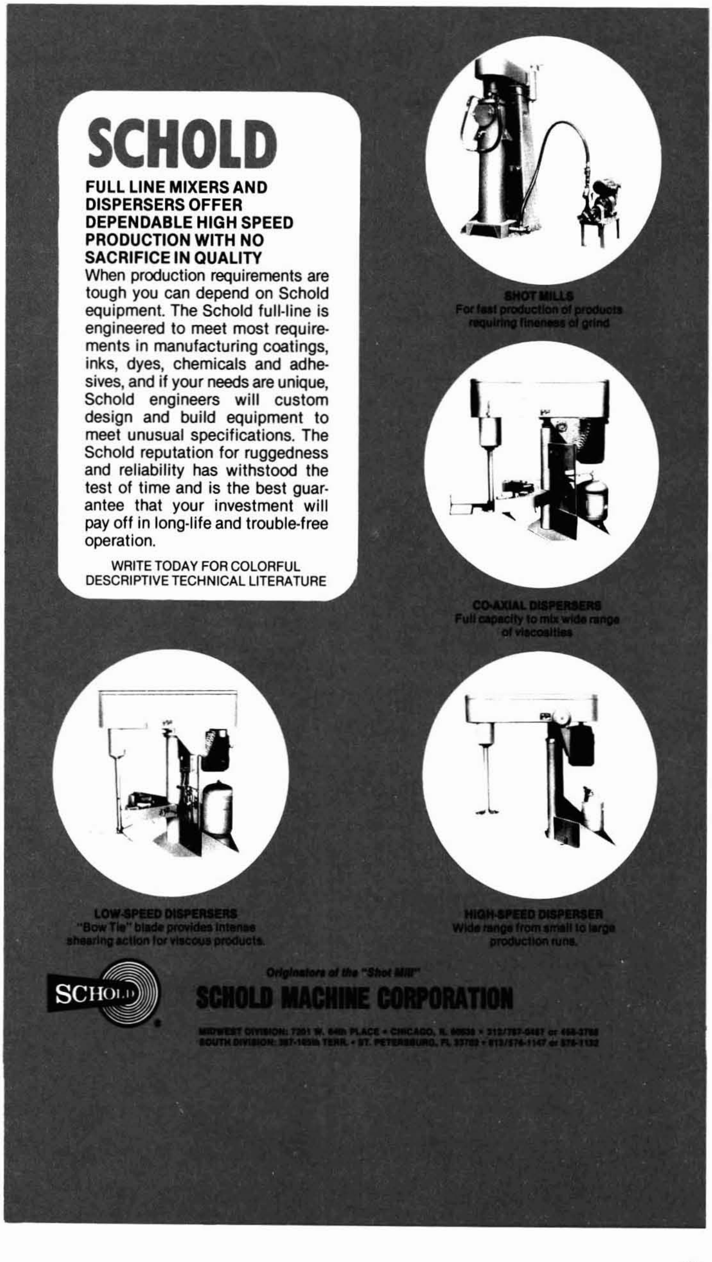
Paul McCurdy, of Reichhold Chemicals Corp., spoke on "THE USE OF CONVERSION ENAMELS AS ENERGY SAVERS."

Mr. McCurdy stated that the primary goal of conversion enamels is to achieve the properties of a system baked at 300° F with a bake temperature of only 175°–200° F. Generally, catalysts of the phosphoric or sulfonic type are used to increase cure response at low bake temperatures, he said. Of the sulfonics, paratoluene sulfonic acid gives the best cure response, but causes a drop in package stability.

Pigmentation has varying effects, but generally, will suppress cure speed, he reported. This can be partially overcome by higher catalyst levels, but it may result in a gloss drop.

Mr. McCurdy mentioned organic titanates and a proprietary catalyst as being useful. The organic titanate had to be ground in with the pigments and was found to be ineffective with melamines, he explained.

JAY A. ROBEY, *Secretary*



Future Society Meetings

Baltimore

(Apr. 17)—Educational Committee program

(May 15)—Technical Steering Committee program on "Water-Borne Coatings"

Birmingham

(Apr. 3)—"Purchasing in the Paint Industry"—D.F. Brocklehurst, of Berger Chemicals Ltd.

(May 1)—"Confessions of a Small Paint Manufacturer"—D. Penrice, of Newtown Industrial Finishes Ltd.

Chicago

(April 7)—Society Technical Committee Program; and "Evaporation Behavior of Organic Co-Solvents in Water-Borne Coatings"—R. F. Eaton, of Union Carbide Corp.

C-D-I-C

(Apr. 14)—"New Concepts in the Formulation of Glass Latex Coatings"—John Bax, of Pacific Scott Bader, Inc.

(May 12)—"Miscibility Characteristics of Solvent/Water Mixtures"—Larry Culver, of Eastman Chemical Co.

Cleveland

(April 15)—Plant Tour—Davies Can Co.

(May 20)—"Painting and Decorating from the Female Point of View"—Spouses' Night.

Detroit

(Apr. 22)—"Defoaming Agents"—Eileen E. Reich, of Air Products and Chemicals, Inc.

Louisville

(Apr. 16)—FSCT Slide Presentation—Federation Officers.

Montreal

(Apr. 2)—Speaker to be announced.

(May 7)—"Government Specifications in the Paint Industry"—Joe Roberge, of B.N.Q., and Frank Eadie, of C.G.S.B.

Pittsburgh

(Apr. 7)—"Nonlead Pigments for Corrosion Control"—Clive Hair, of Clive Hair, Inc.

(May 5)—"Symposium on Government and Coatings" (one-half day programs).

(June 2)—"Consumerism"—Jean Fox.

Elections

PHILADELPHIA

Active

Hebler, John—Stonhard Inc., Maple Shade, N.J.

Lalas, Jose P.—Rohm and Haas Co., Philadelphia, Pa.

Ruenzle, Richard J.—Nordson Corp., Norristown, Pa.

Sims, Victor A.—Air Products & Chemical Co., Marcus Hook, Pa.

Stump, David—M. A. Bruder & Sons, Inc., Philadelphia.

Associate

Farr, John D.—Emery Industries Inc., Clifton, N.J.

Frearson, David B.—Rohm and Haas Co., Bristol, Pa.

Rumsey, Robert C.—Hunter Lab., Runnermede, N.J.

ROCKY MOUNTAIN

Active

Carnes, Ginney—J. D. Mullen Co., Denver, Colo.

Gillen, Frank T.—Colorado Paint Co., Denver, Colo.

Hansen, Craig R.—George C. Brandt Co., Denver.

Hauser, Ray L.—Hauser Laboratories, Boulder, Colo.

Lewandowski, Lawrence—J. D. Mullen Co., Denver.

Meyer, Duane E.—Wyoming State Highway, Cheyenne, WY

Neill, Vernon W.—Independent Petro, Englewood, Colo.

Ortego, Louis—Wellborn Paint Co., Albuquerque, NM

Peterson Dale A.—Loveland Ind. Inc., Loveland, Colo.

Summons, Wayne L.—Sashco Inc., Denver.

Trousil, Edward G.—Komac Paint Co., Denver.

Umbreit, Gerhard C.—Kwal Paints, Denver.

Vonder Haar, Ron—Industrial Chemicals Corporation, Lakewood, Colo.

Wiruth, John P.—Komac Paint Co., Denver.

Associate

Archer, Carl D.—Glidden Durkee Pigments, Bedford, Tex.

Hamilton, Edward L.—Hilton-Davis, Artesia, Calif.

Johnson, Ron—McCloskey Varnish Co., Los Angeles, Calif.

King, Cham J.—Dresser Minerals, Houston, Tex.

Scott, James P.—NL Industries, Inc., Newport Beach, Calif.

FSCT Scholarship Program

To meet the demand for more technically trained people in the coatings industry, the Federation is continuing its scholarship program, with funds made available to various universities in the U.S.

These funds are to be used as grants-in-aid for students in the coatings technology program at each institution, with preference given to qualified scholarship applicants who are children of members of the Federation.

Members who have children wishing to make application for the 1980–81 academic year should contact Federation headquarters. Deadline for receipt of applications is April 1, 1980. Write Scholarship Fund, Federation of Societies for Coatings Technology, 1315 Walnut St., Suite 830, Philadelphia, Pa. 19107.

Technical Articles in Other Publications

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

Pigment and Resin Technology

Published by Sawell Publications, Ltd., 127 Stanstead Rd.
London SE23 1J2 England

Vol. 8 No. 1 January 1979

Bennett, R.R.—"Nitropropane as an Aid to Solvent Balance Control"; 5-9.

Uerdingen, W.—"Low Solvent Two-Pack Polyurethane Coatings"; 10-13 (Originally published in Farbe und Lack, July 1976)

Anon.—"Coatings Update—Coating Film Studies (Literature review)"; 15-18.

Vol. 8 No. 2 February 1979

Smith, C.A.—"Commercial Printing Ink Pigmentation. Pt. I"; 5-8.

Lombardo, F.—"Investments and Outlooks for Titanium Dioxide"; 9-12. (Synopsis of report presented at First European Meeting on Inorganic Pigments & Metallic Oxides, September 1978).

Anon.—"Coatings Update—New Raw Materials (Literature review)"; 13-16.

Vol. 8 No. 3 March 1979

Vinaik, J.K., Chandra, S., and Vasishtha, A.K.—"Polycarbonate Modified Alkyds"; 5-9.

Smith, C.A.—"Commercial Printing Ink Pigmentation. Pt. II"; 10-14.

Vol. 8 No. 4 April 1979

Keith, G.—"Acrylic Coatings for Wood"; 4-9, 17.

Anon.—"Coatings Update—A Look at the Future (Literature review)"; 10-12.

Smith, C.A.—"Commercial Printing Ink Pigmentation. Pt. III"; 13-17.

Vol. 8 No. 5 May 1979

Anon.—"Coatings Update—New Proprietary Products (Literature review)"; 4-8.

Pasari, S. and Chandra, S.—"Polyblends of Polystyrene Glycol and Alkyd in Surface Coatings"; 12-15.

Vol. 8 No. 6 June 1979

Rigby, J.A.—"Thermal Fluid Heating Systems for Resin Plants"; 4-6.

Anon.—"Coatings Update—New Proprietary Products, Part II (Literature review)"; 7-12.

Pasari, S. and Chandra, S.—"Studies on Blends of Polystyrene Glycol and Alkyds in Surface Coatings"; 15-18, 24.

Vol. 8 No. 7 July 1979

Haagenson, K.A. and Ross, R.T.—"Modified Barium Metaborate: a Non-lead, Non-chromate Corrosion Inhibitor for Alkyd Paints"; 5-13.

Anon.—"Coatings Update—Recent Studies on Corrosion and Adhesion (Literature review)"; 14-17.

Kresse, P.—"Influence of Inert Pigments on Anti-corrosive Properties of Paint Films. Pt. I"; 18-22.

Vol. 8 No. 8 August 1979

Engelhardt, R.R.—"Water Reducible Industrial Coatings"; 5-11, 15.

Anon.—"Coatings Update—Reviews on Water-Borne Coatings (Literature review)"; 16-17.

Vol. 8 No. 9 September 1979

Todd, D.B.—"Energy Control in Twin Screw Polymer Compounding Extruders"; 4-7.

Ellis, R.A.—"Review of Gel Permeation Chromatography. Pt. I"; 10-14.

Kresse, P.—"Influence of Inert Pigments on Anti-corrosive Properties of Paint Films. Part II"; 15-20.

Vol. 8 No. 10 October 1979

Ellis, R.A.—"Review of Gel Permeation Chromatography. Part II"; 4-8.

Anon.—"Coatings Update—Scientific Studies (Literature review)"; 9-15.

Smith, C.A.—"Aluminum Flake Pigment, Part I"; 17-20.

Please consult the *Union List of Series* or *New Series* at your nearest public or college/university library for the location of listed periodicals in American libraries.

WPTG to Hold 20th Symposium April 14–15

The 20th annual symposium of the Washington Paint Technical Group, to be held at the Marriott Twin Bridges Motel in Washington, D.C., April 14–15, will feature as its theme, "New Coatings Technology for the 80's."

The Keynote Address, "Fundamental Scientific Concepts to Meet the Challenges of Low Emission," will be delivered by Dr. Zeno W. Wicks, Jr., Chairman of the Polymers and Coatings Dept. of North Dakota State University, Fargo, N.D.

The program also includes the following presentations:

"Cathodic Electrodeposition"—Dr. Marco Wismer, of PPG Industries, Inc.

"Underwater Application of Coatings"—Dr. Richard Drisko, of Civil Engineering Laboratory.

"Formulation and Application of Water-Borne and High Solids Industrial Coatings"—Al Heitkamp, of Cargill, Inc.

"Use of Glycoluril Crosslinking Agents in Coatings"—Werner J. Blank, of American Cyanamid Corp.

"Navy Developments in Smooth Hull Coating Systems for Improved Ship Performance"—Herman S. Preiser, of David Thomas Naval Ship R&D Center.

"Fundamental Concepts of High Solids Latexes"—Dr. Kenneth L. Hoy, of Union Carbide Corp.

"Intumescent Coatings"—David Pulley, of Naval Air Development Center.

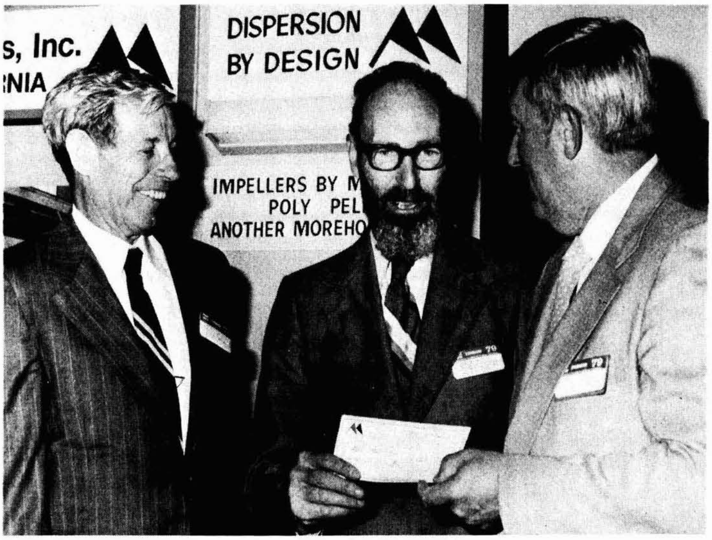
"Nitrocellulose Coatings with Chlorinated Solvents"—Charles M. Winchester, of Hercules, Inc.

"Weathering of Organic Coatings"—Richard M. Holsworth, of Glidden Div. of SCM Corp.

"High Solids Two-Component Urethanes"—Ken Yonek, of Mobay Chemical Corp.

"Water-Borne Acrylic Coatings for Wood"—Dr. Milton Lapkin, of Polyvinyl Chemical Industries Div.

For additional information, registration forms, and programs, please contact WPTG, Box 12025, Washington, D.C. 20005; or telephone Mr. Maurice S. Moen, (301) 779-5766.



Roland E. Swett (right), Vice President/General Manager of Morehouse Industries, Inc., presents first $1,000 Annual Morehouse Scholarship check to Zeno W. Wicks, Jr., Chairman/Polymers & Coatings Dept., North Dakota State University with Hugh F. Purcell (left), Vice President Applications & Technical Services of Morehouse Industries adding congratulations. The Morehouse Scholarship (in honor of George E. Missbach, Sr. to advance the study of pigment dispersion) will be awarded annually to a student majoring in chemistry, to be chosen by the Dept. of Chemistry, North Dakota State University

Committee Named for West Coast Symposium and Show

The Los Angeles Society, host organization, has announced the members of the Symposium Committee for the 15th Biennial Western Coatings Societies Symposium and Show at the Disneyland Hotel & Convention Center, Anaheim, Calif., March 4-6, 1981.

Heading the list as General Chairman is Tony Rumfola, of TCR Industries. The Co-Chairman is Don Jordan, of Cargill, Inc.

Subcommittee Chairmen are:

Exhibits: W.A. Addington, of Universal Paint Co.

Publicity: Andrew R. Ellis, of Pacific Air Chemicals.

Advisor: Romer Johnson, of Dorsett & Jackson, Inc.

Entertainment: Ron Johnson, of McCloskey Varnish Co.

Technical: Bob McNeill, of PPG Industries, Inc.

International: Mario Montferrand, of Given Paint Mfg. Co.

Secretary-Treasurer: Geneva Schminke, of H.M. Royal, Inc.

Registration & Housing: Richard C. Sutherland, of E.T. Horn Co.

Decontamination of Toxic Substances Is Subject of Battelle Symposium

Chemical and physical methods for the decontamination of toxic chemical substances will be discussed at a symposium April 22–24 at the Sheraton-Columbus (Ohio) Hotel. The symposium is sponsored by the U.S. Army Chemical Systems Laboratory, ARRADCOM, Aberdeen Proving Ground, Maryland.

Guest speakers will discuss the current state of the art in the decontamination of toxic chemical agents, the Army's current R&D decontamination program objectives, and various approaches to the more general problem of the cleanup of toxic materials. Workshop discussions will allow free exchange of ideas and explore avenues of possible exploitation for the Army and industry.

The symposium is being coordinated by Battelle's Columbus Laboratories. Additional information may be obtained from Phillip Wells, Battelle Columbus Laboratories, 505 King Ave., Columbus, Ohio 43201.

Rochester is Site of ISCC 49th Annual Meeting

The Inter-Society Color Council will hold its 49th annual meeting at the Genesee Plaza Holiday Inn in Rochester, N.Y., April 21-22.

Open meetings of the ISCC Project Committees will be held on April 21. Two 1-1/2 hour periods will be held at both the morning and afternoon sessions to reduce, as much as possible, conflicts resulting from simultaneous meetings.

On Monday evening the Rochester Institute of Technology will conduct a tour of the Graphic Arts Research Center and the School for American Craftsmen, which will allow participants to view the whole graphic arts process, from photography through separation and plate making, to printing and the finished product.

The program on Tuesday, April 22, will open with a symposium on "Graphic Reproduction from Theme to Finished Product," which will present the viewpoints of photographers, platemakers, publishers, and advertising agencies in the graphic arts field.

The Tuesday luncheon will feature the installation of officers for 1980-82. William D. Schaeffer will succeed Franc Grum as President. During the luncheon, the 1980 ISCC Macbeth Award will be presented to Dr. W. David Wright.

Preregistration for this event is advised. For additional information, or the registration brochure, please contact ISCC Secretary, Dr. Fred W. Billmeyer, Rensselaer Polytechnic Institute, Dept. of Chemistry, Troy, N.Y. 12181.

Topical Subjects to be Featured at Louisville Spring Symposium

The Louisville Society for Coatings Technology will hold its Spring Symposium at the Marriott Inn, Clarkesville, Ind. (about 3 miles from Louisville) on April 14 and 15.

The following presentations which address the topic, "Compliance with Government Regulations," will be made on April 14:

"Product Liability"—Thomas Graves, of National Paint and Coatings Association.

"Coping with Government Regulations"—John McGuigan, of Shell Chemical.

"New MSD Waste Water Discharge Regulations"—Thomas Herman, of Louisville and Jefferson County Metropolitan Sewer District.

"Update—Solvent Emission Control Regulations"—Robert Duzy, of Union Carbide Corp.

"Industrial Hygiene in Paint Plants"—Harold Peters, of Kentucky Dept. of Labor for OSHA.

"An Overview of TOSCA Regulations"—Ben Woodhouse, of Dow Chemical.

A reception and dinner will be held Monday evening with John Gordon, of the University of Missouri—Rolla, speaking on "What Can We Do to Survive?"

On Tuesday, April 15, the subject, "Hazardous Waste Disposal," will be discussed by the following:

"Federal Perspective on Hazardous Waste Management"—John Dickinson, of EPA—Atlanta Region.

"Historical and Political Ramifications of the Valley of the Drums"—Dan Dolan, of Dept. of Natural Resources.

"The Latest Hazardous Waste Laws and How to Comply with Them"—Thomas Roberts, of Celanese Polymer Specialties Co.

"The Chemistry of Waste Disposal"—Rodger Henson, of Chemical Waste Management.

"Siting and Maintenance of Hazardous Waste Facilities"—James Parsons, of Chemical Waste Management.

"Incineration Techniques for Disposal of Hazardous Wastes"—Charles Richmond, of Wheelabrator-Frye.

"Progress of Super Fund Bills on Congress and NPCA Comments"—Thomas Graves, of NPCA.

Registration fees for the symposium are $45 for one day, and $60 for the entire program.

For further information, please contact Miss M. Joyce Sprecht, Manager, Compliance and Analytical Dept., Porter Paint Co., 400 S. 13th St., Louisville, Ky. 40203.

NCCA Annual Meeting To be Held May 4-7

Interaction with regulatory government will dominate the program of the National Coil Coaters Association's annual meeting at the Hotel del Coronado, Coronado, Calif., May 4-7.

A major program on government affairs will highlight the business session on May 6.

Business sessions will also include presentations emphasizing working with various government groups and public relations.

Technical committee meetings are also scheduled with special workshops conducted by the aluminum, laminating and processing techniques committees.

Lehigh to Offer Symposium On Emulsion Polymers

The Emulsion Polymers Institute of Lehigh University, Bethlehem, Pa., will present a two-day symposium focusing on "Emulsion Polymerization of Vinyl Acetate" on April 10-11.

Leading scientists from industry and various universities will examine such topics as the "Mechanism and Kinetics of Vinyl Acetate Emulsion Polymerization," "Colloidal Stability of Poly Vinyl Acetate and Vinyl Acetate Copolymer Latexes," and "Surface and Morphological Properties of Poly Vinyl Acetate Copolymer Latexes and Films."

Papers in these areas of emulsion polymerization are invited. The deadline for paper submission is Dec. 15, for titles, and Feb. 15, for two-page abstracts. Papers submitted should be directed to symposium co-chairman Dr. J.W. Vanderhoff, Sinclair Lab. #7, at Lehigh.

Registration cost of $250 covers extended abstracts of the papers, as well as two luncheons. Checks payable to VAc-Symposium, Lehigh University, should accompany applications.

Further information and registration forms are available from Chairman, Dr. M.S. El-Aasser, Dept. of Chemical Engineering, Whitaker Lab. #5, Lehigh University, Bethlehem, Pa. 18015.

FSCT Educational Committee Offers Updated Coatings Courses Guide

The 1980 "Guide to Coatings Courses, Symposia, and Seminars," compiled by the Federation Educational Committee, is now available.

Based on information supplied by the Constituent Societies, the Guide lists a variety of coatings educational offerings by geographic region and Society. The Committee plans to update the listing annually to reflect current programs, curricula, etc.

To obtain free copies of the Guide, write to Educational Committee (Coatings Courses), c/o Federation of Societies for Coatings Technology, 1315 Walnut St., Suite 832, Philadelphia, Pa. 19107.

People

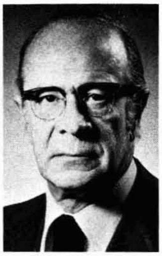
Dr. George E.F. Brewer, Coating Consultant, of Brighton, Mich. has been elected a Director-at-Large of The American Institute of Chemists for a three-year term commencing January 1, 1980. A Fellow of the Institute since 1966, Dr. Brewer received the Chemical Pioneer Award of the Institute in 1978 for his work in the development of electrodeposition of paint, and for his other accomplishments. He is also the recipient of the Midgley Medal of the Detroit Section of the American Chemical Society, as well as the Society's Doolittle Award granted by its Div. of Organic Coatings. A member of the Detroit Society, he has been honored as a Mattiello Memorial Lecturer of the Federation. Dr. Brewer previously was Staff Scientist at the Ford Motor Co., where he was involved in new procedures for the application of paints and coatings to domestic automobile bodies.

Donna L. Batdorf has been named a Sales Representative for the Pigments Div. of The Hilton-Davis Chemical Co., Cincinnati, Ohio. Ms. Batdorf will service customers in the paint, plastics, and printing ink industries in the Midwest.

Wendell D. Gillund has been appointed Vice-President, Coatings Group, of The Sherwin-Williams Co., Cleveland, Ohio. Previously President and General Manager, Consumer Div., Mr. Gillund will replace **William Moonan,** Senior Vice-President, Coatings. Continuing in his capacity as Vice-President, Mr. Moonan will report to **John G. Breen** and will be assigned corporate projects.

Francisco Calderon has joined Emery Industries' Export Group as Area Manager, Latin America. He will be responsible for all sales activity in the region.

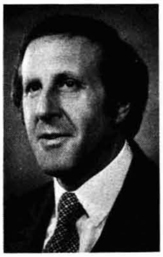
Buckman Laboratories, Inc., Memphis, Tenn. has announced the following appointments. **Dr. Richard T. Ross,** newly appointed Vice-President, Marketing, will oversee all marketing efforts in the company. He is a member of the Southern Society. **Raymond L. Thorton** will assume the duties of Vice-President, Marketing, U.S., and will be responsible for all phases of marketing in the U.S. **A. Kyle Wells** has relocated in Memphis at the Buckman headquarters and will assume duties as Manager of Distributor and Formulator Marketing. He is a member of the Louisville Society.



G.E.F. Brewer

S. Brandes

E.C. O'Connor



L.C. Afremow

Sheldon Brandes has recently joined Thiokol/Specialty Chemicals Div. as Business Manager for contract manufacturing. Mr. Brandes' responsibilities will include planning and directing all business aspects of the contract manufacturing activities of the division.

In addition, **John B. Fabriele, Jr.** has joined Thiokol as Senior Technical Representative for contract manufacturing. He will report to Mr. Brandes.

Terence P. McNulty has joined Kerr-McGee Corp., Oklahoma City, as Vice-President of technical operations. Among the responsibilities of this position is the ensuring of development and the application of new or improved technologies in the chemical mining and processing, mineral beneficiation, electrochemistry, and pigment-finishing operations of the company.

Meanwhile, Kerr-McGee has named **E.C. O'Connor**—Director of titanium pigments marketing; **J.K. Sandie**—Director for soda ash marketing; and **W.P. Woodward**—Western Sales Manager for soda ash.

Reichhold Chemicals, Inc. has appointed **Dieter W. Jungclaus** Vice-President of manufacturing services. He will assume responsibilities in the production area at the company's headquarters in White Plains, N.Y.

Eugene P. D'Amico has been named to the position of Technical Director of Neville Chemical Co., Pittsburgh, Pa. He succeeds **John J. Freemen,** who recently retired.

Charles L. Stein has been named Regional Manager of Ashland Chemical Co.'s Industrial Chemicals and Solvents Div. for the St. Louis, Mo. region. Mr. Stein is a member of the Golden Gate Society.

Leonard C. Afremow has been named Vice-President, Research and Development, of the Midland Div., The Dexter Corp., Waukegan, Ill. In this position, Mr. Afremow will take responsibility of research, development, and quality control activities of the domestic and foreign operations of Midland. He is a member of the Chicago Society.

Also announced by the company are the following appointments and promotions: **Dr. Albert Paolini, Jr.**—Vice-President and General Manager of European Operations; **Thomas P. Szczeblowski**—Technical Director, Packaging Research & Development labs; **John P. Scalzo**—Manager, Packaging Research & Development labs; **Dr. Daniel L. Neumann**—Supervisor, Special Projects lab. These men are members of the Chicago Society.

Diano Corp., Woburn, Mass., has appointed **Bruce A. Bakker** to the position of Product Manager for Field Service and Replacement Parts. He will assume full responsibility for the selection, training, and technical support of all field service personnel.

Schenectady Chemicals, Inc. has appointed **Kenneth C. Petersen** Executive Vice-President and **John T. Greene** Vice-President of Manufacturing. In their new positions, Mr. Petersen will be responsible for the overall management of the company's domestic research, marketing, and manufacturing operation, while Mr. Greene will take charge of the domestic manufacturing operations.

Celanese Plastics & Specialties Co., Louisville, Ky., has named **Robert D. Kinny** Product Manager for international specialties. In this newly created position, he will be responsible for providing product line tactics and strategies for specialty product lines in international markets.

As part of its organization into three business groups, the Pigments Department of CIBA-GEIGY has announced the following appointments: **Paul J. Papillo**—Chairman; **Daniel J. Barufaldi**—Director of Sales; **Everett A. Kliphouse**—Director of Administration and Product Management; **Dr. Richard H. Mumma**—Technical Director; **Nathan W. Putnam**—Director of Marketing; and **John Simas**—Site Manager of its Glen Falls, N.Y. plant.

In addition, Jack Stewart has been named General Manager of Drakenfeld Colors, in Washington, Pa., and **Edward Franz** as General Manager of Radiant Color in Richmond, Calif., the newly created business groups, of CIBA-GEIGY.

Dr. Donald T. Sawyer, chemist and educator from the University of Calif., Riverside, has been chosen to assume the position of Provost and Vice-President of Lehigh University, effective July 1, 1980. Dr. Sawyer succeeds **Dr. A.C. Zettlemoyer**, who will retire after 38 years of service.

In a series of promotions, PPG Industries, Coatings and Resins Div., Allison Park, Pa., has appointed **Dr. Leland H. Carlblom** and **Dr. Clifford K. Schoff**—Research Associates; **H. Peter Doerge** and **Dr. John R. Peffer**—Senior Research Associates; and **Richard C. VonHor**—Project Leader. Dr. Schoff is a member of the Pittsburgh Society.

In a series of promotions, DeSoto, Inc., Des Plaines, Ill. has appointed **Leslie E. Nack**—Manager, Industrial Research; **Roman Berka**—Technical Manager, Business Products and Reprography; **Bruce Sicklesteel**—Senior Research Chemist; and **Vic Pietryga**—Research Chemist. Messrs. Nack and Pietryga are members of the Chicago Society.

Dr. Paul F. Bruins is the recipient of the Annual Award of the Thermoplastic Materials and Foams Div. of the Society of Plastic Engineers for Outstanding Achievement in Polymeric Materials. Dr. Bruins, Professor Emeritus in Chemical Engineering, has spent 44 years in plastics education at the Polytechnic Institute of New York.

Clyde L. Smith, of Ameritone Paint Div. of Grow Group, was named President of the PRA laboratories, a cooperative coatings research and development organization.

Other officers named were: Vice-President—**Ronald Armstrong**, of James Bute Co.; Secretary—**C.L. Krill**, of General Paint Co.; and Treasurer—**Paul D. Dague**, of Jones-Blair Paint Co.

Obituary

Harry Kelfer, 70, Vice-President of Sterling-Clark-Lurton Corp., Malden, Mass., died on January 9, 1980, in Massachusetts General Hospital, Medford.

A longtime member of the New England Society, he served as President of both the Society and the New England Paint and Coatings Association. Mr. Kelfer was named "Man of the Year" by the Sealants Committee of ASTM and was elected a Fellow of ASTM in 1974.

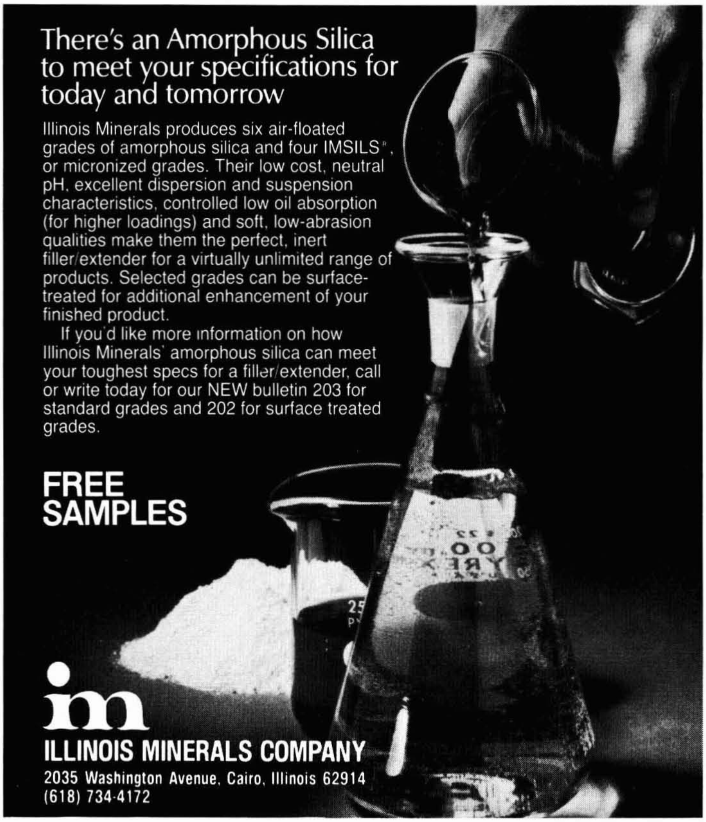
J.R. Rawley, retired Executive Vice-President of Martin-Senour Paint Co. and later Vice-President of Sappanos Paint Co., died on December 29, 1979. He was 77 years old.

Henry J. Stalzer, a member of the New York Society, died on November 11, 1979. Formerly associated with the Hilo Varnish Co. and Hotopp Paint and Varnish, he retired from the Titanium Pigments division of National Lead Co. in 1970.

F.J. Cihak, 68, an active member of the Northwestern Society, died on January 4, 1980. Recognized as one of the foremost authorities in the paint industry, he was employed by the Industrial Supplies Div., Warner Hardware Co., for 46 years. At the time of his death, he was the longest term employee in the Warner organization. Mr. Cihak was a member of the Paint, Decorator & Contractors Association and the National Paint and Coatings Association.

W. Ivan Coulston, 90, Chairman of the Board of Reichard-Coulston, Inc. died January 5, 1980, in Glen Ridge, N.J. He was active in the paint and allied industries for 72 years.

Eugene Louis O'Brien, Sr., formerly a Vice-President of the O'Brien Corp., South Bend, Ind., died on December 31, 1979 in Tucson, Ariz. He was 66 years old.



Literature

Thermosetting Acrylic Resin

A new brochure describing a thermosetting acrylic resin designed for use in direct-roll coatable baking enamels for beer and beverage cans has been released. Included in this bulletin are typical physical properties, performance comparisons, and safe handling information. For a copy of Publication 82A27, contact the Marketing Services, Rohm and Haas Co., Independence Mall West, Philadelphia, Pa. 19105.

Phosphate Coatings

A four-page bulletin has been published which details iron, zinc, heavy zinc, and manganese type phosphating agents for use in metal finishing application. For copies of Bulletin #1412, write Ashland Chemical Co., Dept. MF, Box 2219, Columbus, Ohio 43216.

Channel Oxygen Recorder Series

A six-page brochure which describes a new one/two channel oxygen recorder series has been issued. The brochure discusses product features and customer benefits; sensor elements; and sensor assembly types available for specific application requirements. For a free copy of Bulletin 4176, contact Beckman Instruments, Inc., Process Instruments Div., 2500 Harbor Blvd., P.O. Box 3100, Fullerton, Calif. 92634.

Helium Pycnometer

Product literature which describes a completely automated helium pycnometer has been recently released. This instrument determines absolute density for a wide variety of materials, involving minimal time and operator attention. For additional information, write Micromeritics Instrument Corp., 5680 Goshen Spring Rd., Norcross, Ga. 30093.

Defoamer

Literature has been published which introduces the second in a new series of anti-foaming agents for reducing or eliminating foam in the production and application of water-based coatings. For details, write Interstab Chemicals, Inc., Technical Services Dept., 500 Jersey Ave., P.O. Box 638, New Brunswick, N.J. 08903.

Laboratory Plasticware Catalog

A 32-page catalog describing an extensive line of laboratory plasticware has been published. In addition to all specifics needed to order every item, the catalog contains tips on how to mark or label plasticware, cleaning (Including autoclaving), and chemical resistance. For a free copy of the catalog, write Mallinckrodt, Inc., Science Products Div., Plasticware, P.O. Box 61128, Raleigh, N.C. 27661.

Particle Size Analyzer

Information is now available which describes a particle size analyzer which has been refined to provide better efficiency and easier operation for laboratory analyses. For literature concerning SediGraph 5000D, contact Micromeritics Instrument Corp., 5680 Goshen Springs Rd., Norcross, Ga. 30093.

Colorant Timer

A new timer that automatically agitates colorant twice daily is the topic of recently released literature. This timer helps prevent settling of the pigment in the cannisters which can cause costly mistints. For additional information on form #304-030, contact Graco Inc., P.O. Box 1441, Minneapolis, Minn. 55440.

Safety Color Bulletin

A new bulletin on safety colors is now available to industry. This safety color code for the identification of piping, apparatus, and equipment is designed to promote safety and boost production. Additional data may be obtained from DuPont Company, Public Affairs Dept., Wilmington, Del. 19898.

Polyester Resins

A brochure which details a new line of thermosetting polyester resins has been published. For copies of Bulletin #1431, contact the Polyester Div., Ashland Chemical Co., Box 2219, Columbus, Ohio 43216.

High-Speed Paint Mixer

A new high-speed paint mixer which claims to reduce paint mix time by as much as 800% per can has been introduced in recently released literature. For specific information, write Graco, Inc., P.O. Box 1441, Minneapolis, Minn. 55440.

Anti-Foaming Agent

The first in a new series of anti-foaming agents for reducing or eliminating foam in the production and application of water-based coatings is described in recently released literature. A cream colored liquid, this agent is effective in a wide variety of water-based coatings, with particular capabilities in water-reducible paint, terpolymers, and PVA. For additional information, contact Interstab Chemicals, Inc., Technical Service Dept., 500 Jersey Ave., New Brunswick, N.J. 08903.

High Temperature Enamels

A new polymer which provides high temperature resistance and low surface friction with significantly lighter color and better color retention is described in a recently published bulletin. For copies, write Amoco Chemicals Corp., Dept. JPAT, Mail Code 4102, 200 East Randolph Drive, Chicago, Ill. 60601.

Glossmeter

Information is now available which describes a new glossmeter. Conforming with ASTM and TAPPI specification, this glossmeter is designed to provide strict optical alignment and quality control through the use of precision fixtures which control the incident beam angle and receptor field angle. For additional details on D48-7 glossmeter, contact Hunterlab Marketing Dept., Hunter Associates Laboratory, Inc., 11495 Sunset Hills Rd., Reston, Va. 22090.

Amorphous Silica

A new four-color brochure featuring the production, performance characteristics, and uses of amorphous silica has been produced. For a free copy of bulletin #203, including a reply card requesting free samples, write Illinois Minerals Co., 2035 Washington Ave., Cairo, Ill. 62914.

Epoxy Curing Agents

The results of a study comparing 1,3-BAC and MXDA with diethylenetriamine in curing five different epoxy resins has recently been released. For a copy of Technical Bulletin 159, write Sherwin-Williams Chemicals, Publication Dept., 10909 S. Cottage Grove Ave., Chicago, Ill. 60628.

Aqueous Acrylic Resin

An aqueous acrylic resin for high gloss metal decorating enamels is described in a new bulletin. This resin, supplied in solubilized form, gives transfer and flow out on mandrel application indistinguishable from current solvent enamels, whether applied at slow or fast line speeds. A copy of Publication 82B9 on Acrysol WS-43 may be obtained by contacting the Marketing Services Dept., Rohm and Haas Co., Independence Mall West, Philadelphia, Pa. 19105.

Small Media Mill

Literature which details a new model small media mill is now available. The continuous throughput high speed horizontal ball mill for wet grinding and dispersions of suspensions in a completely enclosed system is designed to be suitable for laboratory tests and for processing small production batches. For complete information, write Dept. 1 RN, Chicago Boiler Co., 1965 Clybourn Ave., Chicago, Ill. 60614.

High Temperature Polyimides

Literature is now available which describes two grades of a thermoplastic polyimide which requires no high temperature curing cycle. For information and/or samples of either the standard or the high purity grade of XU 218, write CIBA-GEIGY Corp., Resins Dept., Saw Mill River Rd., Ardsley, N.Y. 10502.

Rigid Urethane Foam Insulation

How rigid urethane foam insulation saves energy and solves a variety of other problems is described and illustrated in a 4-page, color brochure. For a copy of this brochure, write Witco Chemical Corp., Isocyanate Products Div., 900 Wilmington Rd., New Castle, De. 19720.

Black Dispersions

Literature has been prepared which details two new additions to a line of black pigment dispersion for masstone and tinting applications. Further information and samples are available from Daniel Products Co., 400 Claremont Ave., Jersey City, N.J. 07304.

Sulfate Surfactant

A sodium alkylaryl polyether sulfate that exhibits anionic surfactant properties especially suited to the emulsion polymerization of acrylic and vinyl acetate copolymers has been introduced in literature. Further information on Witcolate D51-51 is available from Witco Chemical Corp., Organics Div., 3230 Brookfield St., Houston, Tex. 77045.

Plating Technique

A fully automated technique for depositing decorative and protective coatings on plastics, metals, and other base materials is the subject of a new 12-page, color brochure. This system offers such advantages as lower cost, lower energy consumption, and minimum operator skill. Free copies may be obtained from Varian Associates, Palo Alto Vacuum Div., 611 Hansen Way, Palo Alto, Calif.

Finishes Systems

Four abrasion-, corrosion- and chemical-resistant finishing systems for lining covered hopper cars are introduced in recently released literature. These new systems are tailored to meet specific industry needs depending on ladings, transportation, environment, durability, application facilities, and cost factors. Information may be obtained from the DuPont Co., Public Affairs Dept., Wilmington, Del. 19898.

Book Review

HOUSEHOLD AND AUTOMOTIVE CHEMICAL SPECIALTIES
Recent Formulations

Written by
Ernest W. Flick
Noyes Data Corp.
Park Ridge, N.J.
1979, (390 p.), $32.00

Reviewed by
Dr. Henry K. Wren
Standard T Chemical Co., Inc.
Chicago Heights, Ill.

This book is a compendium of formulations for chemical specialties. Most of the formulations have been taken from the literature of the manufacturers of the ingredients involved. Areas covered include cleaners, detergents, dishwashing compounds, disinfectants, polishes, etc.

The book should provide a wealth of valuable information for manufacturers of chemical specialties wishing to extend their product line. It should also be useful to those individuals contemplating starting a chemical specialties manufacturing business.

Apparently the author did not revise or edit the formulations he chose. On 18 separate pages, formulations are given using the Freons as the propellants for aerosols. By this time we should all be aware of the reported deleterious effect of the fluorocarbons on the ozone layer. It might have been prudent to have made some recommendations as to other propellants, at least in the footnotes. Some individuals wanting to duplicate these formulations might not be aware of these facts. Very comprehensive lists and descriptions of the raw materials are given, as well as the addresses of the suppliers.

It is gratifying to find formulations given on a 100% basis. This allows for maximum revision with a minimum of computations. All in all, this can be a very useful book to chemical specialty manufacturers or to chemists involved with these products.

Coming Events

FEDERATION MEETINGS

1980

(May 15–17)—Federation Spring Meetings. Society Officers—15th; Executive Committee—16th; Board of Directors—16th and 17th. North Star Inn, Minneapolis, Minn. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, Pa. 19107).

(Oct. 28)—Federation Board of Directors Meeting. Hyatt Regency Hotel, Atlanta, Ga. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, Pa. 19107).

(Oct. 29–31)—58th Annual Meeting and 45th Paint Industries' Show. Atlanta Civic Center, Atlanta, Ga. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, Pa. 19107).

1981

(Mar. 24–26)—"Symposium on Color and Appearance Instrumentation." Jointly sponsored by Federation of Societies for Coatings Technology, Manufacturers Council on Color and Appearance, and Inter-Society Color Council. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, Pa. 19107).

SPECIAL SOCIETY MEETINGS

1980

(Mar. 25–26)—Chicago Society, SYMCO '80, "Additives." Fountain Blue, Des Plaines, Ill. (Dennis Socha, U.S. Gypsum Co., 1000 E. Northwest Highway, Des Plaines, Ill. 60016).

(Mar. 25–26)—23rd Symposium of the Cleveland Society, "Advances in Coatings Technology." Baldwin-Wallace College, Berea, Ohio. (James A. Miller, Morgan Adhesives Co., 4560 Darrow Rd., Stow, Ohio 44224, (216) 688-111.)

(Apr. 14–15)—Louisville Society Spring Symposium, "Compliance with Government Regulations" and "Hazardous Materials Waste Disposal." Marriott Inn, Clarksville, Ind. (M. Joyce Specht, Porter Paint Co., Corporate Office, 400 South 13th St., P.O. Box 1439, Louisville, Ky. 40201).

(April 17–19)—Dallas and Houston Societies. Southwestern Paint Convention, Hilton Inn, Dallas, Tex. (W.F. Holmes, De Soto, Inc., P.O. Box 401268, Garland, Tex. 75040).

(May 1)—Detroit Society FOCUS Seminar. "Environmental Challenges to Automotive Coatings." Michigan State Management Conference Center, Troy, Mich. (G. Sastry, Chrysler Corp., Chemicals Div., 5437 W. Jefferson, Trenton, Mich. 48183).

(May 1–3)—Pacific Northwest Society Annual Symposium. Hilton Hotel, Portland, Ore. (W. Clyde, Glidden Ctg. & Resins, 2800 N.W. 31st St., Portland, Ore. 97210).

(May 5)—Pittsburgh Society Symposium on "Hazardous Waste Disposal." Graduate School of Industrial Administration of Carnegie-Mellon Univ., Pittsburgh, Pa. (Dr. R. Marcus, PPG Industries, Inc., 151 Colfax St., Springdale, Pa. 15144).

(May 8)—Kansas City Symposia, "Modernistic Approaches to Hiding." (Dennis Mathes, Cook Paint & Varnish Co., P.O. Box 389, Kansas City, Mo. 64141.)

(May 13–14)—"Coatings and Ink Expo '80," sponsored by the New England Society. Sheraton Inn and Conference Center, Boxborough, Mass. (Dame Assoc., Inc., 51 Church St., Boston, Mass. 02116, (617) 482-3596.)

(May 15)—Birmingham Club Symposium, "Effect of Current Legislation in the U.K. Paint Industry." Metropole Hotel, Birmingham, England. (D.M. Heath, Arthur Holden & Sons Ltd., Bordesley Green Rd., Birmingham, B9 4TQ, England.)

(June 6–7)—Joint meeting of Kansas City and St. Louis Societies. Hilton Plaza Hotel, Kansas City, Mo. (Tim T. Walsh, Walsh & Associates, Inc., 500 Railroad Ave., N. Kansas City, Mo. 64116).

(June 16)—Golden Gate Society. Manufacturing Committee Seminar on "Manufacturing Aid for the Decade." (Louie Sanguinetti, Jasco Chemical Corp., P.O. Drawer J, Mountain View, Ca. 94042).

(Oct. 7)—Cleveland Society Manufacturing Committee Symposium, "Formulation for and Utilization of Pigment Dispersion Equipment." Cleveland Engineering and Scientific Center, Cleveland, Ohio. (G. Dubey, Cambridge Coatings, Inc., 5461 Dunham Rd., Cleveland, Ohio 44137).

1981

(Mar. 4–6)—Western Coatings Societies Symposium and Show. Disneyland Hotel, Anaheim, Ca. (Richard C. Sutherland, E.T. Horn Co., 16141 Heron Ave., La Mirada, Ca. 90638).

OTHER ORGANIZATIONS

(Mar. 25–27)—Society of Manufacturing Engineers Workshop on Radiation Curing in the Graphic Arts. Ramada O'Hare Inn, Chicago, Ill. (Susan E. Buhr, Technical Division, Society of Manufacturing Engineers, One SME Drive, P.O. Box 930, Dearborn, Mi. 48128).

(Mar. 26–28)—Marine Coatings Conference, Marriott Hotel, New Orleans, National Paint and Coatings Assoc.)

(Mar. 31–Apr. 11)—Paint Short Courses at University of Missouri-Rolla. Fundamentals of Paint Formulation—Mar. 31–Apr. 4; Chemical Coatings Workshop—Apr. 7–11. (Norma Fleming, Continuing Education, University of Missouri-Rolla, 501 West 11th St., Rolla, Mo.).

(Apr. 7–11)—"Nuclear Quality-Assured Coating Work," Phoenix, AZ. (Institute of Applied Technology, Jean L. Kaplan, 1200 - 17th St., N.W., Suite 406, Washington, D.C. 20036.)

(Apr. 10–11)—"Symposium on Emulsion Polymerization of Vinyl Acetate," Emulsion Polymers Institute, Lehigh University, Bethlehem, Pa.

(Apr. 10–12)—National Paint and Coatings Association, "Production, Planning, and Inventory Management Seminar." Stouffer's Riverfront Towers, St. Louis, Mo. 63102. (Karen B. Bradley, NPCA, 1500 Rhode Island Ave., N.W., Wash., D.C. 20005).

(Apr. 14–15)—20th Annual Symposium, "New Coatings Technology for the 1980's," Marriott Twin Bridges Motel, Washington, D.C. (Washington Paint Technical Group, Box 12025, Washington, D.C. 20005.)

(Apr. 15)—AFP/SME Conference, "Taking the Mystery Out of Coatings with Powders." Sheraton O'Hare, Chicago, Ill. (Susan Buhr, Society of Manufacturing Engineers, One SME Drive, P.O. Box 930, Dearborn, Mich. 48128).

(Apr. 20–22)—Inter-Society Color Council. Annual meeting. Downtown Holiday Inn, Rochester, N.Y. (Dr. Fred Billmeyer, Secretary, ISCC, Rensselaer Polytechnic Institute, Troy, N.Y. 12181).

(Apr. 21–25)—"High Performance Coating Procedures," Philadelphia, Pa. (Institute of Applied Technology, Jean L. Kaplan, 1200 - 17th St., N.W., Suite 406, Washington, D.C. 20036.)

(Apr. 23–24)—"Trade Sales Coatings—New Frontiers," The Chemical Institute of Canada, Protective Coatings Div., Montreal and Toronto, respectively. (Th. Mitsopoulos, Ashland Chemicals, 2620 Royal Windsor Rd., Mississauga, Ontario, Canada L5J 4E7).

(Apr. 29–May 1)—Oil and Colour Chemists Association Australia, Victoria Section. Symposium on "Toxicity." In Melbourne on Apr. 29; Sydney on May 1. (Brian Gray, Secretary, OCCAA, 25 Shanley St., Pascoe Vale, Vic. 3044, Australia).

(May 4–5)—National Coil Coaters Association Annual Meeting, Hotel Del Coronado, Coronado, Calif. (NCCA 1900 Arch St., Phila., Pa. 19103.)

(May 5–8)—Society of Plastics Engineers, 38th Annual Technical Conference (ANTEC). New York Hilton, N.Y. (Rod Ellis, SPE, 656 W. Putnam Ave., Greenwich, Conn. 06830).

(May 12–16)—"Coatings and Polymer Characterization" Short Course. Kent State University, Kent, Ohio. (Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, Ohio 44242).

(May 12–16)—"High Performance Coating Procedures," New Orleans, LA. (Institute of Applied Technology, Jean L. Kaplan, 1200 - 17th St., N.W., Suite 406, Washington, D.C. 20036.)

(May 13–15)—Oil and Colour Chemists Association Technical Exhibition, OCCA 32, Cunard International Hotel, London, England. (The Director and Secretary, OCCA, Priory House, 967 Harrow Rd., Wembley, Middlesex HAO 2SF, England).

May 15–17)—National Paint and Coatings Association, "Production, Planning, and Inventory Management Seminar." Stouffer's Riverfront Towers, St. Louis, Mo. (Karen B. Bradley, 1500 Rhode Island Ave., N.W. Wash., DC 20005).

(May 19–23)—"Advanced Chemical Coatings Workshop," University of Missouri—Rolla. (Norma Fleming, Continuing Education, University of Missouri—Rolla, 501 W. 11th St., Rolla, Mo.)

(May 19–23)—Dispersion of Pigments and Resins in Fluid Media" Short Course. Kent State University, Kent, Ohio. (Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, Ohio 44242).

(June 1–6)—"Polymer Blends and Composites" Short Course. Lehigh University, Bethlehem, Pa. (Ms. Jone Svirzofsky, Lehigh Univ., Materials Research Center, Coxe Lab. 32, Bethlehem, Pa. 18015).

(June 2–13)—Basic Coatings Science Course. North Dakota State University, Fargo, N.D. (Dr. Zeno W. Wicks, Jr., Polymers and Coatings Dept., NDSU, Fargo, N.D. 58105).

(June 8–13)—XVth Congress of FATIPEC, RAI Congress Centre, Amsterdam, Netherlands. "Activities of the Coatings Industry in the Framework of Ecology, Energy, and Economy Problems." (Congress Secretary is C. Kork, Oostenrijklaan 43, Haarlem, Netherlands).

(June 15–18)—Dry Color Manufacturer's Association Annual Meeting. The Greenbriar, White Sulpher Springs, W.Va. (J.L. Robinson, Dry Color Manufacturers' Association, Suite 100, 117 North 19th St., Arlington (Rosslyn) Va. 22209).

(June 16–20)—"Adhesion Principles and Practice for Coatings and Polymer Scientists" Short Course. Kent State University, Kent, Ohio. (Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, Ohio 44242).

(June 16–20)—"High Performance Coating Procedures," San Francisco, Calif. (Institute of Applied Technology, Jean L. Kaplan, 1200 – 17th St., N.W., Suite 406, Washington, D.C. 20036.)

(June 16–27)—Advanced Coatings Science Course, North Dakota State University, Fargo, N.D. (Dr. Zeno W. Wicks, Jr., Polymers and Coatings Dept., NDSU, Fargo, N.D. 58105).

(June 23–27)—"Applied Rheology for Industrial Chemists," Rheology and Coatings Laboratory, Kent State University, Kent, Ohio. (Carl J. Knauss, Chemistry Dept., Kent State University, Kent, Ohio 44242.)

(June 25–27)—"Interpenetrating Polymer Networks" Short Course. Lehigh University, Bethlehem, Pa. (Ms. Jone Svirzofsky, Lehigh Univ., Materials Research Center, Coxe Lab. 32, Bethlehem, Pa. 18015).

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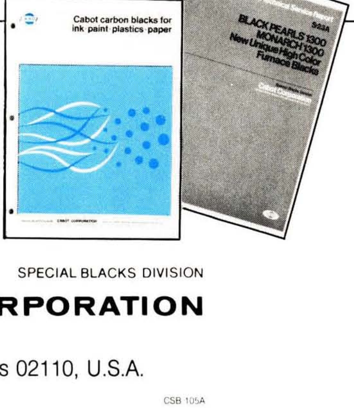

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CSB 105A

Comparison of Busan® 11-M1 (middle) with zinc phospho oxide (left) and calcium borosilicate (right) in latex emulsion primer. Each primer topcoated with two coats of latex emulsion paint without inhibitor. Panels exposed 200 hours in salt fog cabinet. Panels shown before and after paint was removed.

Comparison of Busan® 11-M1 with zinc chromate in an oil-alkyd primer. Primer on top panel contains 0.7 lb. Busan® 11-M1 per gal. Primer on bottom panel contains 0.7 lb. zinc chromate per gal. Both primers topcoated wth alkyd finish coat without inhibitor. Panels exposed for 10 years.

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