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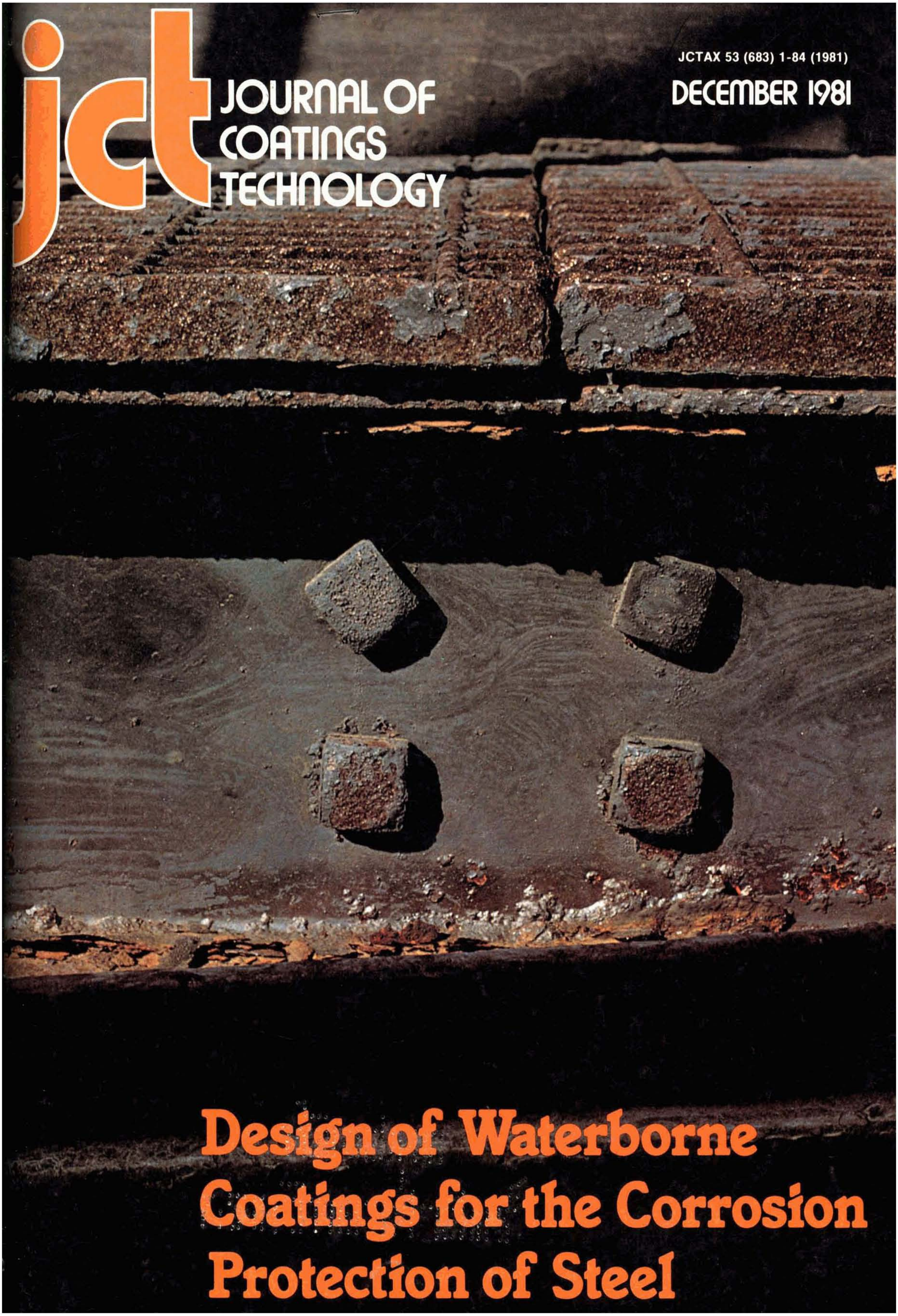

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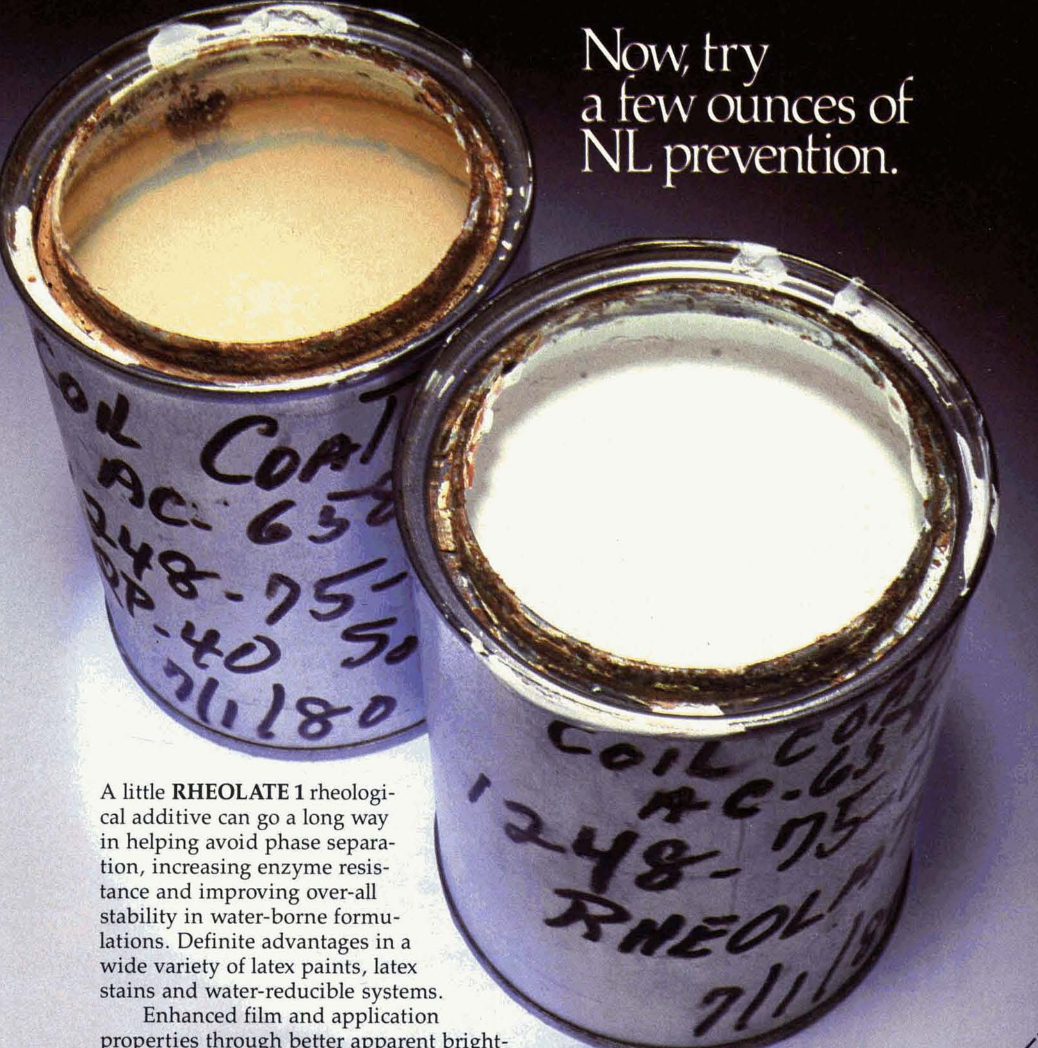

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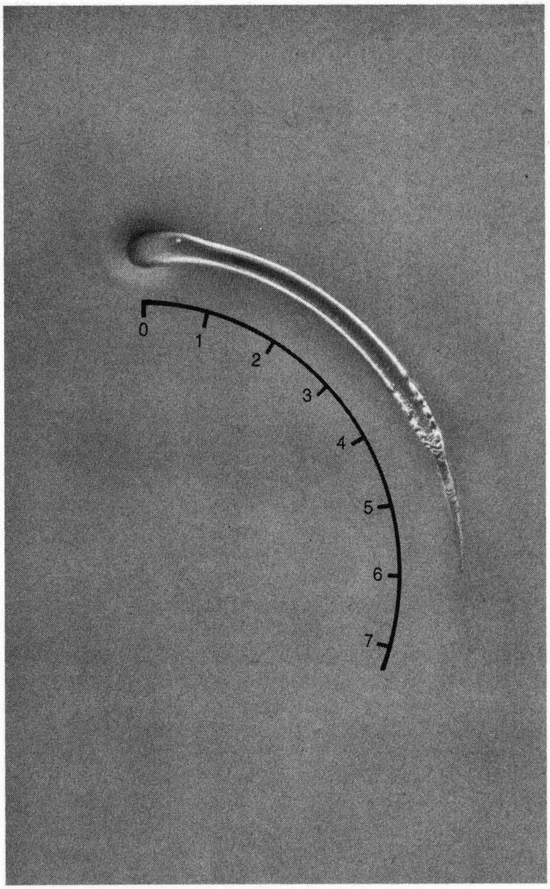
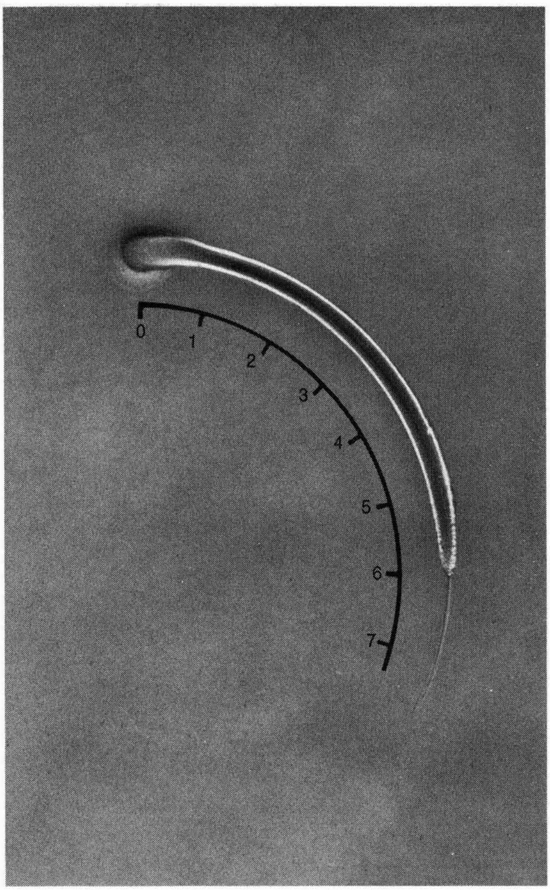


Solvent-thinned coating with ACTIV-8 plus manganese dried in less than 5 hours.



Solvent-thinned coating with cobalt, on an equal cost basis, dried in over 5 hours.

DECEMBER 1981

jct JOURNAL OF COATINGS TECHNOLOGY

Volume 53 Number 683

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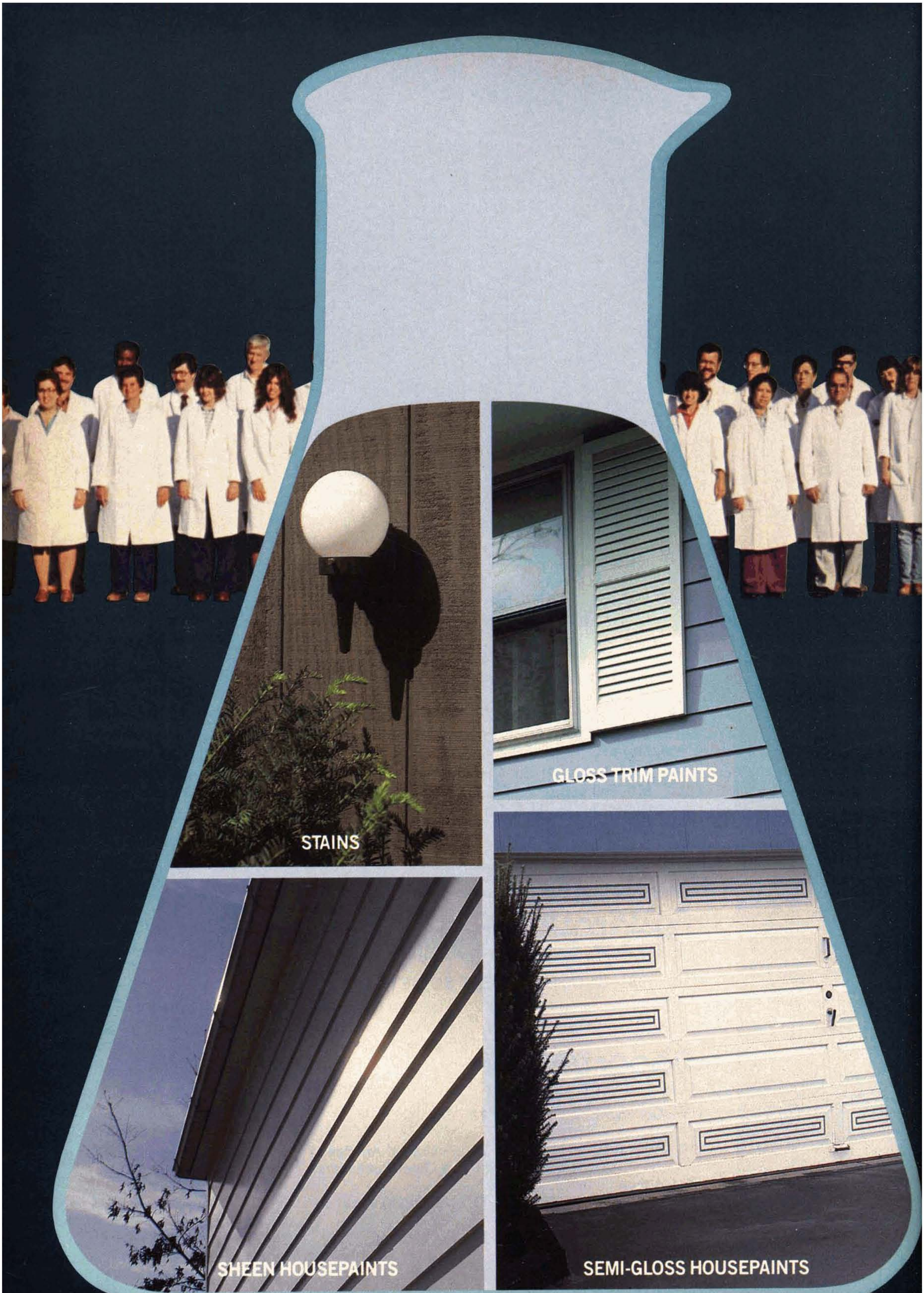
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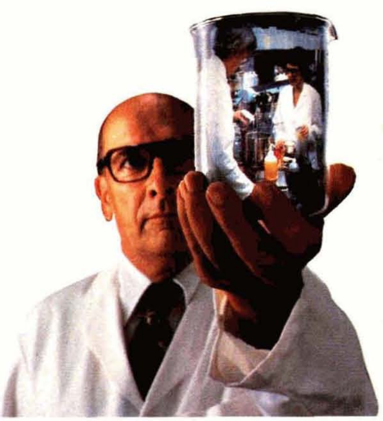

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Comment

The Year Ahead

The first flush of excitement is over. The installation of 1981–82 Federation Officers at the Annual Meeting in Detroit on October 30 is fast becoming a memory, albeit a pleasant one.

Suddenly comes the realization that the responsibility of leading the Federation for the next year is mine. It's like a splash of cold water after a pleasant dream. Kinda' scary.

I wonder if my predecessors felt the same way? Did they go through the same emotions? I can recall some of the Past-Presidents who struck me as being as "cool as cucumbers."

There really is no need for me to be overly concerned. Knowing who will be my Committee Chairmen and members of the Board of Directors for the coming year, I can honestly say—"all is well." These people are a superb group that will supply the brain power, the energy, and the loyalty to keep the Federation "on track." They are committed to serving the Federation and we can all count on them to give their best efforts.

But, there is a long way to go in 1982. The Ad Hoc Committee report on the Paint Research Institute has been referred to the Executive Committee and the PRI Trustees for whatever recommendations they deem necessary. Not an easy task.

Another Ad Hoc Committee will be formed to study ways to promote career opportunities in the coatings industry. I have long been in favor of some action in this direction.

It appears we are off and running—but we need membership commitment. Without their willingness to participate in Federation activities, there would not be a Federation.

Get personally involved. We will all be better off for it.—*Howard Jerome, Federation President, 1981–82.*

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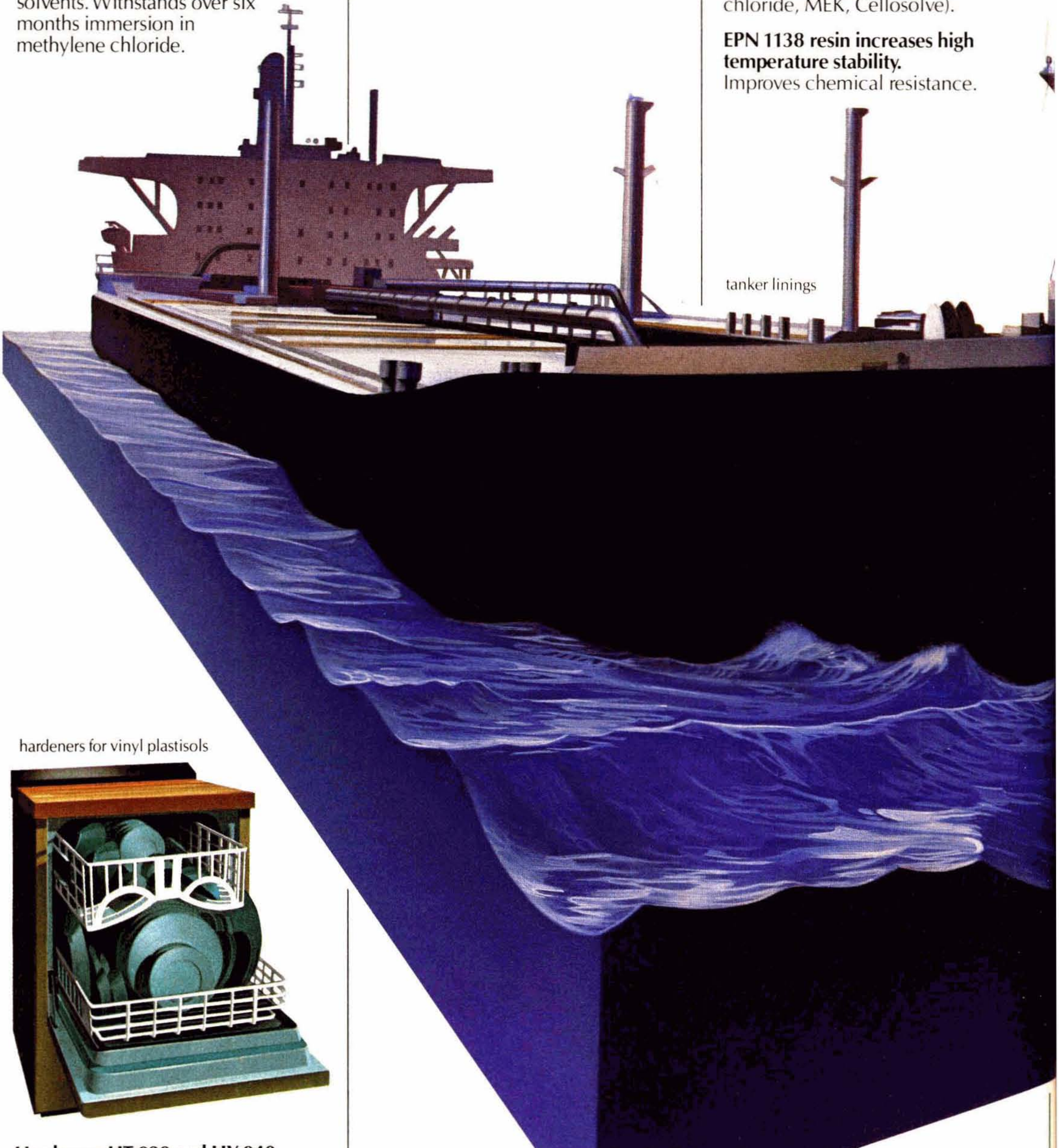

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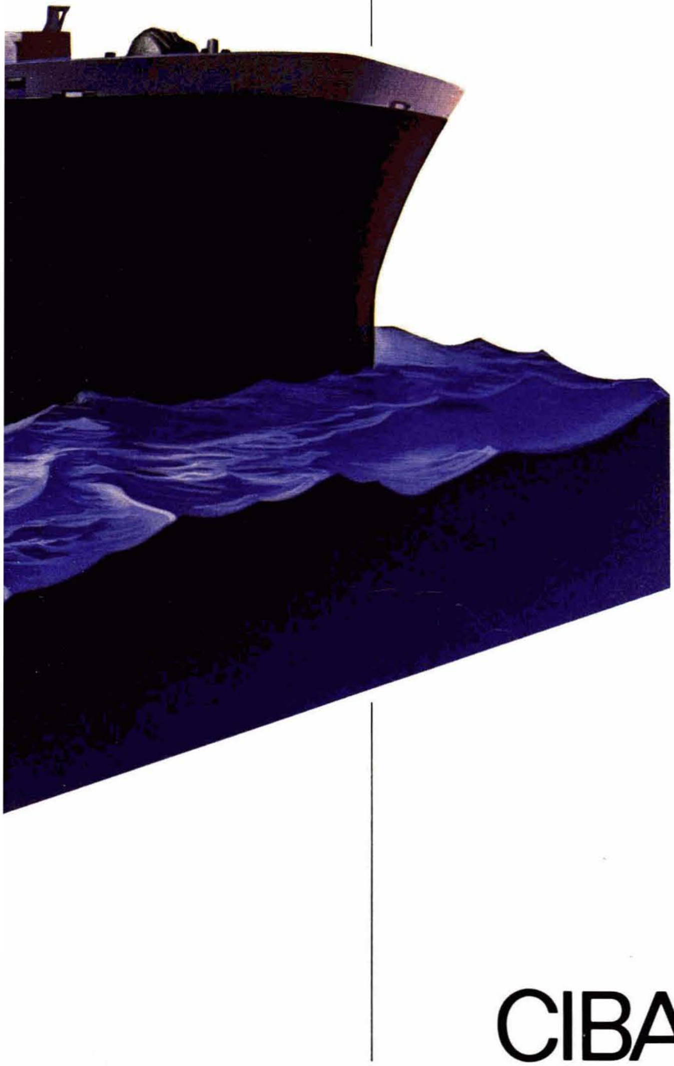


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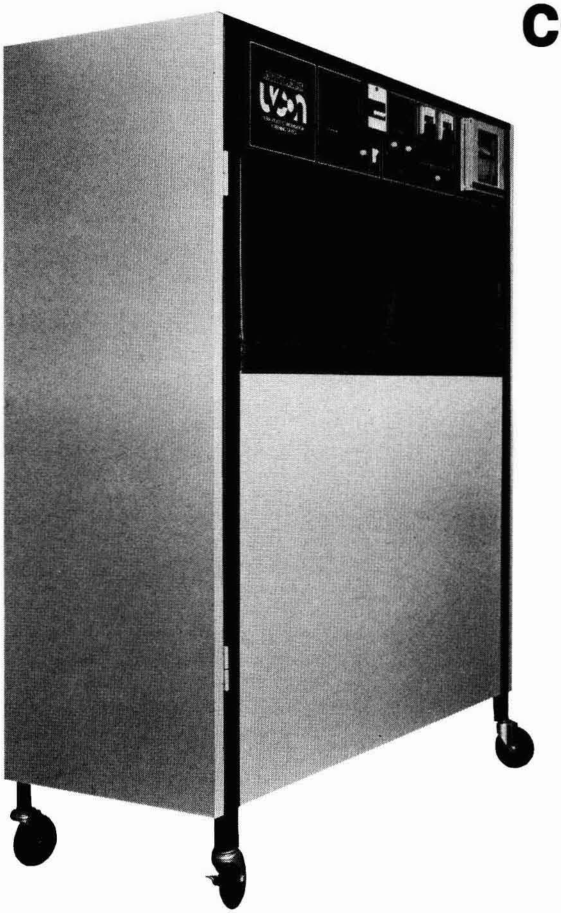

Abstracts of Papers in This Issue

DESIGN OF WATERBORNE COATINGS FOR THE CORROSION PROTECTION OF STEEL. PART I: INTRODUCTION—NEW ENGLAND SOCIETY FOR COATINGS TECHNOLOGY

Journal of Coatings Technology, 53, No. 683, 27 (Dec. 1981)

The key factors which influence the corrosion of coatings on steel are water permeability, oxygen permeability, ion permeability, adhesion of the coating under wet conditions, resistance of the coating to alkali, and the inclusion of corrosion inhibitors in a coating formulation. Understanding these basic factors is important when designing aqueous coatings.

SOLUTION PROPERTIES OF HIGH SOLIDS INTERMEDIATES—M.A. Sherwin, J.V. Koleske, and R.A. Taller

Journal of Coatings Technology, 53, No. 683, 35 (Dec. 1981)

The solution viscosity characteristics of a series of experimental, functionalized cotelomers and selected commercial, low molecular weight polymers were studied. The investigation was conducted with dilute and concentrated solutions to obtain an improved understanding of the effect of polymer structure and functional groups on the rheology of high solids coatings. Intrinsic viscosity results in various solvents indicate that low molecular weight polymers assume equilibrium conformations approaching those of a rigid ellipsoid or spheroid. Results from concentrated solution studies are in agreement with this model, and the viscosities are generally the same for a given polymer in both good and poor solvents. The results indicate that the important considerations for attaining the highest solids coatings are mainly a function of polymer molecular weight and T_g and solvent density and viscosity.

USE OF AMINE TRIFLATE CATALYSTS AND FLUOROCHEMICAL SURFACTANTS IN HIGH SOLIDS EPOXY COATINGS—R.R. Alm

Journal of Coatings Technology, 53, No. 683, 45 (Dec. 1981)

Amine triflate catalysts and fluorochemical surfactants can be used in formulating one-part, epoxy-based, high solids thermoset coatings. The necessity of employing these fluorochemical additives vs state-of-the-art acid catalysts and flow control agents is clearly demonstrated.

Four unique starting point high solids formulations based on commercially available liquid epoxy resins, condensation resins, and polyols are presented which, when baked, exhibit a wide variety of cured film properties.

EVALUATION BY PHOTOELECTRON SPECTROSCOPY AND ELECTRON MICROSCOPY OF THE STABILIZATION OF CHROME-YELLOW PIGMENTS—M.L. Somme-Dubru, et al.

Journal of Coatings Technology, 53, No. 683, 51 (Dec. 1981)

Electron microscopy examination has allowed the distribution of chrome-yellow pigments in six grades, according to quality of coating by stabilizing agents, with grade 1 corresponding to an even and compact pellicular coating. The intensities of XPS peaks characteristic of the crystal constituents (Pb, Cr, S) and of the stabilizers also characterize the completeness of the coating; deduced atomic concentration ratios are well correlated with the electron microscopy grades. The role of the coating, acting as a diffusional barrier with respect to aggressive chemicals, is illustrated by the effect of a brief exposure to hydrogen sulfide (H_2S).


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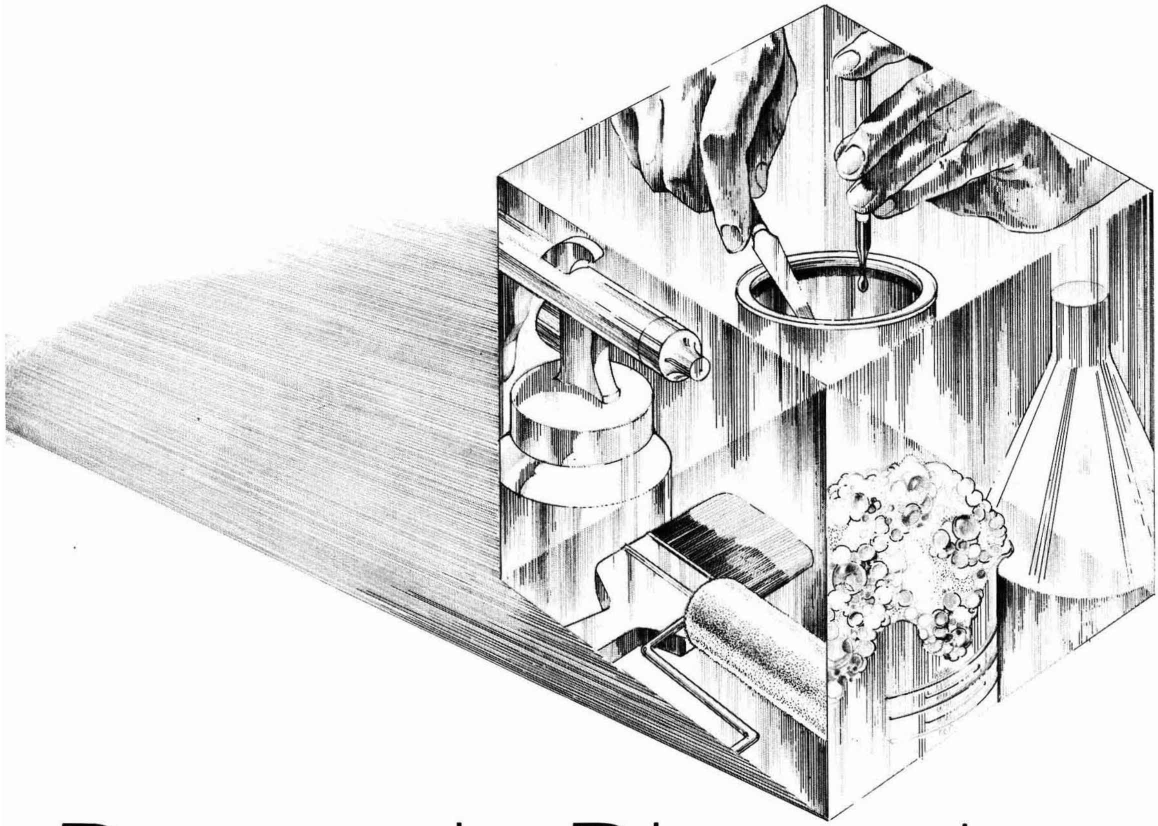

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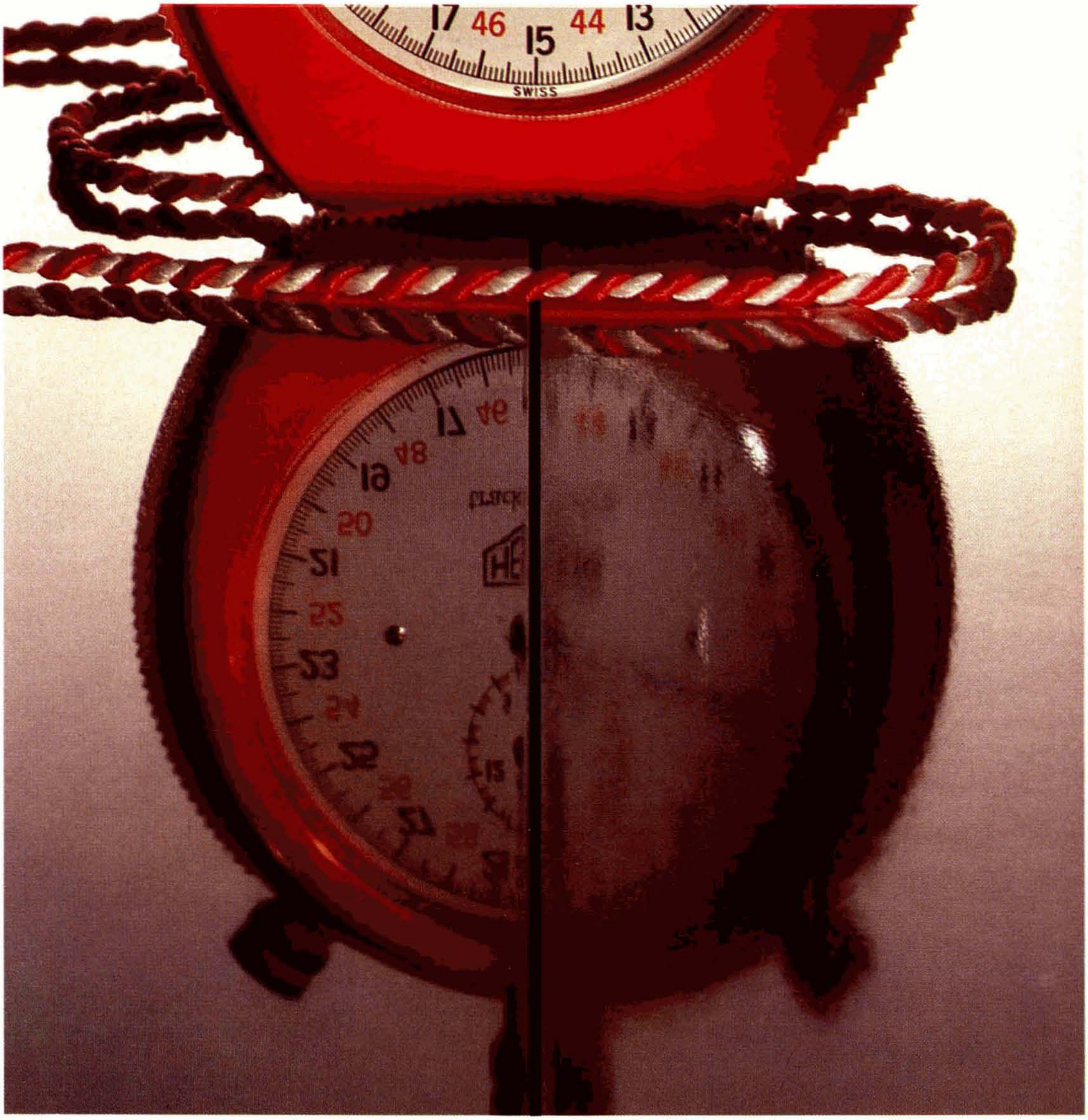

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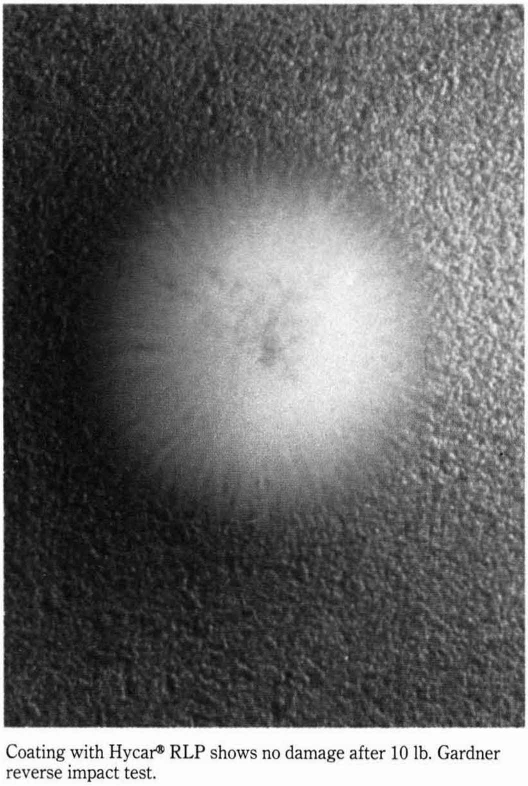

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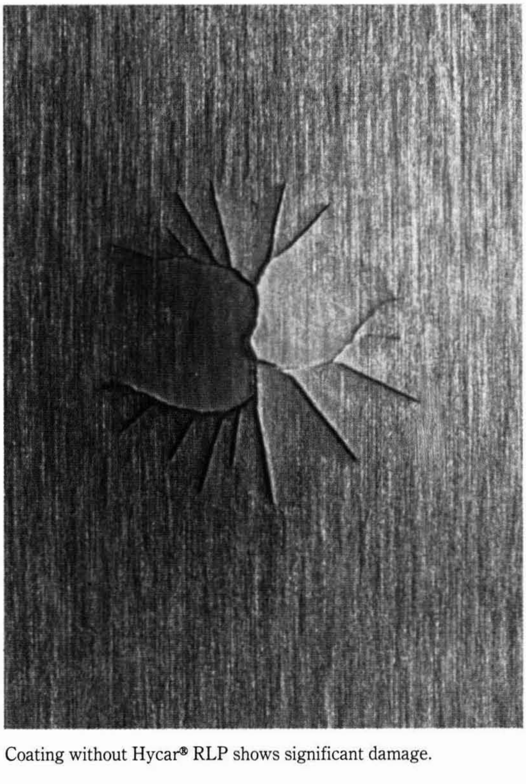

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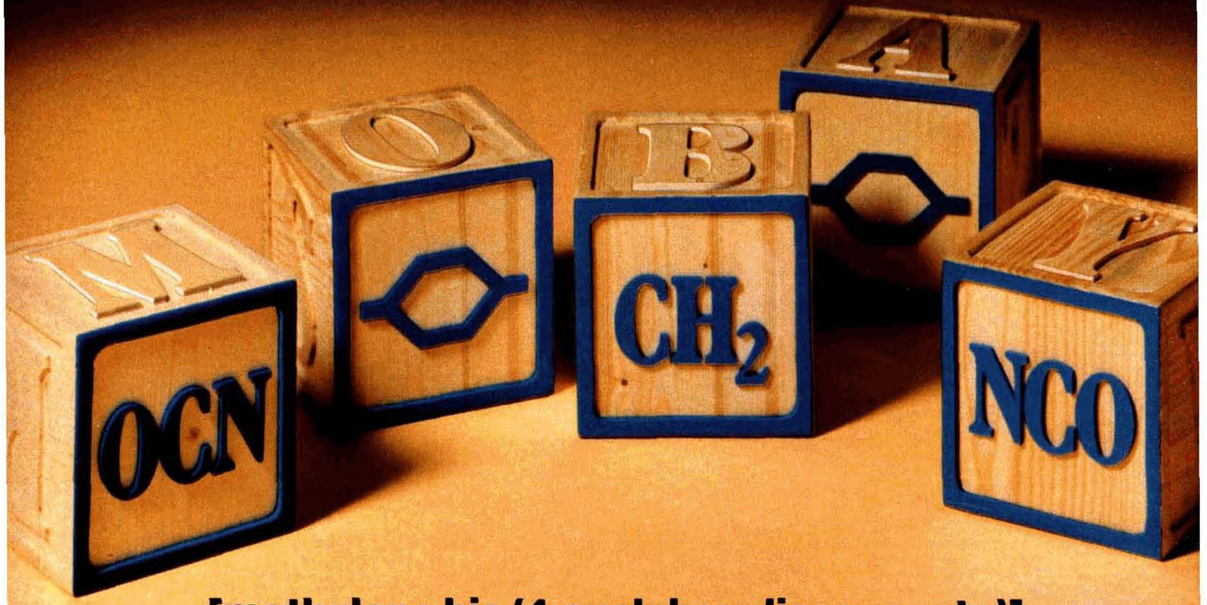
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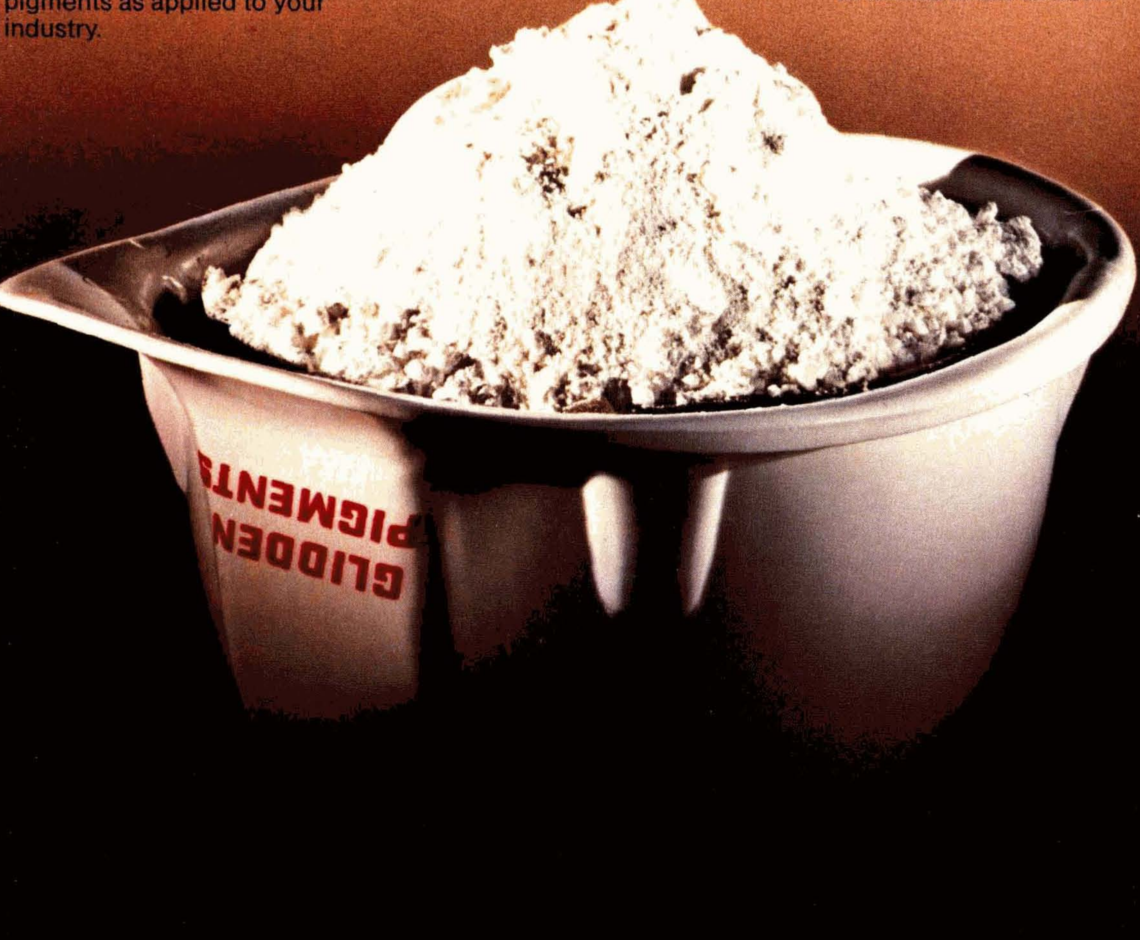
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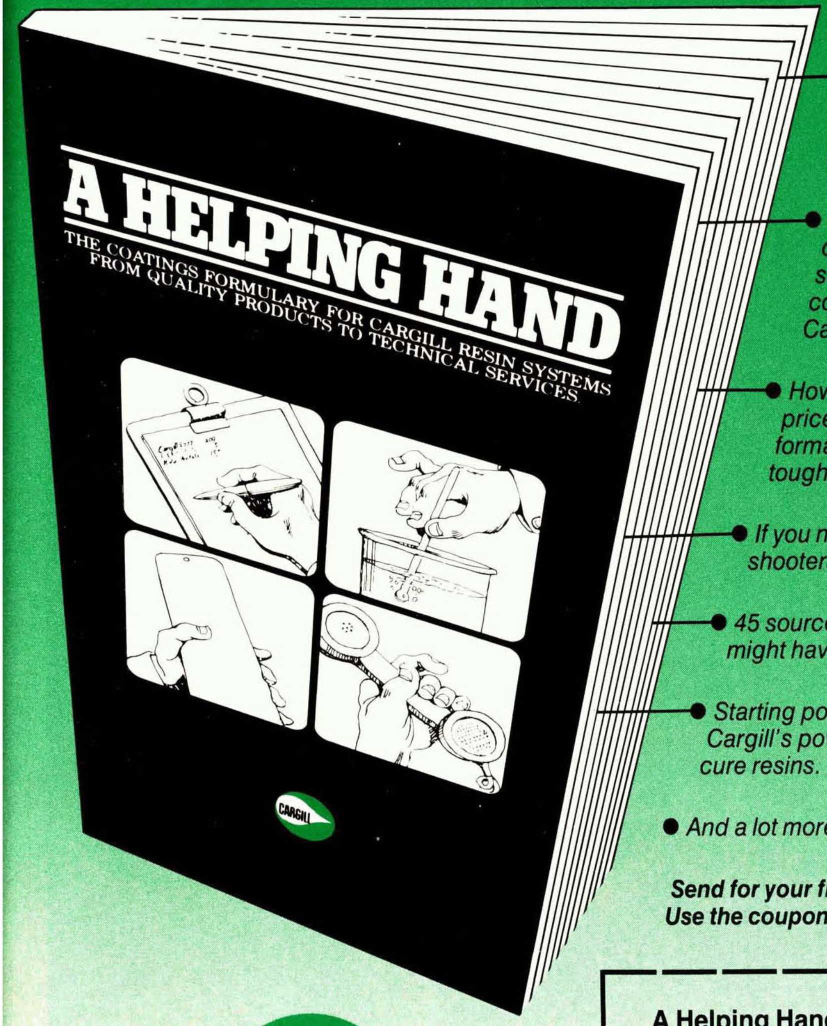
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Design of Waterborne Coatings For The Corrosion Protection of Steel

Part I: Introduction—A Survey of Various Factors That Affect the Corrosion Protection of Coatings on Steel

New England Society for Coatings Technology
Technical Committee

The key factors which influence the corrosion of coatings on steel are water permeability, oxygen permeability, ion permeability, adhesion of the coating under wet conditions, resistance of the coating to alkali, and the inclusion of corrosion inhibitors in a coating formulation. Understanding these basic factors is important when designing aqueous coatings.

INTRODUCTION

The protection of ferrous substrates from corrosion has been under intense research for many years. Gladstone[1] studied the corrosion effects of saccharine juices on iron and other metals in 1855, and alleged that saccharine juices in some cases caused portions of machinery in sugar refineries to totally dissolve.

Recent estimates[2] concerning the loss of material and function due to corrosion are about 20 billion dollars nationally. Thus, it can be seen that the premature oxidation of metals is a severe and costly problem. There are many ways to control the corrosion of metals such as design, environmental control, material selection, electrochemical protection, and coatings.

In 1970, the U. S. government passed the Clean Air Act, which laid the ground work for the ultimate control of hydrocarbon emissions. In essence, the use of organic coatings containing hydrocarbon solvents was being restricted or limited. A great deal of research dollars are being spent today trying to develop nonpolluting coatings that meet with governmental approval.

In view of the already mentioned problems dealing with the control of the corrosion of ferrous metals, we are now faced with the problem of designing aqueous coatings to control corrosion.

This paper is a survey of the factors that affect the corrosion resistance of coatings on steel and provides essential background information for a series of papers to be presented by the New England Society for Coatings Technology on "The Design of Aqueous Coatings for the Corrosion Protection of Steel Substrates."

MECHANISM OF CORROSION

Corrosion may be defined as the destruction of metal by chemical or electrochemical means with its environment.[3] Most of the common metals are unstable, or chemically active, in some environments, and tend to revert to more stable combinations. The metallic ores are familiar examples of these stable combinations. Iron and steel are won from the ores by expenditure of energy, and there is a natural tendency for them to return to combinations of oxygen, sulphates, carbonates, etc., with the release of energy.

Thus, the mechanism of the corrosion of ferrous substrates can be readily seen by a study of free energy. Dodge[4] states the following rule for determining quickly,

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Presented by John E. Fitzwater, Jr. at the 57th Annual Meeting of the Federation of Societies for Coatings Technology in St. Louis, MO, October 4, 1979.

but only approximately, whether any given reaction is promising at a given temperature: If ΔF is less than zero, the reaction is promising; if greater than zero but less than 10 k-cal/mol, the reaction is doubtful but warrants investigation; if greater than 10 k-cal/mol, it is unfavorable. Latimer[5] gives the value for the ΔF of iron as follows:

$$2\,Fe^{\circ} + O_2 + 2H_2O \longrightarrow 2\,Fe\,(OH)_2$$
$$\Delta F \text{ is } -115.7 \text{ k-cal/mol}$$

Therefore, the element iron when placed in contact with water and oxygen has a definite inherent tendency to go into solution in the form of ferrous hydroxide.

There have been many theories on the mechanism of corrosion: they include the Peroxide Theory,[6] Oxygen Attack Theory,[7] Alkaline Theory,[8] and Electrochemical Theory.[9] The Electrochemical Theory, today, is recognized as the standard rule for the manner in which ferrous substrates corrode.

In 1904, Whitney[9] described the primary way in which iron corrodes:

> "Hydrogen acts as a metal and is electrolytically classified in the group with copper when compared with iron and zinc. That is, if a cell were made up on the Daniell model, iron being used instead of zinc, and hydrogen in place of copper, the cell would generate a current when the iron and hydrogen electrodes were connected. Iron would then dissolve with a velocity dependent on the total resistance of the circuit. So also, and for the same reason, iron when placed in a solution containing hydrogen precipitates, just exactly as when placed in the copper-salt solution. That iron does oxidize or dissolve in all solutions containing appreciable quantities of hydrogen ions is well known. This electrochemical relationship between iron and hydrogen is the primal cause of rusting."

Thus, when a piece of iron is immersed in water, the element immediately plated out is hydrogen which gathers on the surface of the iron as a thin invisible film as follows:

$$Fe^{\circ} + 2H_2O \longrightarrow Fe^{+2} + 2H + 2OH^{-} \qquad (1)$$

Usually, the thin hydrogen film is destroyed by either of two mechanisms:

$$2H + \tfrac{1}{2}O_2 \longrightarrow H_2O \qquad (2)$$

or

$$2H \longrightarrow H_2\ (\text{gas}) \qquad (3)$$

In general, the rate of destruction of this thin film is determined by the effective concentration of dissolved oxygen in the water next to the metal and this in turn depends upon such factors as the degree of aeration of the water, whether the water is at rest or in motion, the temperature, the presence of metal surface films or soluble salts, and other factors.[3]

In acid solutions, the reaction is identical but the hydrogen film is removed mainly as bubbles of gas. This happens because the tendency of the hydrogen to plate out from a solution increases as the degree of acidity increases. This accounts directly for the fact that corrosion is generally more rapid in acid solutions and less rapid in alkaline solutions.

With the destruction of this thin hydrogen film, the following reaction is allowed to proceed:

$$2Fe\,(OH)_2 + \tfrac{1}{2}O_2 \longrightarrow \underset{(\text{rust})}{Fe_2O_3 \cdot H_2O} + H_2O \qquad (4)$$

In the presence of oxygen, the ferrous hydroxide is converted into the hydrated form of iron oxide or rust.

The use of coatings for the protection of ferrous substrates from corrosion relies mainly on the ability of the coating to prevent the substances necessary for corrosion from reaching the film/substrate interface.

The extent to which an organic coating will protect a ferrous substrate from corrosion is dependent upon the following factors:

(a) the permeability of the coating to water and water vapor;[10-15]
(b) the permeability of the coating to oxygen;[16-17]
(c) the permeability of the coating to ions;[17-19]
(d) the adhesion of the coating under wet conditions;[20-22]
(e) the resistance of the coating to alkali;[23-25]
(f) the inclusion of a corrosion inhibitor in a coating formulation.

PERMEABILITY OF COATINGS TO WATER AND WATER VAPOR

The permeability of organic coatings to water and water vapor has been studied by many people. The mechanism for the permeability of water and water vapor through organic coatings is a very complex and poorly understood subject.

Many biologists have studied the diffusion of ions through membranes, and one of the earliest theories was based on the idea that ions diffused through pores in the membranes. The "pore theory" was carried over to explain the diffusion of water through organic coatings.

Cherry and Mayne[18] reported that some work had been done measuring the electro-endosmotic transfer of water through paint films and through columns of macerated paint membranes and so determined the existence of pores.

Boxall, et al.[10] studied the water and water vapor permeability of four typical polymers used in protective coatings. He concluded that the water and the water vapor transmission through polymers occurs via capillaries which exist in the crosslinked molecular structure of the coating. He determined that water vapor permeability is generally faster than water transmission, but in the case of chlorinated rubber, the water vapor transmission is slower because water is absorbed on the capillary walls causing a swelling which promotes faster diffusion of the water. No such absorption/swelling phenomena would be possible with water vapor owing to the absence of a condensed liquid phase on the polymer surface.

Other people[10,11] have proposed the presence of intramolecular as well as intermolecular pores in pigmented coatings.

Eckhaus et al,[26] however, did substantiate the existence of pores in pigmented films, but found that these pores only exist as the pigment volume concentration approaches the critical value.

Attempts were made[27-29] to observe pores under an electron microscope, but this was found to be impossible.

In 1950, Wolock and Harris[30] attempted to detect the existence of pores in paint membranes. They absorbed krypton on detached linseed oil films and calculated the roughness factor. They concluded that since the roughness factor was low, the presence of an appreciable quantity of pores can be negated.

If pores did in fact exist, then gases when passed through them should obey Graham's Law of Diffusion.

Northrop[31] measured the rate of diffusion of various gases through cellulose nitrate both when wet and dry and found that in neither case was Graham's Law obeyed. He suggested that this was strong evidence for the absence of pores.

Thus, it appears that if there are pores in a paint film they are of molecular dimensions and under these circumstances the pore theory becomes indistinguishable from the "solution theory."

The "solution theory" states that the diffusing material first dissolves in the paint film and moves through under a concentration gradient.

The "solution theory" can be applied to the work of Perera and Heertjes[11-15] which states that the permeation of water through paint films consists of three steps: (1) the sorption of water at one boundary of the membrane; (2) the diffusion through the membrane under a concentration gradient; and (3) the desorption of the water at the other boundary of the membrane.

The second step is the rate determining step since it was determined by Perera[11] to be the slowest of the three.

In a subsequent study by Perera and Heertjes[14] the diffusion coefficient either increased or decreased depending on the affinity of the polymer for water.

Morgan[32] determined the moisture permeability of a wide variety of film forming materials and concluded that most polymers having low moisture permeability have: a saturated or nearly saturated carbon chain; a minimum of chain branching; a high degree of lateral symmetry; a fair degree of longitudinal symmetry; and a very high proportion of relatively small nonhydrophilic substituents.

Other researchers have concluded that the degree of crystallinity and the hydrophobic or hydrophilic character of the polymer determine its ultimate water vapor permeability.

Brubaker[33] determined that molecular weight did not affect permeability.

Simril and Hershberger[34,35] found that the least permeable films were those whose molecular structure was such as to permit close packing and strong intermolecular bonding.

The solvent used in the coating and the substrate to which the coating is applied can influence the water vapor permeability of films.[36] This is due to the orientation of the molecules in the film due to the nature of the solvent. The closer the structural similarity between the resin and the solvent, the lower the water vapor permeability because of favorable molecular alignment.

Table 1—Permeability to Oxygen of Paint Films Of 100 μm Film Thickness. Partial Pressure of Oxygen = 2×10^3 Nm²

	Permeability to oxygen at various temp. (10^{-3}mg/cm²/day)				
Vehicle Base	**10° C**	**20° C**	**30° C**	**40° C**	**50° C**
Cellulose nitrate	69.3	105.8	149.8	237	318
Alkyd melamine	4.2	10.3	19.2	30.3	50.6
Epoxy resin	4.7	7.3	8.6	17.8	33.7
Vinyl chloride/vinyl acetate					
(i) air dried	3.9	7.5	10.5	29.9	37.5
(ii) force dried	4.1	4.9	6.4	10.7	19.0
Chlorinated rubber	1.1	2.2	3.4	4.3	15.9

We have just reviewed the permeabilities of organic coatings to water and water vapor. In most cases, the water and water vapor permeability of coatings is sufficiently high enough to support corrosion.

Baumann[37] has calculated the amount of water which must be present on a metal surface to allow corrosion at a certain rate. Baumann's calculation shows that 0.003-0.06 mg $H_2O/cm^2/day$ is necessary to allow a corrosion rate of 0.02-0.35 mg $Fe/cm^2/day$. This figure agrees with Hudson and Banfield[38] who indicated that an average value for the rate of corrosion of unpainted mild steel exposed in the open air under industrial conditions would be 0.070 g $Fe/cm^2/yr$ or a rate of 0.191 mg $Fe/cm^2/day$.

The fact that in many cases more water can be supplied by permeation than is needed for corrosion to occur shows that water permeability cannot be the rate-determining step in the corrosion process.

PERMEABILITY OF COATINGS TO OXYGEN

The permeability of coatings to oxygen seems to be the most important aspect when trying to determine whether an organic coating will prevent corrosion.

Speller[3] points out that in a closed system, where the supply of oxygen is limited, the corrosion of iron when immersed in water is greatly reduced.

In 1961, Wettach[39] correlated the oxygen permeability of typical paint films to the degree of rusting on panels immersed in water.

Guruviah[16] studied the relationship between the oxygen and water permeability of detached films with the corrosion of painted panels. For his oxygen permeability data he used a method similar to ASTM 1434-66. He concluded that the rate of corrosion is governed by the permeability of coating films to oxygen. His theoretical calculation of the amount of corrosion based on oxygen permeability did agree to some extent with the experimental calculation observed through salt spray testing and humidity testing of the same paint films on steel. He did see some inconsistencies. For instance, the epoxy polyamide film was low in permeation to oxygen but did show a high degree of rusting in the salt spray cabinet. A possible explanation may be that this film could have had ionogenic properties, allowing the free diffusion of chloride ions, which resulted in attack of the steel.

Haagen[17] tested the oxygen permeability of five paint films: cellulose nitrate, alkyd melamine resin, epoxy resin, vinyl chloride/vinyl acetate (87/13), and chlorinated rubber. The results from this test are shown in *Table* 1.

When the results from *Table* 1 are compared with the calculated amount of oxygen necessary for a corrosion rate ranging from 0.02 to 0.35 mg Fe/cm^2/day as being 8 to 150 × 10^{-3}mg/cm^2/day, it is easy to see that some of the coatings are at or below the calculated threshold value necessary for corrosion.

The data indicates that at higher temperatures the oxygen permeability of some coatings is greatly affected. This may lead to some of the discrepancies in the testing done by Guruviah.

Other factors such as the film thickness of the coating and the relative humidity affect the oxygen permeability of paint films.[40]

Whereas pigmentation influences water permeability in a very specific way, depending on the participation of different diffusional pathway mechanisms, the rate of oxygen diffusion was always found to decrease markedly with increasing pigmentation. This may explain why some pigments, like aluminum flakes, mica, and talc, due to their shape have proved to be most useful in corrosion inhibiting coatings.

The question of why corrosion occurs at all under coating films is still open. It was found that films of some coatings exhibit both high water permeability and very good corrosion resistance. On the other hand, there are also examples of low permeation rates but poor corrosion resistance.

Rothwell[41] has stated that the degree of protection that a coating will afford is likely to be related to its electrical resistance in an environment.

PERMEABILITY OF COATING TO IONS

The question arises as to whether data on the permeability of paint films to water and oxygen are alone sufficient to predict the performance of an organic coating. It has already been stated that the phenomenon of rusting depends on the formation of ions such as Fe^{++} and OH^-. In the case of Fe^{++} ions, formed at the anode, and OH^- ions formed at the cathode, a diffusion through the electrolyte takes place to form $Fe(OH)_2$.

It is the purpose of a coating to restrict the flow of these ions formed at the film/substrate interface and to provide a barrier against the permeation of other anions such as Cl^- and $(SO_4)^{-2}$ anions through the film to the substrate.

Haagen and Funke[17] have concluded that paint films are essentially impermeable to anions such as Cl^- and $(SO_4)^{-2}$. They stated that contamination of the surface must be the cause of corrosive influences. To the contrary, Kittleberger and Elm[42] have found that the permeability of coatings to chloride ions in some cases was of the same order of magnitude as the oxygen permeability. The ability of coatings to allow the permeation of ions must in fact be due to some electrolytic structure.[19]

Cherry and Mayne[18] mentioned the fact that a varnish film even though it contains no pigments which are inhibitive to the anodic reaction, may still prevent corrosion by interposing a path of high electrical resistance between the cathodic and anodic sites. This electrical resistance inhibits the flow of movable ions through the film via fixed ions in the film which act as stepping stones.

In another paper, Mayne[43] showed that films of polystyrene, linseed oil and a coumarone-tung-oil varnish are selectively permeable to cations, which means that when their films are immersed in water the film acquires a negative charge. This charge is believed to arise from carboxyl groups present in the film. Upon immersion in water, these groups ionize, and, thus, the system consists of fixed anions associated with movable cations. These cations may be displaced if a supply is maintained from one side; thus, the membrane is cation permeable. On the other hand, anions cannot enter owing to repulsion from the negatively charged film.

Further investigations by Bacon,[44] who tested about 300 pigmented films, showed that changes in electrical resistance of paint films with time correlate well with their performance in marine environments. Changes in ion exchange capacity with time should, therefore, have some relationship with the ability of paint films to prevent rust.

The ion exchange capacity of alkyds and pigmented alkyds when exposed to a 5% sodium chloride solution in a salt spray chamber had been measured by Malik and Aggarwal.[45] It was observed from their work that an alkyd which shows a slow change in ion exchange capacity with time has better corrosion resistance.

Malik and Aggarwal also found that a pigment having high conductivity decreased the ion exchange capacity to a greater extent than a pigment having low conductivity. It was further observed that the change in ion exchange capacity with time depends on the nature of the binder as well as the pigment present.

Others, such as Ulfvarson, et al.,[46] have found good correlation between the ion exchange of paint films and salt spray testing. The ion exchange capacity of resins is, thus, an important principle and it has been studied by electrochemical means as well as by radiochemical means.[47]

Anderton[23] stated that atmospheric contaminants may permeate the film in the molecular form and then ionize the water-rich layer (WRL). A contaminant such as sulfur dioxide may be converted to the sulphate ion and in this form become locked in the water-rich layer (WRL). Anderton suggested that water will tend to concentrate in the coating near the steel/coating interface. It is this concentration which he calls the water-rich layer. Ionic materials can ionize in this layer and the electrical resistance of this layer will become considerably reduced.

Sea water cations such as Na^+ migrating through the coating would tend to remain in solution in the WRL. Such cations will be hydrated and will carry more into the

WRL. If the adhesion is destroyed, oxygen may diffuse along the interface.

ADHESION OF THE COATING UNDER WET CONDITIONS

Data have been discussed concerning the permeability of coatings to oxygen, water, and ions. The end result of these agents is the loss of adhesion of the coating followed by rusting.

Funke[21] in a paper dealing with the pigment coating/interface stated: "Earlier investigations with unpigmented films showed that the amount of water absorbed by the supported film was in no case less than by the corresponding free film. Moreover, supported films frequently absorbed considerably more water than free ones and tended to blister formation after prolonged immersion. It could be stated that, generally, an increased water absorption of supported films indicated loss of adhesion to the substrate and finally resulted in blister formation or even film detachment." In other words, a comparison between the water absorption of free and supported films enables one to judge whether the interaction between the film and substrate is strong enough to resist the penetration of water into the interface.[20]

Walker[22] has shown that, on exposure of coatings on stainless steel to an atmosphere of high relative humidity, adhesion was reduced below the initial value. He measured initial adhesion values of various coatings on stainless steel and also the adhesion of these coatings after intervals of exposure under controlled humidity. With all types, there was a reduction of adhesion at relative humidities greater than 90%. At 100% relative humidity the adhesion was, in most cases, reduced to half the initial value and in some cases to less than 20%. The loss of adhesion seemed to have been caused by the entry of water into the film, with the initial adhesion having no obvious relationship to the adhesion when exposed to a humid atmosphere. This loss of adhesion could be explained by a concentration of water adjacent to the substrate. Hoffmann[48] has observed the loss of the adhesion of coatings with relative humidity, and in a later paper by Funke and Haagen,[40] it was stated that the loss of adhesion by coatings under wet condition is the primary cause of the breakdown in the corrosion protection of coatings.

RESISTANCE OF THE COATING TO ALKALI

Anderton[23] alleged that the formation of a water-rich layer at the film substrate interface will be more severe if this water-rich layer is alkaline. He stated that the effect of the alkali may be to increase the water concentration by osmotic effects.

Anderton[23] also observed the tendency of some paints to lose adhesion near a bare area on cathodically protected steel immersed in sea water. A strongly alkaline condition exists at the steel/coating interface where adhesion has been lost. The destruction of coatings near bare areas on steel cathodically protected is presumed to occur through the generation of alkali as follows:

$$H_2O + \tfrac{1}{2}O_2 + 2e \longrightarrow 2OH^-$$

To increase the production of hydroxyl ions at the steel/coating interface adjacent to a bare area on steel would increase the exchange of ionic current between the interface and the environment. The resistance of the film to the ionic current may be reduced with time as adhesion is lost until current supply is no longer the controlling factor. The lateral supply of oxygen and water also increases as adhesion is lost.

Leidheiser and Kendig[24] observed the delamination of polybutadiene coatings on steel when immersed in a 0.5M NaCl solution. This delamination was attributed to the formation of hydroxyl ions in the cathodic area surrounding the anodic site. They summarized their work by stating that one of the primary causes for the delamination of polybutadiene coatings on steel is the alkalinity produced at the steel/coating interface.

Smith and Dickie[49] studied the mechanism for the adhesion failure of primers on steel. In this study they used an electrochemical technique which separates the anodic (iron oxidation) and cathodic (oxygen reduction) reactions so that they could be analyzed as to their affect on a film defect (scribe). In this study, the contribution of different substrate preparations to the overall corrosion resistance of coatings was also taken into consideration. The results of this study can be summarized as follows: "Zinc phosphate conversion coatings retarded adhesion failure due to anodic undercutting, but were susceptible to chemical dissolution by cathodically produced hydroxide ions. Iron phosphate conversion coatings were resistant to hydroxide but did not prevent anodic undercutting. In addition, the degree of failure was influenced by the alkaline resistance of the primer."

Thus, it can be seen that the primary cause of adhesion failure in the salt spray exposure testing of coatings may be the cathodic alkali displacement of the paint film.

CORROSION INHIBITORS

It is well known that the addition of a corrosion inhibitor to a coating formulation can affect the corrosion resistance of a coating on steel. The number of corrosion inhibitors that can be added to a coating formulation is too numerous to be listed. Many textbooks and manuals give detailed information on corrosion inhibitors.

Both anodic and cathodic corrosion inhibitors can be used in coating formulations. These designations refer to the property whereby inhibitors preferentially affect either anodic or cathodic sites in a coating system. In general, it is a complex relationship which exists between the vehicle in which an inhibitor is used and the effectiveness of the inhibitor in reducing corrosion.

For example, Mayne,[50] while discussing the inhibitive properties of red lead, zinc oxide, and calcium carbonate, pointed out that investigations have shown that these additives form soaps with linseed oil. These soaps act as strong corrosion inhibitors. Corrosion inhibitors such as lead, zinc, and chromates perform differently and can

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affect corrosion in different ways. The most common problem is not finding a corrosion inhibitor that will enhance corrosion resistance but finding an inhibitor that will in addition not adversely affect other properties.

The inclusion of a corrosion inhibitor in a coating formulation can affect the corrosion resistance of a coating on steel by rejecting, repelling, or neutralizing corrosives such as water, oxygen, and ions that permeate the coating film.

SUMMARY

The corrosion resistance of coatings on steel can be affected by many factors. The most important factors are: the permeability of the coating to water and water vapor; the permeability of the coating to oxygen; the permeability of the coating to ions; the adhesion of the coating under wet conditions; the resistance of the coating to alkali; and the inclusion of a corrosion inhibitor in a coating formulation.

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4 Innovative Anticorrosive Pigments

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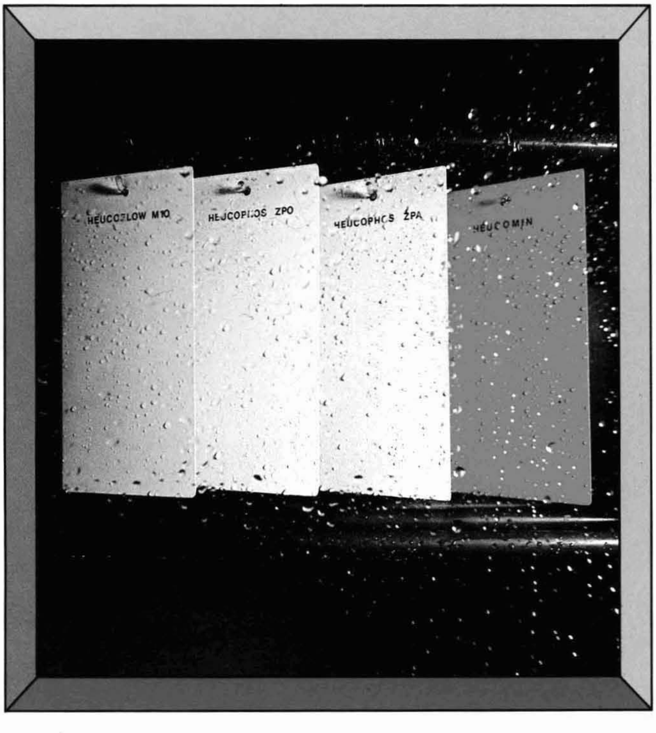
HEUCOFLOW M 10
HEUCOMIN 5



heubach

HEUCOPHOS ZPO
HEUCOPHOS ZPA

New Anticorrosive Pigments on Phosphate Base

In a test the new HEUCOPHOS-Pigments have been compared with high quality zinc chromates and zinc phosphates.

Test Conditions:

Sand blasted sheet metal was coated to 50 ± 5 micron dry film thickness and then weather exposure tests were done.

Pigmentation:

40 vol. % Anticorrosive Pigment
25 vol. % Barium sulphate
25 vol. % Talcum
10 vol. % Titanium dioxide

Binding Agents:

Alkyd resin and Epoxy Esters
In order to guarantee the comparability of the pigments the free binding agent Q = PVK/KPVK has been held constant.

Results:

In the salt spray test better results were achieved in both binding agents for HEUCOPHOS ZPO and ZPA compared to zinc phosphate and same results compared to zinc chromate. In the Kesternich test ZPO and ZPA exceed zinc chromate and zinc phosphate in both cases. The good test results are based on the special analysis, the exactly defined particle size distribution as well as on the optimal pigment surface of ZPO and ZPA pigments. These facts combined with the binding agents lead to effective adhesive and inhibitory complexes on metal substrates.

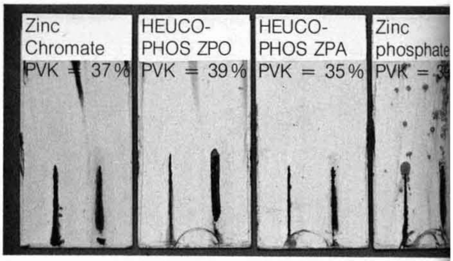
Alkyd resin	Zinc Chromate	HEUCO-PHOS ZPO	HEUCO-PHOS ZPA	Zinc Phosphate
Salt spray test	80	70	80	40
Kesternich test	20	70	70	40

▲▼ Rating Numbers: 100 = very good, 0 = bad ▲▼

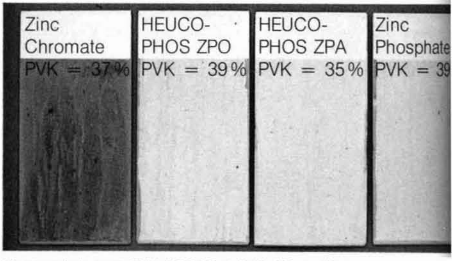
Epoxy Esters	Zinc Chromate	HEUCO-PHOS ZPO	HEUCO-PHOS ZPA	Zinc Phosphate
Salt spray test	90	90	75	35
Kesternich test	20	80	85	60

Resume of the criterions for review of protective effect according to DIN 53209, 53151, 53167

Aklyd resin, modified wood oil – tall oil – oil length

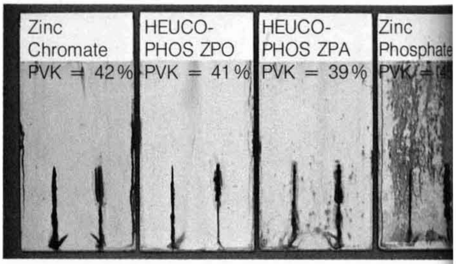


Salt spray test DIN 50021 – 300 h

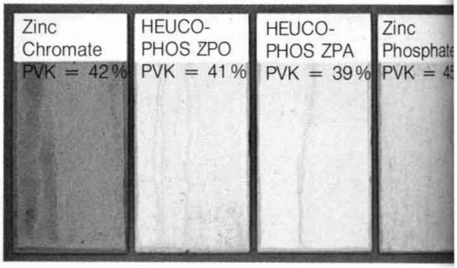


Kesternich test DIN 50018 1.0 S-10 cycles

Epoxy Esters (Q = 0,8)



Salt spray test DIN 50021 – 300 h



Kesternich test DIN 50018 1.0 S-10 cycles heubach

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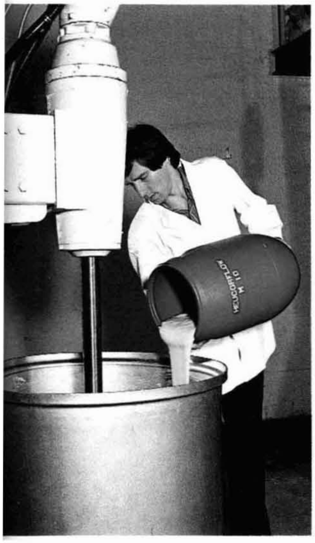
HEUCOFLOW M 10

Zinc Chromate Paste, free of binding agents



HEUCOFLOW M 10 zinc chromate paste eliminates the former industrial hygienic stress as the zinc chromate no longer exists in respirable form.

HEUCOFLOW M 10 zinc chromate paste is an alternative to zinc chromate in powder form without any risks and an immediate replacement.

HEUCOFLOW M 10 zinc chromate paste is free of binding agents, has a 75% pigmentation and with it's 23% share of solvents it can fit into existing zinc chromate recipes without any problem.

HEUCOFLOW M 10 zinc chromate paste shows a Grindometer fineness of below 15 microns for dissolver handling.

Technical Data:

COMPOSITION		HEUCO-FLOW M 10
ZINC CHROMATE M 10	± 1%	75
Aromatics	%	23
Montmorillonites	%	2
Density of Paste	g/cm³	2
Grindometer Fineness	μm	15

COMPOSITION		ZINC CHRO-MATE M 10
CrO_3	%	43,5
ZnO	%	39,0
K_2O	%	10,0
Cl	%	0,02
SO_4	%	0,03
wsl. CrO_3	g/100 cm³/10 g	0,08
Conductivity	m S/cm	1,8
Density	g/cm³	3,5

Reply Card

Please send me a 500-g-sample each of

- ☐ HEUCOPHOS ZPO
- ☐ HEUCOPHOS ZPA
- ☐ HEUCOFLOW M 10
- ☐ HEUCOMIN 5
- ☐ general information on the Heubach-Group

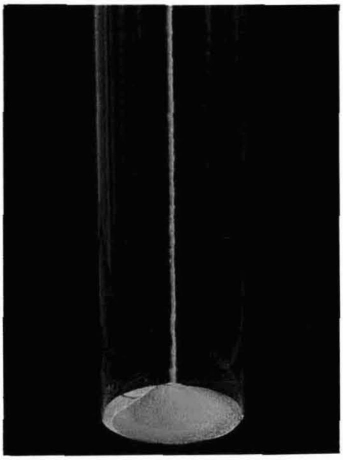
Remarks: ______________________________

heubach

Red Lead non-dusting

The way to meet
OSHA's 50 µm
lead exposure limit

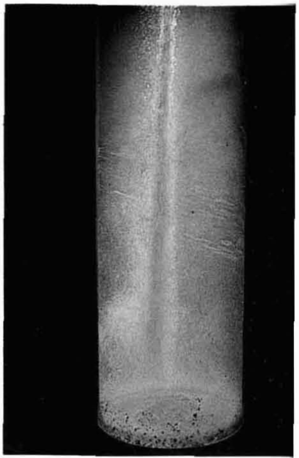
HEUCOMIN 5



HEUCOMIN 5

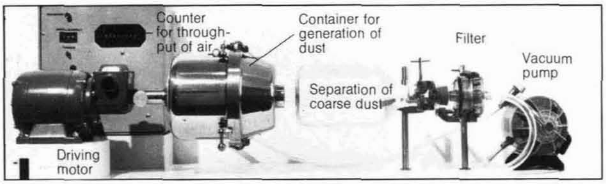
TECHNICAL DATA		Red Lead	
		HEUCOMIN	HIGH DISP.
Dusting Properties	mg/100g	**< 5**	**> 100**
PbO_2	%	> 33,5	> 33,5
Pb_3O_4	%	> 96,0	> 96,0
Density	g/cm³	9	9
Bulking volume	g/ml	1,4	1,4
Tamped volume	g/ml	2,6	2,6
Loss on ignition 750° C	%	0,8	–
Residue on Sieve 63 µm	%	0,1	0,1
Ø particle size (DZV)	µm	0,7	0,7
Oil Absorption	g/100 g	5,0,	5,5

DZV = central value of volume distribution acc. to electronic microscope



Red Lead High Disp

Equipment for Dust Measurements



Technical Description:

Stricter industrial hygienic regulations will in future prohibit the u dusting red lead. As the paint industry cannot dispense with red dusting red lead qualities will be replaced by non-dusting quali e.g. *HEUCOMIN 5*.

The dusting properties of HEUCOMIN 5 are reduced by 95 % co pared with conventional red lead. The handling and anticorrosi properties are identical with high quality red lead HD-types so th direct replacement without modification of recipes is possible.

Name ____________________

Company + Company Address

____

____

____

____

Reply Card

Dr. Hans Heubach
Heubachstraße 7

D-3394 Langelsheim 1
West Germany

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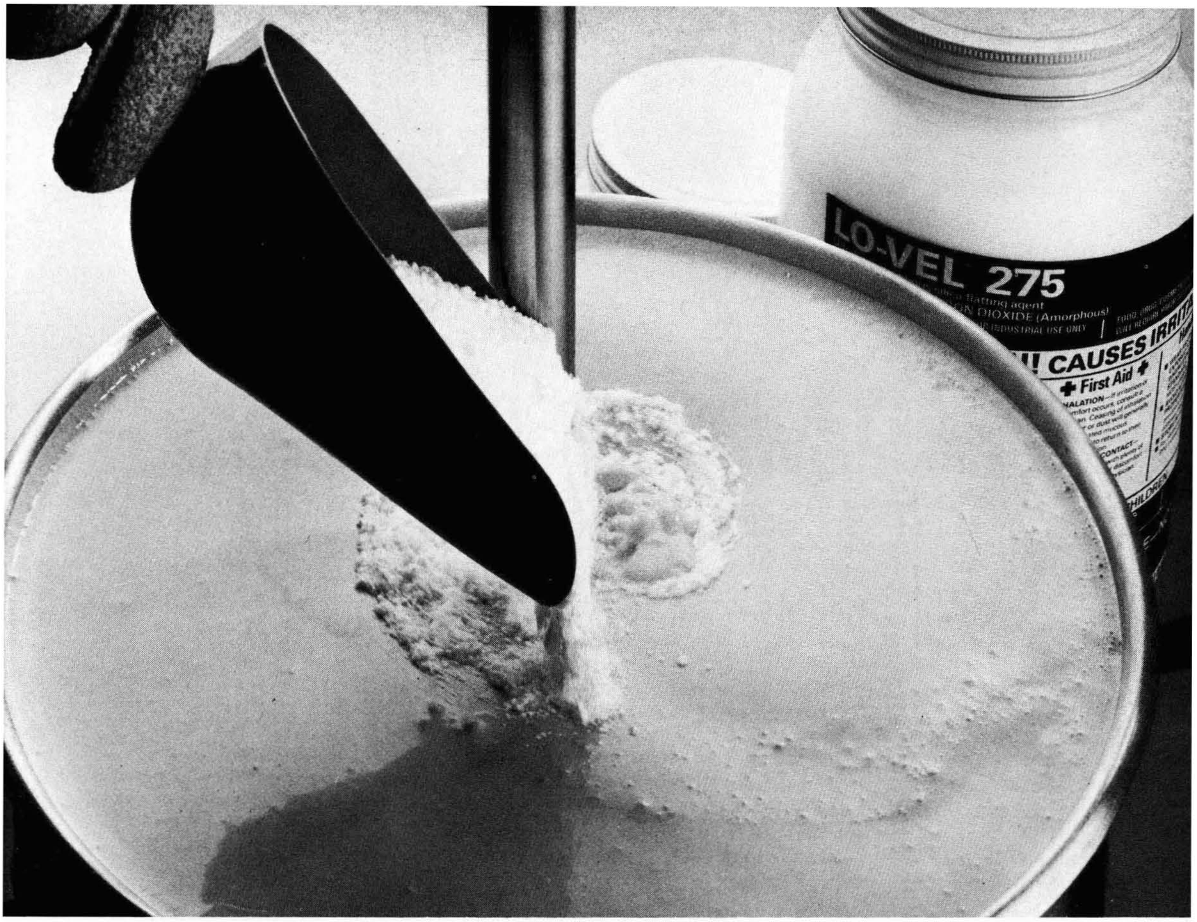
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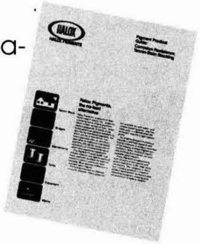

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Solution Properties of High Solids Intermediates

M.A. Sherwin, J.V. Koleske, and R.A. Taller[†]
Union Carbide Corporation[*]

The solution viscosity characteristics of a series of experimental, functionalized cotelomers and selected commercial, low molecular weight polymers were studied. The investigation was conducted with dilute and concentrated solutions to obtain an improved understanding of the effect of polymer structure and functional groups on the rheology of high solids coatings. Intrinsic viscosity results in various solvents indicate that low molecular weight polymers assume equilibrium conformations approaching those of a rigid ellipsoid or spheroid. Results from concentrated solution studies are in agreement with this model, and the viscosities are generally the same for a given polymer in both good and poor solvents. The results indicate that the important considerations for attaining the highest solids coatings are mainly a function of polymer molecular weight and T_g and solvent density and viscosity.

INTRODUCTION

Recently there has been considerable interest in the properties of polymers with a relatively low degree of polymerization. Such polymers have particular interest as intermediates for high solids coatings which are useful in meeting new environmental standards. Typically, a high solids coating contains a functionalized, low molecular weight polymer and a monomeric or oligomeric crosslinking agent dissolved in an organic solvent. The two most common functional moieties on the polymer are hydroxyl or carboxyl groups alone or in combination with each other. The most common crosslinkers are glycidyl and cycloaliphatic epoxides, aminoplasts, or isocyanates.

Over the past few years, various review articles concerning the rheological characteristics of high solids coating intermediates have been published.[1,2] Erickson[3] developed an equation for describing and predicting the viscosity behavior of oligomer solutions. However, compared to high molecular weight polymers, very little fundamental information is available concerning the conformation, structure, and rheology of functionalized low molecular weight copolymers in solution.[2] This investigation is concerned with the dilute and concentrated solution properties of functionalized styrene/acrylic telomers and other low molecular weight polymers. An attempt is made to determine their most probable conformation in solution, the dependence of properties on molecular weight, and the effect of polymer structure, concentration, and temperature on specific polymer-solvent and polymer-polymer interactions.

EXPERIMENTAL

This study is concerned with the solution properties of experimental, functionalized cotelomers and commercial, low molecular weight polymers. The cotelomers were prepared by a free-radical, solution, cotelomerization process using a mercaptan as the chain transfer agent for molecular weight control. They were based on styrene and ethyl acrylate and contained either 2-hydroxyethyl acrylate or acrylic acid as the functionalizing agent.

Intrinsic viscosities were determined at 30°C using a No. 75 Cannon-Ubbelohde dilution viscometer. The polymerization solvent was removed from the cotelomers and other oligomers by drying the solutions in a weighing dish at 110°C at 10 mm Hg for 24 hours. The various solvents used were commercial and used in an as-received condition. Initial concentrations depended on molecular weight and ranged from 3 to 5 g/dL to yield a relative

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[*] Technical Center, P.O. Box 8361, South Charleston, WV 25303.

[†] Present address is Riverain Corp., 11125 Yankee St., Dayton, OH 45401.

Winner of the Interstab Award for best paper presented at the Water-Borne and Higher Solids Coatings Symposium, February 25-27, New Orleans, LA.

Table 1—Molecular and Dilute Solution Parameters For Various Low Molecular Weight Cotelomers and Oligomers

$\bar{M}_w$	Solvent			
	Toluene, 30°C		THF, 30°C	
	[η]	k′	[η]	k′
Cotelomers[a]				
29,620	0.116	0.49	0.134	0.49
13,540	0.079	0.56	0.083	0.61
11,110	0.061	0.80	0.065	0.78
5,680 (Cotelomer A)	0.055	0.85	0.060	0.94
Commercial acrylic[b]				
1,350	0.027	1.96	0.026	0.90
Epoxide[c]				
270	0.023	1.06	0.022	2.40

(a) Styrene equivalent molecular weights obtained by GPC for styrene/ethyl acrylate/2-hydroxyethyl acrylate (42.5/45/12.5) cotelomers.
(b) Hydroxyl-functionalized, all-acrylic oligomer.
(c) Bisphenol A epoxide with epoxide equivalent weight = 185–192.

viscosity between 1.1 and 1.5.[4] The solutions were maintained at ambient conditions for 24 hours and filtered using a stainless steel syringe that held a fiber filter before viscosity measurements were made.

Concentrated solution viscosities were determined between 30° C and 60° C using calibrated Ubbelohde viscometers (Sizes 2B-5). Viscosity is reported in centistokes. The polymer was dried as described above. Solutions were prepared by gently rotating the polymer and solvent in a closed container through a heated water bath.

DILUTE SOLUTION CHARACTERISTICS

Mark-Houwink Relationships

The intrinsic viscosity (η) of a polymer solution is a sensitive measure of the ability of a polymer molecule to enhance viscosity. The relationship between intrinsic viscosity and molecular weight is expressed by the well-known, empirical, Mark-Houwink equation.

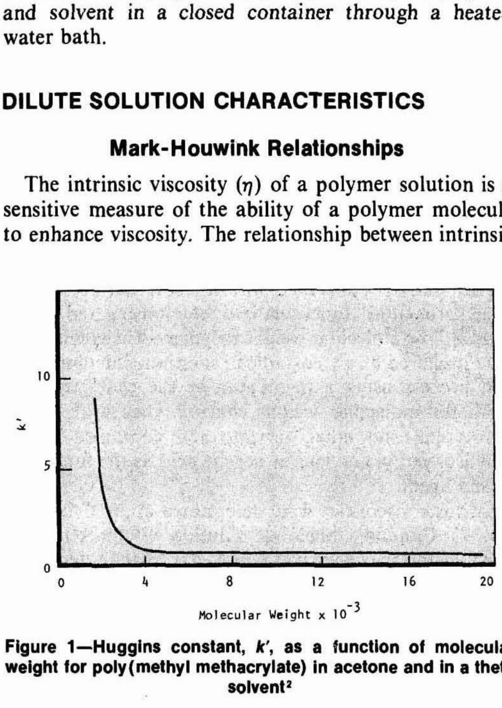

Figure 1—Huggins constant, *k′*, as a function of molecular weight for poly(methyl methacrylate) in acetone and in a theta solvent[2]

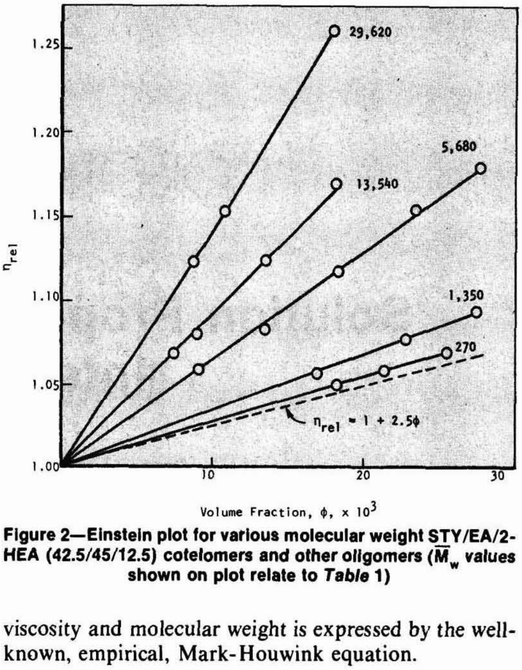

Figure 2—Einstein plot for various molecular weight STY/EA/2-HEA (42.5/45/12.5) cotelomers and other oligomers ($\bar{M}_w$ values shown on plot relate to *Table* 1)

$$(\eta) = K\bar{M}^a$$

For the low molecular weight styrene/ethyl acrylate/2-hydroxyethyl acrylate copolymers described in *Table* 1, the following constants were obtained for the Mark-Houwink equation.

$$[\eta] = 8.7 \times 10^{-4}\,\bar{M}_w^{0.47} \text{ (toluene, 30° C)}$$
$$[\eta] = 7.3 \times 10^{-4}\,\bar{M}_w^{0.50} \text{ (THF, 30° C)}$$

For a specific polymer-solvent system, the magnitude of *a*, which usually varies between 0.5 and 0.8, is a measure of solvent quality on the hydrodynamic volume of the polymer molecule. Generally, *a* approaches 0.5 in poor solvents and is 0.5 under theta conditions. It increases from 0.5 to its upper limit as solvent quality improves wherein the polymer molecules approach free draining coils. At first thought, it might seem surprising that the constants, *K* and *a*, are so similar for the functionalized cotelomers in obviously different types of solvent.

However, this is in agreement with certain investigators who found that the constant *a* becomes 0.5 irrespective of solvent for certain low molecular weight polymers (M < about 10,000).[5-7] Although thermodynamic conditions in these solutions are probably far from those of theta-like conditions, it is not unreasonable to assume that the solvent environment should be less important as the polymer chains decrease in length.

Huggins Constant

Further evidence that low molecular weight polymers do not follow the relationship developed for high polymers can be found by examining the Huggins equation.

$$\eta_{sp}/c = [\eta] + k'[\eta]^2C$$

Table 2—Solubility Parameters and Physical Properties of Various Solvents

	Solvent						
	Butyl Acetate	**Butoxy-ethanol**	**Ethoxyethyl Acetate**	**MEK**	**MIBK**	**THF**	**Toluene**
Solubility parameters							
Non-polar	7.09	7.12	7.02	6.88	7.06	7.19	8.00
Polar	3.79	2.54	4.41	4.52	3.94	4.43	3.90
H-Bond	3.30	6.35	4.33	4.63	2.88	3.28	0.79
Total	8.69	9.87	9.35	9.45	8.58	9.06	8.93
Molecular weight	116.16	118.18	132.16	72.10	100.16	72.11	92.14
Relative evaporation rate	100	8	20	630	164	800	225
Viscosity							
Centistokes, 30°C	0.76	2.84	1.16	0.48	0.67	0.52	0.61
Density, g/mL, 30°C	0.8709	0.8921	0.9651	0.7945	0.7914	0.8791	0.8578
Molar volume, cc/mole	133.38	132.47	136.94	90.75	126.56	82.03	107.41

which is used to extrapolate viscosity data as a function of concentration to infinite dilution. The Huggins constant, k', is related to the polymer-solvent interactions and the hydrodynamic volume of the polymer molecule. The value of k' normally varies between 0.35 (good solvent) and 0.5 (poor or theta solvent) for high polymers. The experimental values of k' obtained for the cotelomers investigated, a commercial functionalized acrylic polymer, and a commercial epoxide, are summarized in *Table* 1. For both solvents considered, k' increases as the molecular weight decreases. Dramatic increases in k' are obtained for the very low molecular weight acrylic and epoxide. Similar large increases in k' with decreasing molecular weight have been described by Shaboldin and coworkers,[2] and their findings are described in *Figure* 1. The increase in k' has been attributed to an increase in the packing density of the coiled polymer as the molecular weight decreases. This results in weakly solvated polymer coils which are relatively impermeable to solvent, i.e., essentially nondraining in character. The short chain length molecules assume a more spherical conformation than the prolate conformation of high polymers.

Einstein Relationship

If these low molecular polymer chains indeed assume rigid spheroid conformations, they should also approach or follow the Einstein viscosity relationship for rigid impermeable spheres.[8] The Einstein equation is as follows:

$$\eta_{rel} = 1 + 2.5\phi$$

where ϕ is the polymer/solvent volume ratio and η_{rel} is the polymer solution/solvent viscosity ratio. The Einstein plots for the cotelomers and oligomers listed in *Table* 1 are shown in *Figure* 2. The dotted line represents the theoretical η_{rel} vs ϕ relationship for rigid impermeable spheres. A hydroxyl-functionalized cotelomer ($\overline{M}_w = 29{,}620$), as expected, does not provide a close fit with the Einstein relationship. However, as the cotelomer $\overline{M}_w$ decreases to 5,680, the slope of the line approaches the Einstein slope. The acrylic, with $\overline{M}_w = 1{,}350$,

Table 3—Physical Properties and Intrinsic Viscosity Values Of Functionalized Cotelomers and Oligomers in Various Solvents

			[η], dL/g @ 30°C						
Cotelomers/Oligomers	**$\overline{M}_w$[a]**	**T_g, °C**	**Butyl Acetate**	**Ethoxyethyl Acetate**	**Butoxy-ethanol**	**MEK**	**MIBK**	**THF**	**Toluene**
STY/EA/2-HEA (42.5/45/12.5 (Cotelomer A)	5.68	13	0.057	0.055	0.051	0.054	0.054	0.060	0.055
STY/EA/AA (42.5/42.5/15)	8.51	27	—	0.088	0.084	0.084	0.079	0.089	0.047[b]
STY/EA/AA (46/46/8)	12.97	26	—	0.089	—	—	0.083	0.088	0.045[b]
Acrylic oligomer[d]	1.35	−14	—	0.032	0.036	0.027	0.034	0.026	0.027
Epoxide[d]	0.27	−16	—	0.026	0.023	—	0.029	0.022	0.023
Polyester polyol[d]	4.66	−57	—	0.043	—	0.039	0.044	—	0.043
Vinyl terpolymer[c]	14.86	45	0.127	—	—	—	0.125	0.130	0.124[e]

(a) Gel permeation chromatography (styrene equivalent molecular weight)—values are $\overline{M}_w \times 10^{-}$

(b) Hazy solutions.

(c) Hydroxyl-functionalized, vinyl chloride-based terpolymer.

(d) Commercially obtained polymers.

(e) [η] obtained using MIBK/Toluene (50/50, w/w).

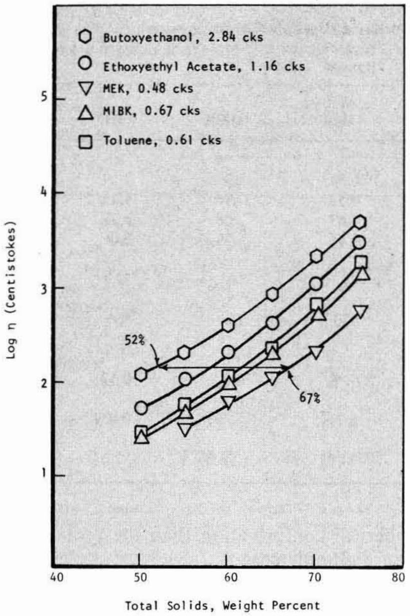

Figure 3—Viscosity-weight solids profiles for Cotelomer A in various solvents at 30°C

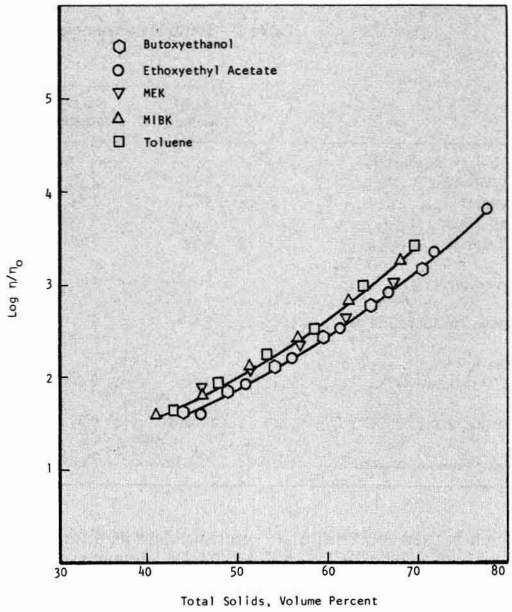

Figure 5—Log η/η_o vs concentration for Cotelomer A in various solvents at 30°C

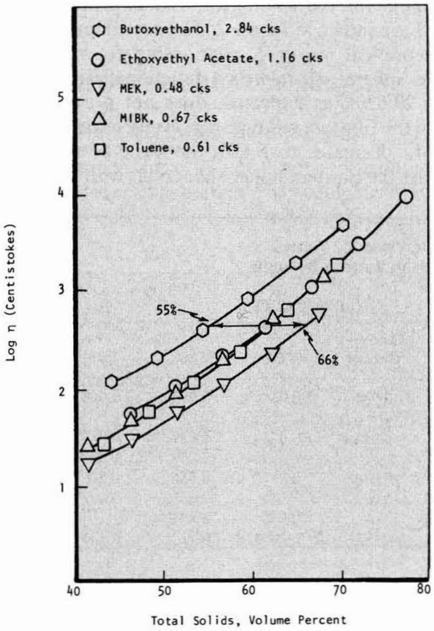

Figure 4—Viscosity-volume solids profiles for Cotelomer A in various solvents at 30°C

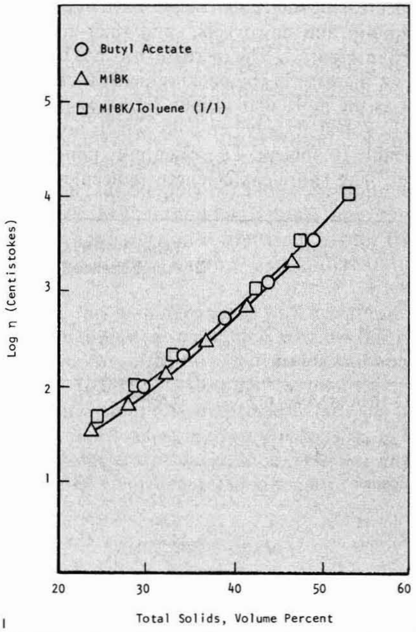

Figure 6—Viscosity-solids profiles for vinyl terpolymer ($\overline{M}_w$ = 14,860) in various solvents at 30°C

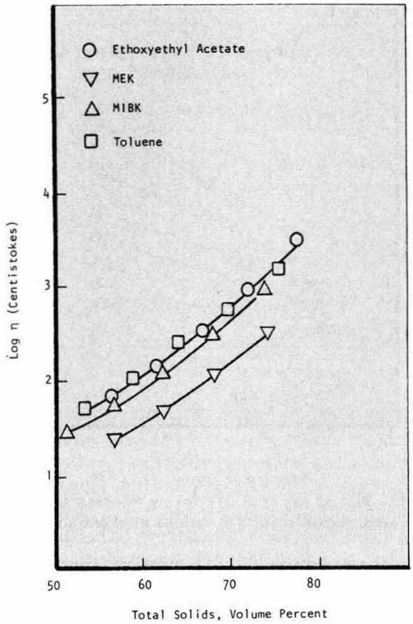

Figure 7—Viscosity-solids profiles for acrylic oligomer ($\overline{M}_w$ = 1,350) in various solvents at 30°C

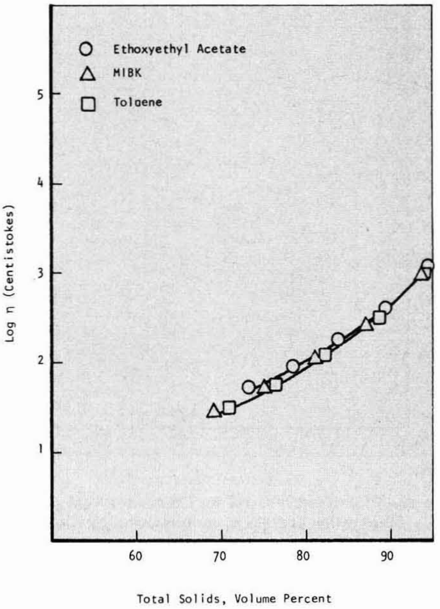

Figure 8—Viscosity-solids profiles for an epoxide ($\overline{M}_w$ = 270) in various solvents at 30°C

provides an even closer approach. Finally, the epoxide $\overline{M}_w$ = 270 closely approximates the Einstein relationship. These results coupled with the values for the Mark-Houwink and Huggins constants indeed suggest that functionalized, low molecular weight copolymers in solution can be considered to assume conformations approaching rigid, impermeable spheres.

Solubility Parameter

The above results also suggest that conventional solubility theories regarding polymer-solvent interactions may not be useful for formulating coatings based on low molecular weight copolymers. In the past, the difference in the intrinsic viscosity of a high polymer determined in various solvents has been used to determine the solubility parameters for that polymer. In a good solvent, the polymer segments were uncoiled and the intrinsic viscosity was high, while in a poor or theta solvent the polymer was tightly coiled and the intrinsic viscosity was lower. The polymer solubility parameter was assumed to be the same as that solvent which provided the highest intrinsic viscosity.[9]

The solubility parameters and physical properties for various solvents are summarized in *Table* 2. Solvents with a wide range of solubility parameters,[10] solvent viscosities, and molar volumes are included. Generally, these three properties are used to predict viscosities of conventional polymer solutions. The intrinsic viscosities of hydroxyl- and carboxyl-functionalized cotelomers as well as other oligomers were determined at 30°C in these solvents. The results are summarized in *Table* 3. For the styrene/ethyl acrylate/2-hydroxyethyl acrylate, commercial acrylic oligomer, commercial epoxide, commer-

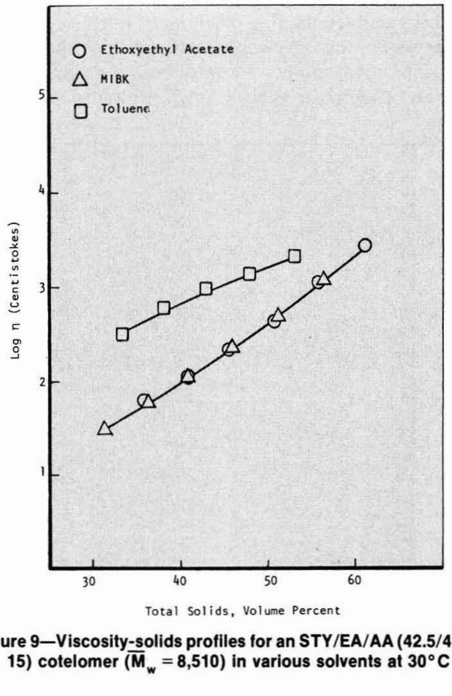

Figure 9—Viscosity-solids profiles for an STY/EA/AA (42.5/42.5/15) cotelomer ($\overline{M}_w$ = 8,510) in various solvents at 30°C

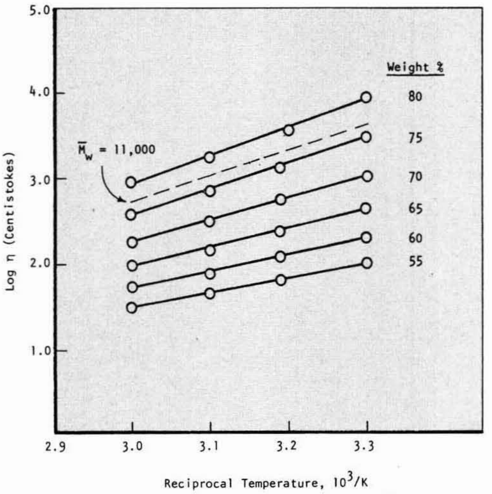

Figure 10—Plot of log η vs 1/T for Cotelomer A ($\bar{M}_w$ = 5,680) in ethoxyethyl acetate at various concentrations

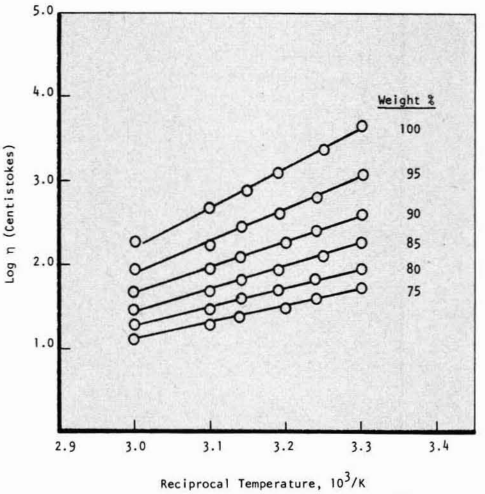

Figure 12—Plot of log η vs 1/T for an epoxide ($\bar{M}_w$ = 270) in ethoxyethyl acetate at various concentrations

cial oligomeric epoxide, and a developmental hydroxyl-functionalized, vinyl chloride-based terpolymer, the variation in intrinsic viscosity values between solvents of dramatically different solubility characteristics is relatively small. The notable exceptions are the two, experimental, carboxyl-functionalized, styrene/ethyl acrylate/acrylic acid cotelomers which show a dramatic 50% decrease in intrinsic viscosity when toluene is used in place of an oxygenated solvent. The lower solution viscosity in toluene compared to tetrahydrofuran may be a result of strong intramolecular hydrogen bonding between the carboxyl groups which serves to collapse the polymer and thus tends to exclude the solvent.[11] However, even for these acid-containing cotelomers, intrinsic viscosity values within the oxygenated solvents once again show only minor variations. At this time, it is difficult to estimate whether or not the small, observed variations in intrinsic viscosity values for a particular functionalized low molecular weight polymer do represent some change in the equilibrium configuration of molecular segments.

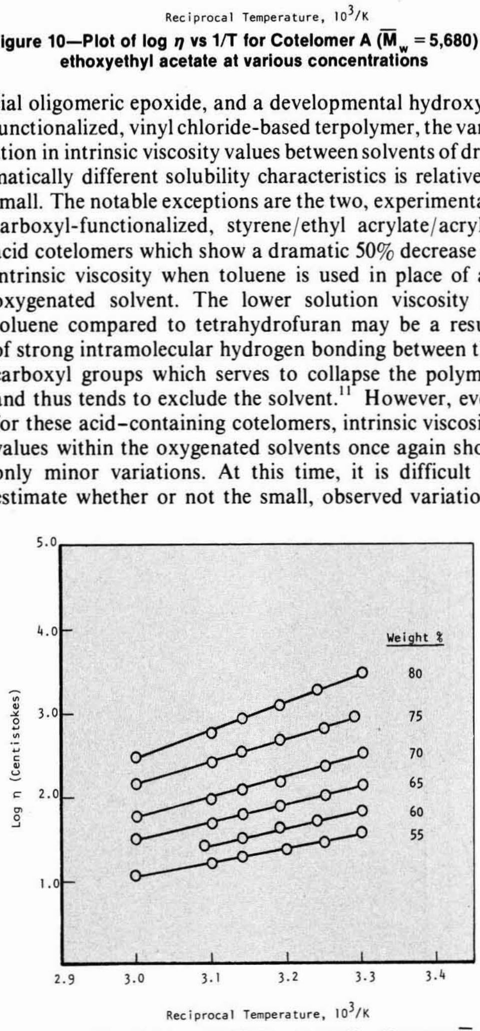

Figure 11—Plot of log η vs 1/T for an acrylic oligomer ($\bar{M}_w$ = 1,350) in ethoxyethyl acetate at various concentrations

Now it is of interest to examine the concentrated solution behavior of these low molecular weight polymers. This will allow one to ascertain whether or not the insensitivity to differences in thermodynamic solvent quality observed in dilute solution is also true for concentrated solutions.

CONCENTRATED SOLUTION CHARACTERISTICS

Effect of Solvent Quality, Density, and Viscosity

The low-shear solution viscosities at various polymer concentrations of the experimental 5680 $\bar{M}_w$ hydroxyl cotelomer (Cotelomer A) were determined in a number of solvents with quite different solubility parameters. The 30° C viscosity curves for these solutions are shown in *Figure* 3. When weight percent polymer solids is used as the independent variable, a large difference, which is related to both solvent viscosity and density, is obtained with the solvents. Methyl ethyl ketone (MEK) provides about 15% higher solids than butoxyethanol at equal solution viscosity. Such a plot is not, however, a true comparison of solvent quality since the solvents have different densities. Hence, even though the same weight of solvent was used, different volumes were used to dissolve a given volume of polymer.

When the data are replotted using polymer volume percent solids as the abscissa, the difference in the curves is markedly reduced (*Figure* 4). The only remaining deviations are found with butoxyethanol and MEK which have the highest and the lowest neat solvent viscosity, respectively (*Table* 2). The effect of solvent viscosity may be removed by using the relative viscosity which serves to normalize the data (*Figure* 5).

$$\eta_{rel} = \eta_{solution}/\eta_{solvent}$$

Table 4—Apparent Activation Energies for Cotelomer A In Various Solvents

	Apparent Activation Energies, Kcal/mole				
Weight % Total Solids	Butoxy-ethanol	Ethoxyethyl Acetate	Toluene	MIBK	MEK
80	—	15.36	—	—	—
75	14.64	13.32	12.31	11.65	9.30
70	13.42	11.69	10.63	9.41	7.93
65	11.74	9.85	8.36	8.39	6.86
60	10.52	8.92	7.86	7.36	5.95
55	9.46	7.67	6.93	6.33	5.34
50	—	—	—	5.69	—

Although the curves are not completely superimposable, the maximum spread between them has been decreased to 3%. This spread probably represents the small differences in polymer-solvent interactions among these different solvents. The close similarity of the normalized curves supports the premise of small, effectively impermeable (or nondraining) spheres that were developed at low concentrations; and it clearly indicates that the low molecular weight chains remain tightly coiled even in very concentrated solutions for ordinary solvents.

Of course, in commercial usage, the actual viscosity rather than η_{rel} is critical to obtain the highest solids at practical viscosities. In that instance, the viscosities of the solvents themselves would be important. The curves in *Figure* 4 show that pure MEK would allow an 11% higher volume solids than butoxyethanol. This separation is nearly constant over the entire solids range even though the relative amount of the solvents is greatly reduced at the higher polymer concentrations. Thus, solvent viscosity can play a determining role in attaining the highest solids level. In this example, ethoxyethyl acetate would offer a good combination of solvency, volatility, and low viscosity.

The solution viscosities of other types of functionalized low molecular weight polymers were determined in appropriate solvents. The values for a hydroxyl-functionalized vinyl chloride terpolymer ($\overline{M}_w = 14{,}860$) are shown in *Figure* 6. There are very small differences in viscosity between butyl acetate, MIBK, and 1/1 blend of MIBK and toluene. Ordinarily, butyl acetate is not considered a good solvent for vinyl polymers; but at this molecular weight, that was no longer true. An acrylic oligomer ($\overline{M}_w = 1{,}350$) showed the same insensitivity to solvent type with only MEK giving a large deviation (*Figure* 7). A nearly monomeric glycidyl ether epoxy resin ($\overline{M}_w = 270$) gave very similar results (*Figure* 8). The only system with a significant deviation was a carboxylated cotelomer of 8,500 $\overline{M}_w$ (*Figure* 9). It gave an appreciably higher viscosity in toluene than in oxygenated solvents. Based on the intrinsic viscosities (*Table* 1), toluene should have afforded the lowest viscosity due to the intramolecular associations postulated previously. It is likely that at high concentrations both *inter*- and *intra*molecular associations are present, thus forming a partial "network" structure in the relatively poor solvent, toluene.

Two general conclusions may be made at this point. The solvent quality has only a minor effect on the concentrated solution viscosity of low molecular weight polymers with the notable exception of highly carboxylated resins. The neat solvent viscosity does have a strong effect on concentrated solution viscosity.

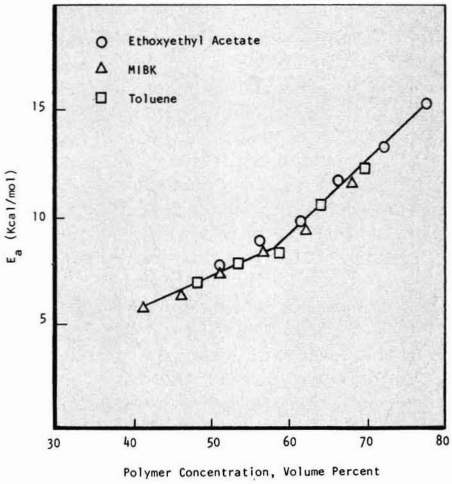

Figure 13—Apparent energy of activation for viscous flow vs concentration for Cotelomer A in various solvents

Temperature Effects

The viscosities of three hydroxylated cotelomers which differ only in molecular weight were determined over a concentration range of 55 to 80% by weight and a tem-

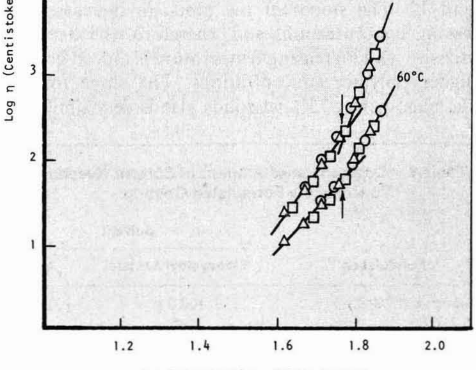

Figure 14—Log η vs log concentration plot for Cotelomer A in various solvents at 30°C and 60°C

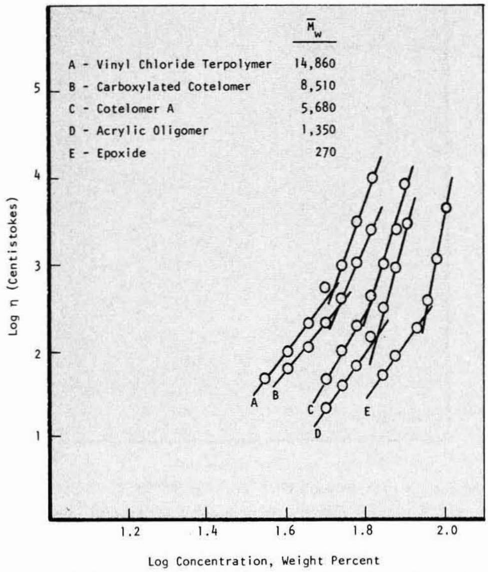

Figure 15—Log η vs log concentration plot for various cotelomers and oligomers in ethoxyethyl acetate at 30°C

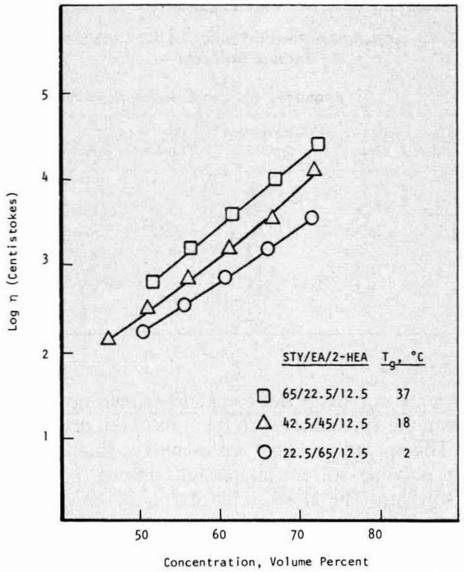

Figure 16—Effect of T_g on the viscosity of various STY/EA/2-HEA compositions ($\overline{M}_w \sim 10{,}000$) in ethoxyethyl acetate at 30°C

perature range of 30 to 60°C. Plots of log η vs reciprocal temperature in hydroxyethyl acetate are given in *Figure* 10 for Cotelomer A, which is the lowest molecular weight member of the series. The plot for the 75% solids data for the 11,000 $\overline{M}_w$ analog is superimposed. Although the two 75% lines occur at different viscosities, the lines are almost parallel. The slope of the 75% solids data for a 30,000 $\overline{M}_w$ analog is also very similar. This result is somewhat different from the widely reported[1,12,13] statements that the viscosity of solutions of low molecular weight polymers ($\overline{M}_w < 10{,}000$) decrease more rapidly with increasing temperature than do those of higher molecular weight polymers ($\overline{M}_w > 20{,}000$). This study suggests that when similar polymers are compared at equal concentrations in the same solvent, there is little or no difference in the viscosity-temperature slopes.

There is a small effect when dissimilar polymers are compared. Log η vs reciprocal temperature plots for the acrylic oligomer and the epoxy resin are given in *Figures* 11 and 12. The slopes of the plots do increase with increasing concentration; and, therefore, the decrease in viscosity with increasing temperature is indeed greater at higher polymer concentrations. The slope for the acrylic oligomer at 75% wt solids also is very similar to those of the three cotelomers. The very low molecular weight epoxy shows some deviation, and the 85% solids line matches the 75% lines for the other polymers. This small change given by the epoxy resin is probably due to differences in thermal volume expansions of the solvent and resin over the temperature range. It would be of interest to determine the thermal expansion coefficient of different molecular weight polymers and then compare systems using accurate corrections for volume solids changes at the different temperatures.

Energy of Activation for Viscous Flow*

The slopes of the plots of log η vs 1/T may be used to calculate the apparent heat of activation, E_a, of viscous flow. E_a is calculated from the Arrhenius equation

$$\eta = A \exp(-E_a/RT)$$

where A is a frequency factor and R is the gas constant. The apparent E_a values for Cotelomer A are listed in *Table* 4. When those values for hydroxyethyl acetate,

Table 5—Comparison of Amount of Solvent Needed To Reduce a Formulated Coating

Formulation	Solvent Ethoxyethyl Acetate	MIBK
Cotelomer A (67% T)	100.0 g.	100.0 g.
P/B 0.7 TiO_2	—	—
Cycloaliphatic epoxide	23.1 g.	23.1 g.
Solvent Needed for 30 sec. No. 2 Zahn		
Weight	22.5 g.	18.5 g.
Volume	23.2 mL	23.2 mL

Table 6—Comparison of Critical Concentration With Applications Solids

Oligomer	Application Solids, 200 cps	Log η vs. Log C, % Solids at Break
Vinyl chloride terpolymer	51%	52%
Cotelomer A	64%	63%
Acrylic oligomer	69%	68%

Polymer —70 Parts
Hexamethoxymethylmelamine—30 Parts
Ethoxyethyl acetate —As Needed for 200 cps

---

*It is worth noting that B. J. Alder and J. H. Hildebrand, *Ind. Eng. Chem. Fundamentals*, *12*, No. 3, 387 (1973), point out that the variation of viscosity with temperature can be represented by a linear relationship rather than the exponential expression used in this paper.

MIBK, and toluene solvents are plotted vs volume percent solids, there is a definite change in slope at 57 volume percent solids (*Figure* 13). The closeness of the data points and the common inflection point further indicate that there is little interaction between the solvents and this particular low molecular weight cotelomer.

If low molecular weight polymers do assume conformations approaching rigid impermeable spheres, the abrupt change in E_a at a given concentration may be attributed to some sort of packing or critical interaction of the spheres. One method of determining contact or entanglement regions in solution is to plot log η vs log volume concentration.[14] Polymer contact or entanglement is noted by a characteristic abrupt change in slope similar to those observed in log η vs $\overline{M}_w$ plots for polymer melts.[14-17] Whereas polymer melt viscosity increases sharply at the critical molecular weight for entanglement from a slope of 1.0 to a constant 3.4 power dependence on $\overline{M}_w$, polymer solutions show a somewhat less pronounced change at an analogous breakpoint. Also, the slope is about 6 below the breakpoint and 10–14 above the breakpoint.[14] It should be noted that most of the other log η vs log concentration plots reported to date[14-17] are for relatively high molecular weight polymers.

The log η vs log volume concentration plots for Cotelomer A in ethoxyethyl acetate, MIBK, and toluene are shown in *Figure* 14. At 30° C, there is a breakpoint at 57% volume solids which corresponds exactly with the breakpoint at 57% solids in the E_a plot (*Figure* 13). A similar break is observed when the temperature is increased to 60° C. *This is not unexpected since these critical interaction regions are temperature independent.*[15]

The interaction regions are dependent upon the polymer molecular weight. As shown in *Figure* 15, the log η vs log weight concentration plots, for the various low molecular weight polymers, exhibit a change in slope that shifts to higher concentration as the molecular weight decreases. Since even the lowest molecular weight systems still exhibit the change in slope, it must be due to some type of interaction between spherically shaped entities rather than any type of classical molecular entanglement.

Effect of T_g

It is well-known that lower T_g systems have lower viscosity at equal concentrations. To quantify this effect, three styrene-acrylic cotelomers were prepared with different ratios of styrene to ethyl acrylate and at similar molecular weights. The solution viscosity curves vs volume solids for these cotelomers are given in *Figure* 16. Approximately a 10% increase in volume solids may be obtained solely by a large decrease in polymer T_g.

PRACTICAL APPLICATIONS

It has been shown that low molecular weight polymers useful as intermediates for high solids coatings assume a spherical shape in both dilute and concentrated solution in a variety of typical coating solvents. This relative insensitivity to solvent solubility parameters indicates, on the practical level, that the attainment of very high solids will be a function primarily of polymer T_g and molecular weight and solvent density and viscosity. An example of the influence of solvent density would be to reduce a high solids coating formulation to spray viscosity using different solvents (*Table* 5). Here the lower density of MIBK allows the use of less solvent to attain the same viscosity.

The influence of polymer molecular weight can be illustrated by reducing a number of polymers to application viscosities and then comparing the total solids to polymer molecular weight. The data in *Table* 6 indicate that the change in slope of the log η vs log concentration plot correctly predicted the results. The direct influence of polymer T_g upon application solids is evident from the curves in *Figure* 15. Thus, the results of fundamental solution property studies can be used to design high solids coatings with the highest application solids.

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Use of Amine Triflate Catalysts And Fluorochemical Surfactants In High Solids Epoxy Coatings

Roger R. Alm
3M Company*

Amine triflate catalysts and fluorochemical surfactants can be used in formulating one-part, epoxy-based, high solids thermoset coatings. The necessity of employing these fluorochemical additives vs state-of-the-art acid catalysts and flow control agents is clearly demonstrated.

Four unique starting point high solids formulations based on commercially available liquid epoxy resins, condensation resins, and polyols are presented which, when baked, exhibit a wide variety of cured film properties.

INTRODUCTION

Coating additives are now available which make possible, for the first time, the formulation of liquid epoxy-based, high solids thermoset coatings with extended shelf life. The two types of additives which make this possible are both based on fluorochemicals, i.e., acid catalysts and surfactants. The fluorochemical acid catalysts, amine salts of trifluoromethanesulfonic acid, can catalyze thin film epoxy homopolymerization and epoxy copolymerization with hydroxy-functional oligomers, aminoplasts, and phenolics. Incorporation of organic-active fluorochemical surfactants makes possible the wetting of low energy, hard-to-wet surfaces and insures good leveling during the bake cycle. With these high surface energy resins the need for improved wetting becomes increasingly critical as solids levels are progressively raised.

Utilizing these fluorochemical additives, totally new high solids thermoset formulations can be developed, based simply on previously uncurable blends of commercially available resins. When baked, these coatings give a broad range of cured film properties while exhibiting unusually low emission levels.

FLUOROCHEMICAL ACID CATALYSTS

Trifluoromethanesulfonic acid, CF_3SO_3H, is a Brönsted "superacid" which can effectively acid-catalyze both condensation and epoxy ring-opening resin reactions.[1,2] The condensation catalyst function is predictable since other Brönsted acids such as p-toluenesulfonic acid and phosphoric acid have been used successfully in this regard for years. However, the epoxy ring-opening feature of CF_3SO_3H is unusual since Brönsted acids, even strong ones such as p-toluenesulfonic acid (pTSA), perform poorly due to termination of the propagating carbonium ion by the nucleophilic acid anion (*Figure* 1). The very non-nucleophilic character of the trifluoromethanesulfonate (abbreviated "triflate") anion, however, allows CF_3SO_3H to cationically polymerize epoxides as if it were a Lewis acid such as BF_3 (*Figure* 2).

CF_3SO_3H can also catalyze the copolymerization of epoxides with hydroxyfunctional oligomers such as simple polyols (*Figure* 3).

In order to achieve extended pot life with epoxy resins, it is desirable to block CF_3SO_3H with an amine.[3] Upon

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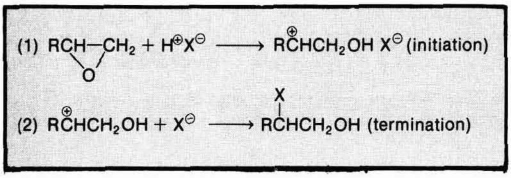


Figure 1—Inability of typical Brönsted acid to homopolymerize epoxide

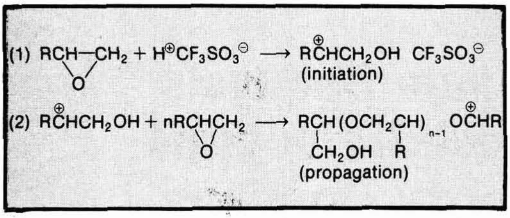


Figure 2—Homopolymerization of epoxide using CF_3SO_3H

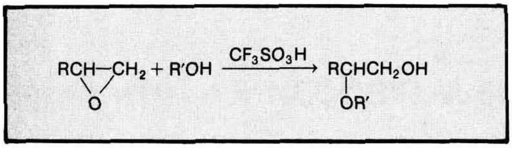


Figure 3—Epoxy-hydroxy coreaction catalyzed by CF_3SO_3H

$$R_1R_2R_3{}^{\oplus}NH\ CF_3SO_3{}^{\ominus} \xrightarrow{\Delta} CF_3SO_3H + R_1R_2R_3N \uparrow$$

Figure 4—Thermal decomposition of amine triflate to liberate free acid

heating with a reactive resin, the amine triflate decomposes to liberate the free acid (*Figure* 4).

Cure response and shelf life for a given formulation are dependent on both the blocking amine for the acid and the epoxy resin selected. The more volatile or less basic the amine, the more reactive and less shelf stable the formulation becomes (*Table* 1). For example, ammonium triflate is more reactive and less stable than triethylammonium triflate.

Virtually any epoxy resin can be employed in a formulation with triflate catalysts. Cycloaliphatic epoxides, which are acid sensitive, can be cured at lower temperatures than amine sensitive glycidyl ethers such as the diglycidyl ether of Bisphenol A. Selecting a liquid epoxide as the primary resin enables the formulation of very high solids coatings which exhibit a wide range of cured film properties.

In *Table* 2, the catalytic ability of FC-520, a commercially available 60% solution of diethylammonium triflate,[4] is compared to that of the Brönsted acid, pTSA, and the Lewis acid, boron trifluoride monoethylamine complex ($BF_3 \cdot$ MEA), in curing a number of commercially available resins and resin blends. Note that FC-520 is effective as both an epoxy ring-opening and a condensation resin catalyst and outperforms pTSA and $BF_3 \cdot$ MEA in most systems. The greatest advantage of using FC-520 is evident when a multiplicity of curing mechanisms is employed, e.g., epoxy-polyol, epoxy-phenolic.

In some coatings where no advantage in cure response is noted with FC-520, cured film properties may be superior. For example the Epon® 828 homopolymer catalyzed by FC-520 is far more impact resistant and solvent-resistant than its counterpart catalyzed by $BF_3 \cdot$ MEA (see *Table* 3).

As would be expected, the bake temperature required to achieve full cure decreases with increasing FC-520 catalyst level (*Figure* 5). The effect is generally more pronounced in formulations based on Bisphenol A epoxy resins than those based on cycloaliphatic epoxy resins.

FLUOROCHEMICAL SURFACTANTS

FC-430 and FC-431 Fluorad® Brand fluorochemical surfactants have been developed for use in non-aqueous media such as organic solvents and resins to reduce surface tension and thus promote wetting and leveling.[5] In general, both produce surface tensions as low as 20 dynes/cm which makes possible the wetting of difficult-to-wet or contaminated substrates. Both FC-430 and FC-431 can reduce surface tensions of epoxides to less than half of their original values, this is not possible with other classes of flow control agents (see *Table* 4). FC-430 is particularly efficient with epoxies in highly polar organic and aqueous media.

Fluorochemical surfactants can also improve leveling in coatings by minimizing surface tension gradients resulting from concentration gradients created during solvent evaporation.[6] *Figure* 6 shows the effect of evaporating heptane (a "low" surface tension solvent) and xylene (a "high" surface tension solvent) from an alkyd resin (which has a surface tension between heptane and xylene). In (A), heptane evaporates at an equal rate from all points on the drop's surface but becomes lowest in concentration at the drop's edge, where the film is thinnest. The resultant higher resin concentration at the edge gives rise to a higher surface tension, thus pulling solution away from the drop's center

Table 1—Comparison of Various Amine Triflates at 0.05M: Cure Temperature Response, Shelf Life In 75/25 ERL-4221/PLURACOL® TP440

Catalyst	Temperature to Achieve Full Cure, 15 Min Bake	Time to Double Viscosity, Aged 120°F (49°C)
$CF_3SO_3H \cdot N$⌬	200°F (93°C)	< 1 day
$CF_3SO_3H \cdot NH_3$	200°F (93°C)	3 days
$CF_3SO_3H \cdot H_2N(C_2H_5)$	220°F (104°C)	5 days
$CF_3SO_3H \cdot HN(C_2H_5)_2$	230°F (110°C)	3 weeks
$CF_3SO_3H \cdot N(C_2H_5)_3$	230°F (110°C)	2 weeks
$CF_3SO_3{}^{\ominus} \cdot N^{\oplus}(C_2H_5)_4$	No reaction	—
CH_3⌬SO_3H	No reaction	—

Table 2—Temperature to Attain Maximum Cure After 15 min Bake: FC-520 vs pTSA and $BF_3 \cdot MEA$ in Various Thermoset Resins and Combinations

	Temperature to Achieve Full Cure Using:		
	1% FC-520 (Solids)	2% pTSA	3% $BF_3 \cdot MEA$
ERL-4221 Cycloaliphatic Diepoxide (100%)	275° F (135° C)	>400° F (204° C)	250° F (121° C)
with Pluracol TP440 Triol (25%)	250° F (121° C)	>400° F (204° C)	300° F (149° C)
DGEBA Diepoxide, EEW = 190 (100%)	350° F (177° C)	>400° F (204° C)	300° F (149° C)
with Pluracol TP440 (30%)	300° F (149° C)	>400° F (204° C)	>400° F (204° C)
with Methylon® 75108 Phenolic (30%)	325° F (163° C)	>400° F (204° C)	>400° F (204° C)
DGEBA Diepoxide, EEW = 500 (100%)	325° F (163° C)	>400° F (204° C)	>400° F (204° C)
with Methylon 75108 Phenolic (30%)	325° F (163° C)	>400° F (204° C)	>400° F (204° C)
with Cymel® 1123 Benzoguanamine (25%)	275° F (135° C)	350° F (177° C)	350° F (177° C)
Acryloid® OL-42 Hydroxyacrylate and Cymel 303 Melamine (25%)	275° F (135° C)	250° F (121° C)	275° F (135° C)

Resins diluted to ~400 cps. with ethylene glycol monoethyl ether acetate, applied to Bonderite® 1000 using #16 wire wound rod. Degree of cure monitored using # double MEK rubs with cheesecloth; temperature to achieve full cure defined where # double MEK rubs exceeded 200 or became constant.

and forming a "doughnut". In (B), evaporation of xylene similarly results in higher resin concentrations at the drop's edge, but now creates a lower surface tension in these thin areas. Retraction this time is toward the center of the drop, forming a "clamshell". Addition of a fluorochemical surfactant, which produces a surface tension lower than any of these components, maintains surface tension at a constant low value during evaporation, thus reducing film mobility and insuring good leveling, (C and D).

Table 3—Comparison of Cured Film Properties: FC-520 vs $BF_3 \cdot MEA$ as Catalyst for DGEBA Homopolymer

Component	Parts by Weight	
Diglycidyl ether Bisphenol A (EEW = 190)	100	100
Ethylene glycol monoethyl ether acetate	20	20
FC-430	0.5	0.5
FC-520 (60% active)	1	—
$BF_3 \cdot MEA$ (100% active)	—	3^{a}
Dry film thickness/Substrate	1.4 mils^{b}/Steel Q-Panel	1.4 mils^{c}/Steel Q-Panel
Bake schedule	350°F/30 min	1) 350°F/15 min 2) 350°F/30 min
Appearance of cured film	Gold, shiny	Colorless, wrinkled
Impact resistance (Gardner reverse)	>60 in./lb	<10 in./lb
Solvent attack, 150°F (66°C), 8 days:		
Deionized water	None	Slight
MEK	Moderate	Severe
1% Tide® in water	Slight	Severe
5% NaOH in water	Very slight	Slight
7.5% CH_3COOH in water	Severe	Very severe

(a) This level required to achieve full cure.
(b) One coat, #18 wire wound rod.
(c) Two coats, #9 wire wound rod (to minimize wrinkling).

The necessity for incorporating an efficient wetting/leveling agent becomes progressively more critical in a coating as percent solids is increased. To illustrate this, three epoxy-phenolic formulations of similar viscosities but differing percent solids were coated on oily tin-plate and baked (*Figure* 7). With no flow control agent added, the "conventional" 40% solids formulation based on DGEBA = EEW 2000 showed surprisingly good coverage with only a few pinholes (A). When a lower equivalent weight (500) DGEBA was substituted to achieve

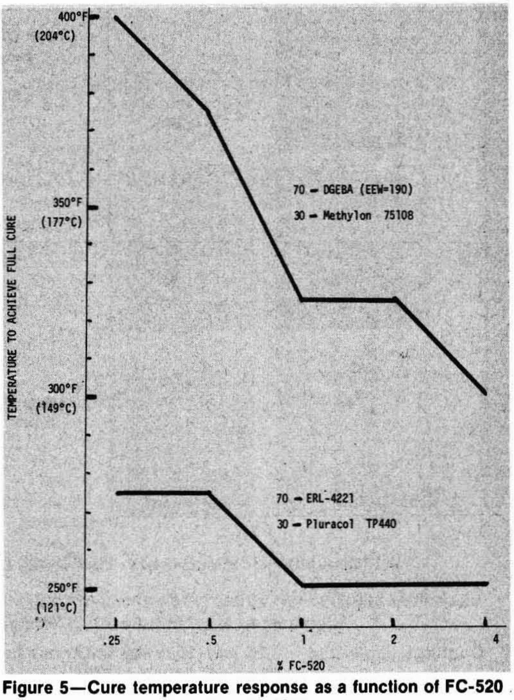


Figure 5—Cure temperature response as a function of FC-520 concentration

Table 4—Surface Tensions Produced by Various Surfactants @ 0.5% Solids in Phenyl Glycidyl Ether

Surfactant	Generic Class	Surface Tension (dynes/cm)
Blank	—	43.1
FC-430 (3M)	Fluorochemical	19.8
FC-431 (3M)	Fluorochemical	20.6
SR-82 (General Electric)	Silicone	35.2
DC #6 (Dow Corning)	Silicone	26.2
Modaflow® (Monsanto)	Polyacrylate	33.3

60% solids, severe cratering erupted (B). Total retraction into droplets resulted when a liquid DGEBA was substituted to achieve 80% solids (C). When FC-430 was added as a flow control agent to each formulation, good wetting and leveling were observed in all cases.

FC-430 is generally superior to silicones and polyacrylates as a flow control agent for very high solids, epoxy-based thermoset coatings, as can be seen in *Table* 5. In general, addition of 0.5% FC-430 (based on resin solids) to such formulations will produce smooth, pin-hole free coatings.

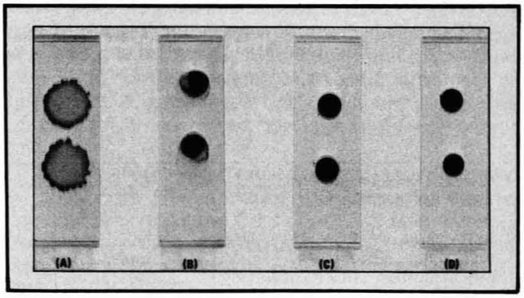
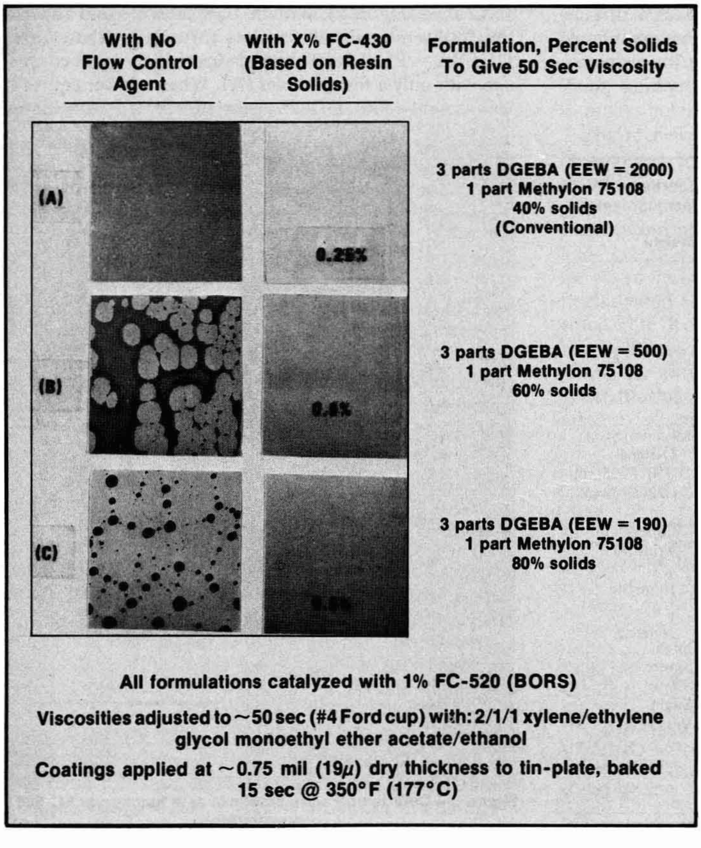


Figure 6—Surface tension gradients: Effect on leveling. Alkyd varnishes in: (A) Heptane (doughnut); (B) Xylene (clamshell); (C) Heptane; and (D) Xylene. (A) and (B) were formulated without fluorochemical surfactant; (C) and (D) were formulated with fluorochemical surfactant

FORMULATION

With these fluorochemical acid catalyst and surfactant tools in hand, it is possible to formulate one-part, high solids, epoxy-based thermoset coatings. FC-520 is the resin catalyst used in all four starting point formulations presented, though other amine triflates could be sub-



3 parts DGEBA (EEW = 2000)
1 part Methylon 75108
40% solids
(Conventional)

3 parts DGEBA (EEW = 500)
1 part Methylon 75108
60% solids

3 parts DGEBA (EEW = 190)
1 part Methylon 75108
80% solids

All formulations catalyzed with 1% FC-520 (BORS)

Viscosities adjusted to ~50 sec (#4 Ford cup) with: 2/1/1 xylene/ethylene glycol monoethyl ether acetate/ethanol

Coatings applied at ~0.75 mil (19μ) dry thickness to tin-plate, baked 15 sec @ 350°F (177°C)

Figure 7—Wetting and leveling on oily tin-plate: Epoxy-phenolic formulations at various percent solids

Table 5—Percent of Flow Control Agents Required For Good Wetting/Leveling of Oily Metal Substrates

Flow Control Agent	60 Parts DGEBA (EEW = 190) 20 Parts Methylon 75108 20 Parts Ethylene Glycol Monoethyl Ether Acetate 1 Part FC-520 Cured at 0.5 mil (13μ) on Oily Tin-Plate	75 Parts ERL-4221 25 Parts Pluracol TP440 1 Part FC-520 Cured at 0.5 mil (13μ) on Oily TFS
FC-430	0.5%	0.5%
SR-82 Silicone	2%	>5%
DC #6 Silicone	>5%	>5%
Modaflow	>5%	>5%

stituted. None of the formulations presented is curable to a useful coating using either pTSA or $BF_3 \cdot$ MEA as a catalyst. FC-430 is the fluorochemical surfactant used in all starting point formulations, as it generally is more effective than FC-431 at promoting flow control of epoxy-based formulations.[7]

The best formulating approach is to select a commercially available liquid epoxide as the principle resin and modify it with a hydroxyfunctional oligomer (e.g., simple polyol) for flexibility and/or a condensation resin such as an aminoplast or phenolic to increase hardness. Care should be taken not to overbake these coatings as discoloration can result.

Epoxy-Polyol

Consider first the unconventional approach of using polyols to flexibilize liquid epoxy resin-based coatings. This concept was originally promoted by 3M in the area of cationic photocuring[8] but is easily translatable to the high solids area. Polyether polyols contribute greater adhesion to metal and hydrolytic resistance while polyester polyols impart greater flexibility. Use of lower molecular weight (<1000) diols and epoxy diluents is not recommended as they volatilize before curing, thus increasing emissions. Nature of the selected epoxy resin is also a factor: for example, cycloaliphatic epoxides are lower in viscosity and cure at a lower temperature than Bisphenol A diglycidyl ether epoxides but are not as chemically resistant.

Table 6—Starting Point Epoxy-Polyol Formulation: For Fabricable Metal Coatings

Component	Parts by Weight
Diglycidyl ether Bisphenol A (EEW = 190)	60
Pluracol TP440	30
Ethylene glycol monoethyl ether acetate	10
FC-520	1
FC-430	0.5
Percent solids (wt.)	90
Viscosity (#4 Ford cup)	100 sec
Bake schedule	300° F(149° C)/15 min
Dry film thickness/Substrate	0.25 mil (6μ)/TFS
Appearance, cured film	Colorless, glossy
% Weight loss after bake (incl. solvent)	12
Hardness, pencil	H
% Adhesion (X-Hatch, #610 Scotch® tape)	100
% Adhesion after pasteurization [160° F(71° C)/30 min]	100 (no blush)
Flexibility	(Passes bend over and back + thumbnail scratch)

Table 7—Starting Point Epoxy-Polyol Formulation: For Decorative Metal Applications

Component	Parts by Weight
#2501 Red pigment dispersion (60% in Epon® 828) (Pigment Dispersions, Inc.)	35
ERL-4221 (Union Carbide)	45
Niax® PCP 0310 (Union Carbide)	15
Ethylene glycol monoethyl ether acetate	5
FC-520	1
FC-430	0.25
Percent solids (wt.)	95
Viscosity (#4 Ford cup)	120 sec
Bake schedule	275° F(135° C)/15 min
Dry film thickness/Substrate	1 mil (25μ)/steel Q-Panel
Appearance, cured film	Red, Shiny
Gloss, 60°/20°	92/80
% Weight loss after bake (incl solvent)	7
Hardness, pencil	3H
% Adhesion (X-Hatch, #610 Scotch Tape)	100
Impact resistance (Gardner Reverse; steel Q-Panel)	120 in.-lb
# Double MEK rubs	>200

A very simple high solids formulation comprising a liquid Bisphenol A epoxide modified with a polyoxypropylene triol is presented in *Table* 6, along with coating performance data. These data indicate that this should be

Table 8—Starting Point Epoxy-Phenolic Formulation: For Applications Requiring Solvent Resistance

Component	Parts by Weight
Diglycidyl ether Bisphenol A (EEW = 190)	60
Methylon 75108	15
Ethylene glycol monoethyl ether acetate	15
Xylene	10
FC-520	1
FC-430	0.4
Percent solids (wt.)	75
Viscosity (#4 Ford cup)	40 sec
Bake schedule	350° F(177° C)/15 min
Dry film thickness/Substrate	0.75 mil (18μ)/tin-plate
Appearance, cured film	Gold, clear
Hardness, pencil	4H
% Adhesion (X-Hatch, #610 Scotch Tape)	100
Impact resistance (Gardner Reverse) (steel Q-Panel)	80 in.-lb
Solvent attack, 150° F(66° C), 24 hr:	
Deionized water	None
MEK	None
1% Wisk® in water	Slight
5% NaOH in water	None, some delamination

Overall performance comparable to 40% solids, conventional epoxy-phenolic coating comprising 3/1 DGEBA, EEW = 2000/Methylon 75108.

Table 9—Starting Point Epoxy-Modified Acrylic-Melamine Formulation: For Outdoor Applications

Component	Parts by Weight
Unitane® OR-650	40
Acryloid® OL-42	30
Cymel® 303	8
Eponex® DRH 151.1	7
Ethylene glycol monoethyl ether acetate	7.5
Xylene	7.5
FC-520	1
FC-430	0.25
Percent solids (wt.)	79
Viscosity (#4 Ford cup)	45 sec
Bake schedule	325°F(163°C)/15 min
Dry film thickness/Substrate	1 mil(25μ)/Bonderite 1000
Appearance of cured film	White, medium gloss
Gloss, 60°/20°	81/48
Gloss, 60°/20°, after 1 week QUV® exposure (235 hr, with 120 hr light)	76/34
Hardness, pencil	2H
% Adhesion (X-Hatch, #610 Scotch Tape)	100
Impact resistance (Gardner Reverse; steel Q-Panel)	10
# Double MEK rubs	200

a good starting point formulation for a closure or can end varnish.

The use of a cycloaliphatic epoxide and polyester polyol in a formulation is shown in *Table* 7. This high solids red pigmented coating exhibits outstanding gloss, good adhesion and solvent resistance, and moderate impact resistance. Coating performance in either formulation can be varied by changing the ratio of epoxide to polyol without greatly affecting the cure schedule. Note the very low weight losses after baking; high solids condensation resin reactions typically exhibit higher weight losses as not all of the resin is incorporated into the coating.

Epoxy-Phenolic

A very solvent resistant, high solids epoxy-phenolic formulation is listed in *Table* 8. Note that this coating also exhibits good impact resistance, probably attributable to the excellent adhesion of the coating rather than flexibility of the film. A polyol could be incorporated if greater flexibility is desired.

Epoxy-Modified Acrylic-Melamine

The epoxy-modified, acrylic-melamine white pigmented formulation shown in *Table* 9 illustrates the use of the epoxide as a minor rather than a major component. The hydrogenated DGEBA resin should be considered for use in applications requiring outdoor exposure and weatherability.

SUMMARY

The use of blocked fluorochemical acid catalysts and fluorochemical surfactants to formulate latent, epoxy-based, high solids coatings has been presented. Amine triflate salts catalyze both epoxy ring-opening and condensation resin reactions, making them uniquely useful for formulating a wide variety of high solids coatings. Addition of fluorochemical surfactants, by greatly reducing and maintaining surface tension, allows these polar liquid resin-based coatings to wet and level on difficult substrates, particularly oily metal.

Four starting point high solids formulations have been presented illustrating the use of FC-520 resin catalyst and FC-430 Fluorad Brand surfactant to cure and promote flow of unique blends of commercially available resins. These one-part, liquid epoxy-containing coatings can be baked to give a wide variety of cured film properties while exhibiting very low levels of emissions.

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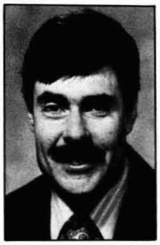

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(2) Alm, R. R., "Formulating Techniques Using Triflic Acid Salts," *Modern Paint and Coatings*, 88, (October 1980).

(3) Kropp, J. E., U.S. Patent 3,843,019 (1974) (3M Co.).

(4) See FC-520 trade literature, 3M Co.

(5) Pike, M. T., "Fluorochemical Surfactants," *Paint Varnish Prod.*, 27, (March 1972).

(6) Bultman, D. A. and Pike, M. T., "Use of Fluorochemical Surfactants in Floor Polish," *Chemical Times and Trends*, 41, January 10, 1981.

(7) See FC-430/FC-431 trade literature, 3M Co.

(8) See FC-508 trade literature, 3M Co.

Trademark References

Acryloid	Rohm and Haas Co.
Bonderite	Parker Division, Oxy Metal Ind.
Cymel, Unitane	American Cyanamid Co.
Epon, Eponex	Shell Chemical Co.
Fluorad, Scotch	3M Company
Methylon	General Electric Co.
Modaflow	Monsanto Co.
Niax	Union Carbide Corp.
Pluracol	BASF-Wyandotte Corp.
QUV	Q-Panel Co.
Tide	Proctor & Gamble Co.
Wisk	Lever Brothers Co.

Evaluation by Photoelectron Spectroscopy And Electron Microscopy Of the Stabilization Of Chrome-Yellow Pigments

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Electron microscopy examination has allowed the distribution of chrome-yellow pigments in six grades, according to quality of coating by stabilizing agents, with grade 1 corresponding to an even and compact pellicular coating. The intensities of XPS peaks characteristic of the crystal constituents (Pb, Cr, S) and of the stabilizers also characterize the completeness of the coating; deduced atomic concentration ratios are well correlated with the electron microscopy grades. The role of the coating, acting as a diffusional barrier with respect to aggressive chemicals, is illustrated by the effect of a brief exposure to hydrogen sulfide (H_2S).

INTRODUCTION

Many pigments, including those based on lead chromate, chrome-yellow and molybdenum red, are very sensitive to light exposure. They may also deteriorate as a result of atmospheric conditions under the combined influence of temperature, humidity, and action of chemical substances, such as sulphur compounds (SO_2, SO_3, H_2S, mercaptans), nitrogen compounds (NO, NO_2, NH_3), oxygen compounds (O_3, CO, CO_2), and organic compounds (hydrocarbons, tars). In case of insufficient light or weather fastness, the hue may become dull and, under severe conditions, paint darkening is observed.

The stability of chromate pigments is improved by various after-treatments.[1] The stabilization mechanisms, as well as the alteration phenomena, are not well-known; however it is generally considered that an important goal of the after-treatment is to coat each individual crystal with a layer of material, often based on silica, which acts as a barrier for diffusion of aggressive reagents and as a screen for ultraviolet light.

Transmission electron microscopy has been used to observe the physical state (compactness, evenness) of the coating on pigments, and its influence on pigment properties has been pointed out.[2] X-ray photoelectron spectroscopy (XPS) provides information on the elemental composition of the outer zone of solid particles and is a potential tool for investigating pigment coatings.[3]

Here, by studying a sufficient number of samples of the same type of pigment, we hope to compare the potential of electron microscopy and X-ray photoelectron spectroscopy for characterizing the quality of pigment coatings as diffusion barriers for the protection of the pigment surface.

SAMPLES

The samples examined are listed in *Table* 1 and mostly represent common commercial types of chrome-yellow pigments. They differ according to chemical composition, color, particle size, after-treatment, and manufacturer. They were studied as received from the manufacturer.

The data from X-ray diffraction patterns are also given in *Table* 1. All samples are monoclinic $Pb(CrO_4)_x(SO_4)_{1-x}$ crystals with a basic lead oxide (#51) added for comparison. Some samples contain traces of $PbSO_4$ orthorhombic phase.

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Table 1—Characteristics of Chrome-Yellow Pigment Samples

Sample	Color Index	X-ray Diffraction	Electron Microscopy (EM grade)[a]	XPS Data (Atomic Ratio)		Sensitivity to H_2S[b]
				$(Pb+Cr+S)/O$	$(\Sigma$ Stabilizers$)/O$	
24	6 G	Monoclinic + $PbSO_4$	6	0.38	—	s
25	3 G	Monoclinic	6	0.34	—	s
26	3 G	Monoclinic + $PbSO_4$	6	0.36	—	s
27	G	Monoclinic	6	0.39	—	s
28	6 G	Monoclinic	5	0.29	0.095	s
29	3 G	Monoclinic	5	0.23	0.1	s
30	G	Monoclinic	5	0.18	0.12	s
31	6 G	Monoclinic	4	0.13	0.174	m
32	3 G	Monoclinic + $PbSO_4$	4	0.13	0.08	s
33	3 G	Monoclinic	4	0.04	0.121	m
34	3 G	Monoclinic	4	0.028	—	w
35	3 G	Monoclinic	4	0.047	0.18	w
36	6 G	Monoclinic	3	0.075	0.153	m
37	3 G	Monoclinic	3	0.036	0.159	w
38	3 G	Monoclinic	3	0.13	—	w
39	3 G	Monoclinic	3	—	—	w
40	3 G	Monoclinic + $PbSO_4$	2	0.017	0.3	w
41	3 G	Monoclinic + $PbSO_4$	2	0.017	0.145	w
42		Monoclinic	2	0.004	0.323	w
43	G	Monoclinic	2	0.021	0.22	w
44	GR	Monoclinic	2	0.027	0.31	w
45	3 G	Monoclinic	1	0.007	0.324	w
46	3 G	Monoclinic	1	—	—	w
47	3 G	Monoclinic + $PbSO_4$	1	0.040	0.15	w
48	G	Monoclinic	1	0.029	0.233	w
49		Monoclinic	1	0.02	0.306	w
50		Monoclinic	1	0.001	0.346	w
51	GR	Basic lead oxide	1	0.002	0.34	w

(a) EM grade : grade 1 : even and compact pellicular coating.
grade 2 : uneven and less compact pellicular coating, plus colloidal aggregates.
grade 3 : uneven coating by individual colloidal particles, plus colloidal particles aggregates.
grade 4 : uncomplete coating, plus colloidal particles aggregates.
grade 5 : no colloidal particles observed.
grade 6 : non stabilized.

(b) s : strong; m : moderate; w : weak.

EXPERIMENTAL METHODS

The samples were examined in an AEI transmission electron microscope (EM6G type) operating at an accelerating voltage of 100 kV. The pigment powder was dispersed in a test tube filled with distilled water and submitted to the action of an ultrasonic bath. The preparations were made by deposition of a droplet of the aqueous suspension on an AEI type copper grid (Smethurst High-Light Ltd.) covered with a thin carbon film. After drying in a desiccator, the grid was directly observed. The contamination was minimized by using an anticontamination device supplied with liquid nitrogen and by cooling the vicinity of the specimen holder.

The XPS spectra have been recorded on a V.G. ESCA 2 system. The aluminum K_α line was used for excitation (hν:1486.6 eV; generator:10 kV, 50 mA; analyzing energy:90 eV). A Tracor Northen N.S. 560 accumulator enabled us to improve the signal/noise ratio during the analysis. The pigment powder was pressed in a pellet and fixed on a sample-support, which was cooled by liquid nitrogen to reduce carbon contamination and to limit pigment destruction from heating.

RESULTS AND DISCUSSION

Electron Microscopy

Representative electron micrographs are presented in *Figure* 1. The particle size is of the order of 0.5–1 μm; some samples have particles with sharp edges while others present a more rounded shape. The chosen micrographs illustrate the various types of distribution of the stabilizing substance.

In some samples, the individual pigment crystals are found to be covered by an even and compact coating which appears as a rim of lower optical density. The transmission micrographs allow to estimate the thickness of the coating, about 12 nm in the case of sample 49 (*Figure* 1a); in the case of sample 47 (*Figure* 1b), it is so thin that it can hardly be observed.

For samples such as 40 (*Figure* 1c) and 42 (*Figure* 1d), the crystals are well-coated but the coating layer is not even and compact; the thickness is not constant and discrete particles can be observed. Additional colloidal particles are also present but they are not strongly

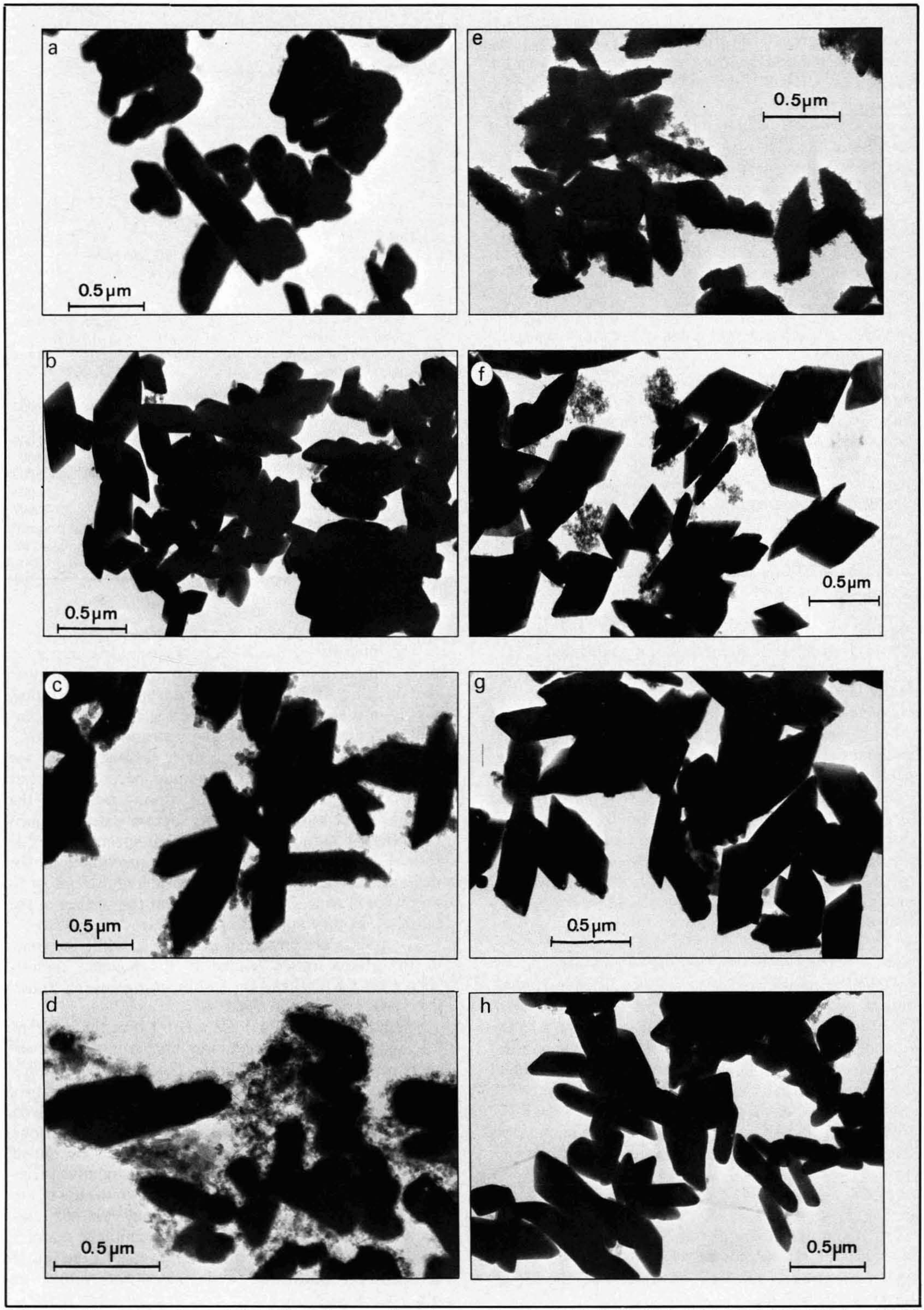

Figure 1—Morphological aspect of stabilized chrome-yellow pigments. Samples 49 (a), 47 (b), 40 (c), 42 (d), 38 (e), 32 (f), 29 (g), and 30 (h)

Table 2—Atomic Ratios for Chrome-Yellow Pigments and Surface Coatings, as Determined From the Intensity Ratios of the Indicated XPS Peaks

Sample	$\frac{Pb_{4f}}{Cr_{2p}}$	$\frac{Pb_{4f}}{O_{1s}}$	$\frac{Cr_{2p}}{O_{1s}}$	$\frac{S_{2p}}{O_{1s}}$	$\frac{Si_{2s}}{O_{1s}}$	$\frac{Si_{2p}}{O_{1s}}$	$\frac{Al_{2s}}{O_{1s}}$	$\frac{Al_{2p}}{O_{1s}}$	$\frac{Ca_{2p}}{O_{1s}}$	$\frac{Ti_{2p}}{O_{1s}}$	$\frac{Sb_{3d}}{O_{1s}}$
24	1.8	0.19	0.11	0.08	—	—	—	—	—	—	—
25	1.45	0.18	0.12	0.04	—	—	—	—	—	—	—
26	1.6	0.19	0.12	0.05	—	—	—	—	—	—	—
27	1	0.2	0.19	n.m.	—	—	—	—	—	—	—
28	1.07	0.13	0.12	0.04	—	0.045	—	—	—	0.05	—
29	1.5	0.14	0.09	n.m.	—	0.06	0.04	—	—	—	—
30	1.56	0.11	0.07	n.m.	—	0.07	—	0.05	—	—	—
31	3.78	0.07	0.02	0.04	—	—	—	0.13	0.004	0.04	—
32	2.3	0.08	0.03	0.02	—	0.05	0.03	0.04	—	—	—
33	3	0.03	0.01	n.m.	—	0.11	—	—	—	—	0.011
34	3	0.02	0.008	n.m.	—	—	—	—	—	0.003	0.01
35	1.7	0.03	0.017	n.m.	0.16	0.12	—	—	0.005	0.005	0.009
36	3.57	0.06	0.015	n.m.	—	0.095	0.03	—	0.013	0.015	—
37	1.95	0.024	0.012	n.m.	—	0.15	—	—	0.002	0.007	0.004
38	2.07	0.09	0.04	n.m.	—	0.61	—	—	—	—	—
40	1.39	0.01	0.007	n.m.	—	0.23	0.064	—	0.005	—	—
41	1.93	0.011	0.006	n.m.	0.13	0.10	—	—	0.002	0.004	0.009
42	n.m.	0.004	n.m.	n.m.	0.2	0.17	0.10	0.08	0.018	0.005	—
43	1.99	0.014	0.007	n.m.	0.21	0.16	—	—	—	—	0.009
44	1.48	0.016	0.011	n.m.	0.30	0.20	—	—	—	—	0.007
45	n.m.	0.007	n.m.	n.m.	0.25	0.22	0.055	0.067	0.002	0.017	0.0005
47	1.73	0.025	0.014	0.01	—	0.13	0.02	—	—	—	0.008
48	2.17	0.02	0.009	n.m.	0.22	0.15	—	—	—	0.004	0.009
49	1	0.01	0.01	n.m.	—	0.21	0.09	—	—	0.006	—
50	n.m.	0.001	n.m.	n.m.	0.23	0.13	0.11	0.09	0.002	0.004	—
51	n.m.	0.002	n.m.	n.m.	0.22	0.15	0.12	0.10	—	—	—

attached to the surface. In sample 42, the isolated colloidal particles are numerous and aggregated.

In sample 38 (*Figure* 1e), a continuous layer is no longer observed but colloidal particles more or less completely cover the surface of the crystals.

For pigments such as sample 32 (*Figure* 1f), aggregated colloidal particles are present in the sample but the pigment coating is far from complete.

In other cases, such as samples 29 (*Figure* 1g) and 30 (*Figure* 1h), practically no colloidal particles are observed, although some were expected to be formed as a result of the stabilization.

Table 1 presents a characterization of the various pigments investigated, according to the classification illustrated above.

X-ray Photoelectron Spectroscopy

The XPS spectra of selected samples, listed in *Table* 2, were obtained and the following peaks were observed. Their binding energy was measured with respect to the binding energy of C_{1s} peak, taken as 285 eV: O_{1s} at 531.3 eV, Pb_{4f} doublet at 138.7 eV and 143.6 eV, Cr_{2p} doublet at 578.7 eV and 588 eV, and S_{2s} at 232.1 eV.

The presence of Si_{2p} (100.8 eV) and Al_{2p} (118.4 eV) peaks shows that silica and alumina are the main stabilizing agents. In some cases the presence of the following elements is also noted:

(1) Ca_{2p} peaks at 345.8 and 349.6 eV, in samples 31, 35, 36, 37, 40, 41, 42, 45, 50.

(2) Ti_{2p} peaks at 457 and 462 eV, in samples 28, 31, 34, 35, 36, 37, 41, 42, 45, 48, 49, 50.

(3) Sb_{3d} peak at 538.6 eV, in samples 33, 34, 35, 37, 41, 43, 44, 45, 47, 48.

(4) Sn_{4p} peak at 89.4 eV, in samples 37, 49.

The intensity of the XPS peaks was determined by measuring their area. Atomic ratios (atom g/atom g), as measured by XPS, were calculated from intensity ratios, taking into account the experimental conditions (accumulation time on each peak and instrument sensitivity), and the ratio of atomic sensitivity factors determined by Wagner.[4] This approach should be considered as approximate estimations of the atomic ratios, as the calibration of atomic sensitivity factors was performed on different samples with a different spectrometer.[5] It should be noted that, as a first approximation, the deduced atomic ratios may be considered as relating to an explored zone, 2–4 nm thick, near the surface of the particles, as they appear in the examined samples.

The results are presented in *Table* 2, while the sums of the atomic ratios related to the pigment crystals [(Pb + Cr + S)/O] and the stabilizing agents [(Σ Stabilizers)/O] are given in *Table* 1.

The atomic ratio (Pb + Cr + S)/O is of the order of 0.36 for nonstabilized pigments. This is in satisfactory agreement with the theoretical value of 0.5; deviations may indeed be due to surface contamination, to instrumental errors and, above all, to approximations involved in the evaluation of the sensitivity factors of the various peaks[4] as already noted above. Even if the determined ratio (Pb + Cr + S)/O is not accurate, its relative variation is not affected by the errors related to the use of the ratio of atomic sensitivity factors. In any case, the relative variation observed within the collection of samples studied is much higher than the relative deviation found between the measured and theoretical values of (Pb + Cr + S)/O.

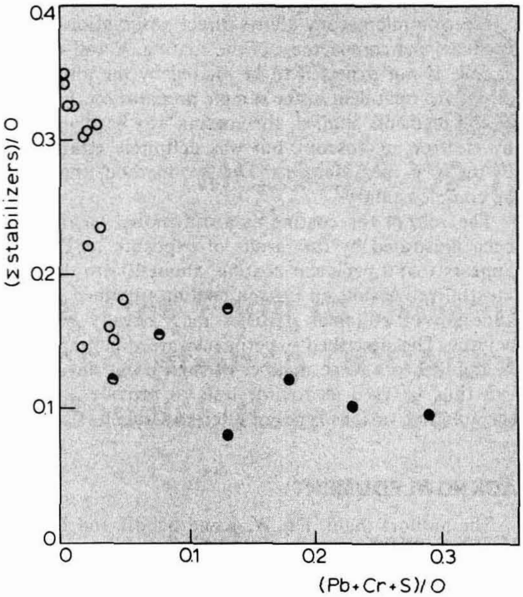

Figure 2—Correlation between the sum of the atomic ratios of the stabilizing elements with respect to oxygen, and the (Pb + Cr + S)/O atomic ratio, both measured by XPS; the symbol indicates the sensitivity to H_2S: strong (●), moderate (◓), weak (○)

Decrease of the (Pb + Cr + S)/O ratio is due to the presence of stabilizing agents. A quantitative interpretation of the data would require making models in which the amount of stabilizing oxides, the particle size of each component, and the space distribution of the components with respect to each other are taken into consideration.[5] This complex task is outside the scope of the present work. However, qualitative information may be obtained if it is kept in mind that, for approximately equal amounts of stabilizing oxides, the measured (Pb + Cr + S)/O ratio will be smaller if the oxides are better dispersed and/or if they form a coating around the pigment crystals.

The sum of the atomic ratios of the elements in the stabilizing agents to oxygen must be inversely related to the (Pb + Cr + S)/O ratio, as illustrated by *Figure* 2. A more elaborate interpretation would require not only modeling of the morphology of the complex solid, but also speculating about the stoichiometry of the stabilizing oxides, particularly their water content.

Figure 3 shows the correlation between (Pb + Cr + S)/O ratios reflecting the attenuation of the XPS signal of the pigment crystals by a coating, and the characteristics of the latter as observed by electron microscopy (EM grade, *Table* 1).

It is clear that untreated or unsuccessfully treated pigments (EM grades 6 and 5) give a (Pb + Cr + S)/O ratio above 0.15; well coated pigments (EM grades 1 and 2) give a (Pb + Cr + S)/O ratio smaller than 0.04; an intermediate range corresponds to pigments showing an irregular or incomplete coating. In sample 47, the coating was hardly visible by electron microscopy, but the XPS data confirm that it is present. It is also confirmed that the coating is not satisfactory for samples 31 and 32 and very bad for samples 28, 29, and 30.

Correlation of Pigment Fastness and Coating Quality

When a nonstabilized chrome-yellow pigment is exposed to H_2S, it turns dark immediately, while the same experiment performed on a well-stabilized pigment does not affect the color. Exposure to H_2S thus provides a simple test for examining the quality of the coating and its efficiency to act as a diffusional barrier for aggressive reagents.

All the pigments (aliquots of one gram in test tubes of 5 mL) have been outgassed together under a primary vacuum in a desiccator and subsequently exposed to

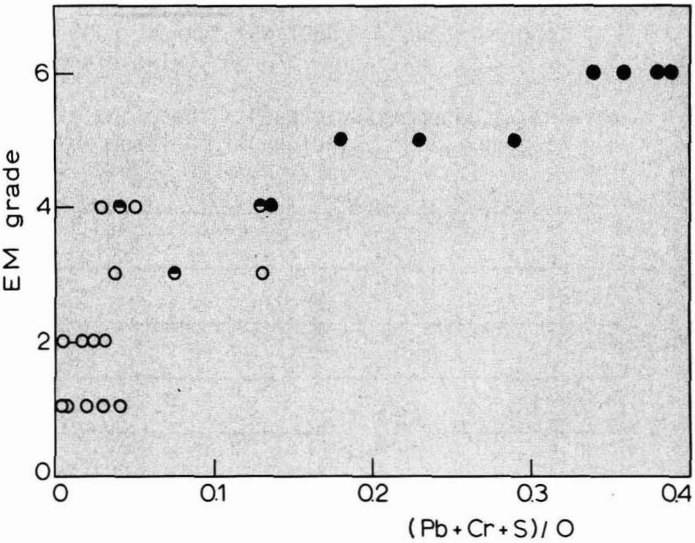

Figure 3—Correlation between the coating quality as observed by electron microscopy (EM grade, see *Table* 1), and the (Pb + Cr + S)/O atomic ratio measured by XPS; the symbol indicates the sensitivity to H_2S: strong (●), moderate (◓), weak (○).

H_2S at a pressure of about 35 Torr for two minutes. Their color was then compared to that of the nonexposed pigments.

The pigments can be divided into three categories according to the degree of color alteration. The results are presented in *Table* 1 and illustrated by *Figures* 2 and 3.

Some samples suffer strong darkening and obviously are very sensitive to H_2S. All pigments to which a stabilizing treatment was not applied or which did not obtain a satisfactory coating (EM grades 6 and 5) fall in this category.

Some samples are hardly affected by H_2S; there is no color alteration but only a slightly less bright hue. This is the case of all pigments showing a pellicular coating (EM grades 1 and 2, $(Pb + Cr + S)/O$ atomic ratio $\leqslant 0.04$).

The other pigments, namely those showing an irregular or incomplete coating (EM grades 3 and 4), may fall into one of these two categories or show a moderate darkening. This must be related to the extent that the crystalline surface is covered by stabilizing oxides and to the nature of the contact between the crystals and the colloidal oxide particles.

CONCLUSION

It has been shown that both electron microscopy and X-ray photoelectron spectroscopy are well suited to characterize the quality of pigment coating resulting from stabilizing treatments.

The use of XPS peak intensities does not require sophisticated models and calculations. The apparent atomic ratio of the constituent elements of the pigment crystal to oxygen reflects the attenuation of the signal originating from the crystal by the coating layer and, consequently, characterizes the completeness of the coating.

Electron microscopy allows direct observation of the evenness and compactness of the coating. A well-coated sample is not expected to be altered by the ultrasonic dispersive treatment in the sample preparation. For one of the pigments studied, the coating was hardly visible by electron microscopy but was definitely established by the XPS measurements. The two methods may thus be complementary.

The role of the coating as a diffusional barrier has been illustrated by the results of exposure to H_2S. It appears that a pellicular coating, about 10 nm thick, is most effective, but an uneven coating obtained by the adhesion of colloidal particles may already be very helpful. The described experiments are quick and can be applied to a large number of samples at once; they can thus be used as routine tests to provide a rough screening of various types of after-treatments.

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Society Meetings

C-D-I-C Sept. 14

The Nuodex gavel was presented to the incoming President, Robert Thomas, of Perry & Derrick Co., Inc. Other officers for 1981–82 are: Vice-President—Nelson Barnhill, Inland Div.; Secretary—Bob Burtzlaff, Potter Paint Co.; Treasurer—Dave Kinder, ASARCO Inc.; and Society Representative—Bill Mirick, Battelle Memorial Institute.

Russell Koch, of Universal Color Dispersions, Inc., presented a talk accompanied by slides entitled "THE WONDERFUL WORLD OF COLOR."

Mr. Koch emphasized the economic and technical advantages of using colors dispersed in universal vehicles as opposed to dispersing dry pigments in a variety of generic vehicles. He pointed out that if a paint company uses 11 different generic types of resins and wants to market a full range of colors using a minimum of 24 different pigments, that company would be faced with dispersing 264 separate batches of various sizes. Mr. Koch said that the cost of an inventory of 264 dispersions is very substantial compared to an inventory of 24 universal dispersions. He also noted that by using commercial universal dispersions the paint chemist will be assured of reproducible quality with respect to strength, color, and pigment type.

An additional important advantage of universal dispersions that is frequently ignored is that they will save both time and labor in the development lab, explained Mr. Koch. Using them will enable the chemist to prepare new samples more quickly, enabling salesmen to deliver sooner which will lead to improved customer appreciation. Universal dispersions will also minimize the problems inherent in scale up from lab to production quantities.

Mr. Koch also suggested that any company which develops a need for more color dispersions should seriously consider using universal dispersions rather than investing a very substantial sum in new dispersing equipment. He emphasized that all factors need to be considered: raw materials, cost of equipment, production losses, milling time, optimum utilization of mixing capacity, development costs, quality control, and cost of inventory.

Q. What if I need a pigment not in the 24 standard colors?

A. Most manufacturers of universal dispersions have a large list of dispersed pigments that they will make on a special basis. These "specials" are very likely to be needed by one or more other paint companies and your requirements can probably be filled quite easily.

Q. What do we do if we encounter flooding or floating when using universal dispersions?

A. These problems do exist but they are generally less severe than with composite grinds. There are a number of good additives that are widely available that should solve the problem.

ROBERT A. BURTZLAFF, *Secretary*

Kansas City Sept. 10

President Richard Warren, of Cook Paint & Varnish Co., expressed his appreciation to the membership for their cooperation during his tenure in office. He then presented incoming President Mike Bauer, of Tnemec Co., Inc., with the 50th Anniversary attache case which is passed from President to President. Ted Terherst, of Abner-Hood, Inc., presented President Bauer with the Tenneco Gavel and President Bauer, in turn, presented Richard Warren with a Past-President's pin. Also recognized as new officers were Treasurer Gene Wayenberg, of Tnemec Co., Inc., and Secretary Mel Boyer, of Patco Coatings Products.

A moment of silence was observed for Past-President Ray Gross, of Welco Manufacturing Co., who died on August 25.

Gerard Chait, of Premier Mill Corp., discussed "THE HORIZONTAL MILL."

The main benefits of the horizontal mill were featured. These included minimal floor space, high media loading, easy cooling, and ease of disassembly for cleaning. According to Mr. Chait, these features increase productivity since up to 2.5 times more product can be processed than with a vertical mill, and one operator can handle up to four machines. The automatic wash system uses only about 25 gallons of solvent.

Q. Do the disc impellers fit on the shaft in only one direction or could they be reversed during reassembly?

A. They can be reversed. However, by switching the tapers on purpose, the products can be kept in the grinding chamber longer.

Mike Bauer, President of the Kansas City Society (left), is presented with the 50th Anniversary Attache Case by Vice-President Dick Warren

Q. What is the cooling method?

A. Normally water, but refrigerated coolant can be used and is used in the agricultural chemical processing field.

MELVAN BOYER, *Secretary*

Los Angeles Sept. 9

President Don Jordan awarded a 50-year pin to Mentis Carrere, a charter member since 1924, for a long and honorable career in the paint industry.

The following officers for 1981–82 were installed: President—Jan Van Zelm, Byk-Mallinckrodt; Vice-President—Romer Johnson, Dorsett & Jackson Co.; Secretary—Earl Smith, Spencer Kellogg; Treasurer—Lloyd Haanstra, Ameritone Paint Co., and Society Representative—Bob McNeill, PPG Industries, Inc.

Robert Gutknecht presented the Nuodex gavel to President Jan P. Van Zelm. President Van Zelm presented Don Jordan with the Past-President's pin and plaque.

Ken O'Morrow, Chairman of the Environment Committee, reported in the area of waste management. He explained that after November 19, 1981 no liquid waste can be dumped into a landfill. Extension of time is expected because there are no alternatives in California. Jim Elliott, of the Committee on Rule 1113, reported on the status of CARB regulations.

William D. Meadows, of Cyprus Industrial Minerals Co., presented "CHLORITE: A NEW EXTENDER PIGMENT FOR THE COATINGS INDUSTRY."

Mr. Meadows presented an interesting new extender for coatings. He defined chlorite mineralogically as a magnesium alumino-silicate with properties similar to both clay and talc. General properties are (1) platey particles, (2) chemical inertness, (3) good exterior durability, (4) hydrophilic, (5) scrub resistant, (6) low oil and water absorption, and (7) basic pH. Compared to talc, he added, chlorite is low in oil absorption providing lower flatting efficiency and lower paint viscosity. Compared to delaminated and calcined clays, chlorite in latex paints exhibited similar or superior properties of opacity, film porosity, 85° sheen, and scrub resistance. Mr. Meadows also pointed out that ultrafine chlorite is attractively priced.

Q. What effect has the 3% iron on color aging?

A. No effect on color aging. The iron is tied up in the mineral structure. This affects original color only.

Q. How much of this new product is available for now and in the future?

A. As much as you want. A good part of a mountain is available. For as long as you want.

Q. What are the suspension properties of chlorite?

A. Similar to talc or better because it is platey. Excellent.

Q. Does the K & N stain really indicate porosity or does it indicate the affinity of the stain for the paint system?

A. A positive and sensitive test, but uncertainty about reproducing enamel holdout. A good indication, however.

Q. Is there any adverse effect in high temperature baking enamels due possibly to loss of water (@ 600° F)?

A. Not much work yet on high temperature baking enamels. Customers have not reported problems. However, we have noted that certain chlorite containing industrial enamels have a slightly more blistering tendency than talc which may be due to its more hydrophyllic nature.

Q. What manufacturing processes are involved in making chlorite pigment? Crushing? Drying? Size classification?

A. Open pit mining. Crushing. Raymond roller mill coarse grinding. Fluid energy mill fine grinding using superheated steam.

EARL B. SMITH, *Secretary*

Louisville Sept. 16

Louisville Society Officers for 1981-82. Left to right: Vice-President—Fred Newhouse; Secretary—Ed Thomasson; President—P.W. Harbaugh; Treasurer—John Lanning; Past-President—J. Kirk Menefee; and Society Representative—Joseph A. Bauer

New officers for 1981-82 were introduced as follows: President—Phil Harbaugh, Reliance Universal Inc.; Vice-President—Fred Newhouse, Reynolds Metals Co.; Secretary—E. D. Thomasson, Louisville Varnish Co.; Treasurer—John Lanning, Porter Paint Co.; and Society Representative—Joe Bauer, Porter Paint Co. Kirk Mennefee, outgoing President, presented President Harbaugh with the gavel.

Mark Schmidt, of Mooney Chemical Co., spoke on "METAL CARBOXYLATES AS DRIERS FOR OIL AND WATER SOLUBLE COATINGS."

Mr. Schmidt reported on three types of driers: fusion or oxidative; direct or polymerization; and indirect or auxillary. He then explained the use of 1-10 phenatroline as an assister or catalyst for driers which are really metal carboxylates. There is a correction for water-based and high-solids coatings. These are based on higher levels of cobalt, calcium, and zirconium as well as 1-10 phenatroline, he said.

E. D. THOMASSON, *Secretary*

New York Sept. 8

President Marvin Schnall presented Leonard Davidson with the certificate of Honorary Membership in the society for outstanding service and active participation. Donald Koenecke also received a certificate in absentia.

President Schnall then introduced the new officers for 1981-82 and relinquished the office of President to Don Brody, of Skeist Labs., Inc., who was presented with the Nuodex Gavel by Tom Scanlon and with an engraved copy of Robert's Rule of Order by Irwin Young. Other 1981-82 officers are: Vice-President—Ted Young, J.S. Young Co.; Secretary—Herbert Ellis, D.H. Litter Co., Inc.; Treasurer—Mike Iskowitz, Koppers Co., Inc.; and Society Representative—Saul Spindel, D/L Laboratories.

Speakers for the meeting were John Becker, of Omya, Inc., and Fred Stieg, a consultant for the paint industry.

"A UNIQUE NEW CALCIUM CARBONATE" was discussed. Mr. Becker explained that this is an ultra-fine calcium carbonate with low oil absorption and very fine particle size allowing for a variety of formulations, alluding to Mr. Stieg's concept of spacing technology. According to Mr. Stieg, spacing technology can improve the efficiency of titanium dioxide. As TiO_2 increases in price, the interest in this spacing-technique increases. With the aid of equations and formulations, Mr. Stieg showed that ultra-fine calcium carbonates can improve total hiding power and cut costs with proper substitutions on a volume basis. The formulator, Mr. Stieg explained, would be able to remove TiO_2 from his formulation at levels dependent upon the spacing efficiency of the ultra-fine calcium carbonate. The only consideration is to maintain porosity levels of old vs new formulation. Mr. Stieg also showed how to use one grade of TiO_2, the enamel grade, along with the spacing extender mentioned in flat latex and gloss systems.

Mr. Becker continued with reformulating flat latex paint parameters with three objectives: (1) Change from flat grade TiO_2 to enamel grade on an equal TiO_2 basis making up volume with perfect spacing extender (ultra-fine) saving 12-16¢/gal; (2) Replace any high oil absorbancy extender with lower absorbing ultra-fine carbonate on an equal volume basis; (3) Replace portion of latex solids with equal volume of ultra-fine carbonate saving 15-20¢ gal.

Q. What's the particle size distribution of this ultra-fine carbonate?

A. 65% below 1 micron.

Piedmont Society Officers for 1981–82. Left to right: Treasurer—Phil Wong; Secretary—Jim Husted; President-Elect—Sara Robinson; and President—Jim Albright

Q. Aren't there dispersion problems with this ultra-fine carbonate as in the past with others?

A. Ultra-fine naturals don't give problems. The others were precipitated and more uniform with high oil absorption.

Q. The spacing efficiency talked about was based on one system. Doesn't it vary with different concentrations of TiO_2?

A. No it doesn't.

Q. Does the spacing principle apply to gloss paints as well as flats?

A. Yes—Definitely, at all P.V.C. levels.

Q. Are there any differences in settling between ultra-fine carbonates and coarse carbonates or calcined clay?

A. Ultra-fine carbonates are better than calcined clay. No information on coarse carbonates yet.

HERBERT ELLIS, JR., *Secretary*

Philadelphia Sept. 10

Richard Kiefer, Jr. installed the 1981–82 officers. They are: President—Willis Johnston, Atlantic Richfield Co.; Vice-President—P.J. Sotorrio, DeSoto Inc.; Secretary—Ralph Myers, Del Val Ink & Color Co.; Treasurer—Frank Bartusevic, Chapman Industrial Finishes, Inc.; and Society Representative, John Stigile, du Pont de Nemours & Co., Inc. Francis Gaffney presented the Tenneco Co. gavel to President Johnston and he in turn presented Barry Oppenheim with the Past-President's pin.

Stanley Gregg, of Allied Corp., gave a talk entitled "TEMPORARY COATINGS."

The talk was introduced with a series of slides and commentary describing the type of polyethylene used to manufacture the emulsions necessary for use in temporary coatings. The significant variations are in molecular weight and hardness. Most of the polyethylenes are homopolymers and some are oxidized for specific end-use, explained Mr. Gregg. A series of slides then showed the various methods of incorporating the molten polyethylene into a premixed emulsion media. Several types of equipment were pictured. Formulation guidelines were given by Mr. Gregg, along with commentary for successful emulsion preparation, e.g., immediate quick cooling with agitation to maximize gloss.

Slides showing common floor polishes and their unique functions, as well as formulas for strippable metal and plastic coatings were shown. One of the points made by Mr. Gregg was that the temporary coatings get a lot of their surface properties and endurance from use of the proper wax additive. Removal of temporary coatings is best accomplished by use of the recommended chemicals. Trying to rub or abrade them off is not recommended.

Mr. Gregg concluded with a list of several trade associations that are specific to the temporary coatings' market and a brief bibliography of some references available for additional information.

Q. How many different varieties of temporary coatings do you work with?

A. We work with eight basic varieties.

Q. Compare hardness, slip and gloss.

A. The harder, the more slip and usually the more gloss . . . everything else being equal. Extra crystallinity with harder molecules often adds to slip and gloss.

Q. Why do you use sodium bisulfite in most of the emulsions?

A. It is an excellent viscosity reducer. Actually, sodium bichloride or sodium bisulfite can be used. It must be kept at least at 0.4% to be effective.

RALPH MYERS, *Secretary*

Piedmont Sept. 16

Past-President Dave Bouldin installed the 1981–82 officers. They include: President—Jim Albright, The Lilly Co.; Vice-President—Sara Robinson, Inland Leidy; Secretary—Jim Husted, Mobil Chemical Co.; Treasurer—Phil Wong, Reliance Universal, Inc.; and Society Representative—Gary Marshall, Paint Products Co., Inc. Bill Bell, of Tenneco, Inc., presented the traditional Tenneco gavel to President Albright.

Ray Hurley, of Tenneco, Inc., discussed "DRIERS FOR WATER-BORNE COATINGS."

Mr. Hurley introduced his talk with statements on the basics of drier technology. He pointed out the types of metallic "soaps" and the appropriate uses of the different types. As an example, cobalt "soaps" would be the choice in air dry systems where increased activity is needed in surface drying. Driers are generally classified as practical for air dry or heat cure applications. Examples of air dry "soaps" are cobalt and manganese. Heat cure types would include iron. Auxillary "soaps" such as lead, barium, and zinc are used as enhancers.

Mr. Hurley supplemented his presentation using slides that showed comparison performance data on synthetic vs naphthanate driers. Other slides included typical drier calculations and recommendations for starting points using driers in several types of vehicle systems. Slides showing cost efficiency using precomplexed "soaps" were applicable to both trade-sale and industrial coatings.

Mr. Hurley pointed out that loss of drying is critical, and can be due to adsorption of the drier on the pigment surface as well as hydrolytic degradation of resin. The best way to combat this degradation is to control the pH, he said.

Q. What is the method of addition of driers into alkyds?

A. Water-reducible driers can be added before or after neutralization. If the driers are added before, the driers will dry faster. If a post-add is used, the drier will need to be water-dispersible.

SARA ROBINSON, *Secretary*

Pittsburgh Sept. 14

President Richard Trudell, of Mobil Chemical Co., was presented with the Neuodex President's gavel by Dennis Dempsey, of Allan Zoller Co. and John McGroarty, of Tenneco Chemical Corp. President Trudell gave Past-President Ray Uhlig a momento in appreciation of his work during the past year. Other officers for 1981–82 include: Vice-President—William Cibulas, Mobil Chemical Co.; Secretary—Michael Gillen, Van Horn, Metz & Co.; Treasurer—Cliff Schoff, PPG Industries, Inc.; and Society Representative—Ed Vandevort, PPG Industries, Inc.

"PROBLEM SOLVERS IN WATERBORNE COATINGS" was discussed by Dave Swaintek, of Air Products & Chemicals Co.

Surfactants, air products, and surfynols, were described by Mr. Swaintek. He then discussed their properties as defoamers. The results of the Droves Wetting Test were explained by Mr. Swaintek. These included: the reduction of water sensitivity, reduced susceptibility to surface contamination, improved organic color development, and grind efficiency. He concluded by discussing their use in can coatings.

MICHAEL GILLEN, *Secretary*

Rocky Mountain — Sept. 14

President Steve Crouse, Kwal Paints, introduced the 1981-82 officers: Vice-President—Don Bagge, G.C. Brandt, Inc.; Secretary—Don Shillingburg, Union Oil; Treasurer—Luis Garcia, Kelly-Moore Paint Co.; and Society Representative—Jim Peterson, Peterson Paints.

Ken O'Morrow, of Oil & Solvents Chemicals, spoke on "HAZARDOUS WASTE AND NEW GOVERNMENT REGULATIONS."

According to Mr. O'Morrow, changes have occurred in the Clean Air Act, Rule 66—Los Angeles, and the Resources and Recovery Act. Government groups, such as the Environment Protection Association, the Department of Health, and the Department of Transportation, will provide information concerning hazardous waste and the new regulations that are in effect, said Mr. O'Morrow. Films are also available explaining what can be done and how.

Hazardous waste was described by Mr. O'Morrow as oil field wastes, truck accidents, and chemical spills. Millions of tons of waste are generated in the production of medicine, plastics, paint, petroleum, metals, and textiles. Hospitals and research laboratories also generate waste, he said.

Waste management regulations sponsored by California include proper disposal sites for solids and liquids and evaporation ponds for burial of solids. Mr. O'Morrow explained that proper waste disposal thru burial can produce methane gas which can be further utilized.

In conclusion, Mr. O'Morrow discussed companies that handle the treatment of hazardous waste. One company utilizes waste solvent as incinerator fuel, said Mr. O'Morrow. Recycling such as this is the recommended method of reducing the risk of waste disposal.

D. M. SHILLINGBURG, *Secretary*

St. Louis — Sept. 15

"QUALITY WITH THERMO-OPTIC SILICATES AS THE FOUNDATION" was presented by Daniel O. Adrien, of Burgess Pigment Co.

With the price of raw materials increasing every year, the paint chemist reaches the point where reformulation is required, said Mr. Adrien. All recent discussions of the "degradation of quality" is really a battle between the different grades of coatings produced. Thermo-optical silicates can contribute to cost reduction in any latex paint formula regardless of grade. Performance of these coatings is improved or at least equal to that of the control, according to Mr. Adrien.

Calcined materials are reported to be energy intensive. That is to say that it takes a lot of fuel to manufacture them, and less fuel is needed to produce thermo-optical silicates. The process is energy efficient and they do not expect prices to increase this year.

Many examples of substituting thermo-optic silicate for part of the titanium dioxide component were given. Cost savings ranged from .15 to .30¢ per gallon. The idea is good not only for latex coatings, but also for any high PVC formula. The product also acts as a flatting agent with titanium dioxide without the use of any other agents. In some cases latex content is reduced along with the titanium, reducing the solids without any negative results. These coatings usually require higher cellulosic thickner content and have good flow, said Mr. Adrien.

Q. What dye solution is used in the test for porosity?

A. A 3% solution of nigrazine black dye in water gives reproducible results. Gilsonite dye is not as reproducible.

Q. How does the calcining temperature relate to the fusion point?

A. The hydrous clay is calcined in a two-step process. First it is heated to 1400° F and then to 1800° F in a fluidized bed. The fusion temperature is 2300° F, but if this temperature was reached grit would be formed.

ROBERT J. GIERY, *Secretary*

Future Society Meetings

Birmingham

(Jan. 14)—"ORGANIZATION AND MANAGEMENT OF BRITAIN'S LARGEST PAINT FACTORY"—A. Sutherland, I.C.I. Paints Division.

(Feb. 4)—"RECENT DEVELOPMENTS IN THE USE OF NICKEL AND CHROME TITANIUM PIGMENTS IN SURFACE COATINGS"—Mr. Kelch, BASF UK Ltd.

(Feb. 26)—ANNUAL LADIES NIGHT.

(Mar. 4)—"WETTING AND DISPERSING AGENTS FOR NON-AQUEOUS SYSTEMS"—Mr. Quednau, Byk-Mallinckrodt Chem. Prod. GmbH, Ltd.

(Apr. 1)—"COPING WITH UNCERTAINTY IN BUSINESS"—L.N. Sneddon, Sundridge Park Management Center.

(May 6)—"COMPARISON OF EXPOSURE TEST METHODS"—Speaker from Hoechst UK Ltd.

Chicago

(Jan. 11)—"ENVIRONMENTAL UPDATE"—Dr. H.M. Smith, Sun Chemical Co., and "VOYAGER SPACECRAFT ENCOUNTER"—Mike Urban, Jet Propulsion Laboratories.

(Feb. 1)—"HIGH SOLIDS VINYL RESINS"—Speaker from Union Carbide Corp., and "HIGH SOLIDS REACTIVE COATINGS"—Dr. L.W. Hill, Monsanto Co.

(Mar. 1)—"ANATOMY OF A LATEX PAINT"—Dr. L.R. Freimiller, Rohm and Haas Co., and "GLOSS LATEX PAINTS"—J. Bax, Pacific Scott Bader Co.

(Apr. 5)—"TECHNICAL EEFFECTIVENESS"—E.B. Euchner, SCM Corp., and "STRESS MANAGEMENT"—Mel Clapp, Cities Service.

Cleveland

(Jan. 21)—JOINT MEETING with Cleveland Paint & Coatings Association. Speaker Royal A. Brown, National Paint & Coatings Association.

(Feb. 16)—JOINT MEETING with National Association of Corrosion Engineers. "STATISTICAL ANALYSIS AND EXPERIMENTAL DESIGN FOR COATINGS CHEMISTS"—Earl Hill, Lord Corp. "POLYURETHANE COATINGS FOR HEAVY DUTY MAINTENANCE"—Richard Hergenrother, Mobay Chemical Co.

(Mar. 16)—MINI-SYMPOSIUM on High Solids. "VERSATILITY OF HIGH SOLIDS INDUSTRIAL COATINGS"—Rich Johnson, Cargill, Inc. "DESIGN CONSIDERATIONS FOR HIGH SOLIDS REACTIVE COATINGS"—Dr. Loren W. Hill, Monsanto Plastics and Resins Co.

(Mar. 23-24)—25th SYMPOSIUM ON ADVANCES IN COATINGS TECHNOLOGY.

(Apr. 20)—PLANT TOUR.

(May 18)—60th ANNIVERSARY OF FEDERATION MEMBERSHIP. PAST PRESIDENTS AND SPOUSES' NIGHT.

Dallas

(Jan. 14)—"FILM SURPRISES OR IRREGULARITIES OF INDUSTRIAL WATERBORNE AND HIGH SOLIDS COATINGS"—Al Heitkamp, Cargill Research Dept.

(Feb. 11)—LADIES' NIGHT.

(Mar. 11)—"OPTIMIZING RESINS AND SOLVENTS FOR LOW VOC HIGH SOLIDS COATINGS"—Steve Belote, Eastman Chemical Co.

(May 13)—"ANATOMY OF AN EMULSION POLYMER"—Benjamin Kine, Rohm and Haas Co.

Golden Gate

(Jan. 18)—"HYDROPHOBIC FUMED SILICAS FOR COATINGS"—Terry Bowerman, Degussa Corp.

(Feb. 15)—"ANIMATION MAGIC—THE PART PAINTS PLAY"—Ron Stark, International Animated Film Society.

(Mar. 15)—"THE UNIQUE PROPERTIES OF ULTRA-FINE SILICA"—John C. Becker, Jr., Omya, Inc.

(Apr. 19)—"HAZARDOUS WASTE DISPOSAL"—Michael L. Markowitz, Rollins Environmental Services of Texas, Inc.

(May 17)—"NEW DEVELOPMENTS IN SANDMILL DISPERSIONS TECHNOLOGY"—Ronald E. Swett, Moorehouse Industries, Inc.

(June 14)—"COMPLIANCE SOLVENTS FOR INDUSTRIAL COATINGS"—Violete Stevens, Dow Chemical Corp.

Houston

(Jan. 13)—"FILM SURPRISES OR IRREGULARITIES OF INDUSTRIAL WATER-BORNE AND HIGH SOLIDS COATINGS"—Al Heitcamp, Cargill Research Dept.

(Feb. 13)—LADIES' NIGHT.

(Mar. 10)—"OPTIMIZING RESINS AND SOLVENTS FOR LOW VOC HIGH SOLIDS COATINGS"—Steve Belote, Eastman Chemical Products, Inc.

(May 12)—"ANATOMY OF AN EMULSION POLYMER"—Benjamin Kine, Rohm and Haas Co.

Los Angeles

(Jan. 13)—"HYDROPHOBIC FUMED SILICAS FOR COATINGS"—Terry Bowerman, Degussa Corp.

(Feb. 10)—LADIES NIGHT. "ANIMATION MAGIC—THE PART PAINTS PLAY"—Ron Stark, International Animated Film Society.

(Mar. 10)—"UNIQUE PROPERTIES OF ULTRA FINE SILICA"—John C. Becker, Jr., Omya, Inc.

(Apr. 14)—"HAZARDOUS WASTE DISPOSAL"—Michael L. Markowitz, Rollins Environmental Services of Texas, Inc.

(May 12)—"NEW DEVELOPMENTS IN SANDMILL DISPERSION TECHNOLOGY"—Ronald E. Swett, Moorehouse Industries.

(June 9)—"COMPLIANCE SOLVENTS FOR INDUSTRIAL COATINGS"—Violete Stevens, Dow Chemical Corp.

Montreal

(Jan. 6)—"FURNITURE FINISHING"—Romeo Millaire, Sherwin-Williams Co.

(Feb. 3)—"THE PAINT BUSINESS—A CHALLENGE OR A DEAD END"—Jacques Mayer, International Paints.

(Mar. 3)—JOINT MEETING with Quebec Paint Industry Association (AQIP).

(Apr. 7)—Manufacturing Committee Presentation.

(May 5)—"THE PURCHASING, SALES INTERFACE"—John Humfreys, Sherwin-Williams Co., and Paul Rheaume, NL Chemicals, Canada, Inc.

New York

(Jan. 12)—"MULTIFUNCTIONAL EPOXY RESINS"—Dr. Edward Bozzi, Ciba-Geigy Corp.

Northwestern

(Jan. 5)—"AN INVESTIGATION OF ABRASION RESISTANCE"—William B. Neuberg, Shamrock Chemicals Corp. "PRECISION SPECIAL ULTRAVIOLET MEASUREMENTS AND ACCELERATED WEATHERING"—G.A. Zerlaut, DSET Laboratories, Inc.

(Feb. 2)—"PIGMENT DISPERSION AND THE C.P.V.C."—R.I. Ensminger, NL Chemicals/NL Industries, Inc. "FACTORS GOVERNING TINTER PERFORMANCE"—F.K. Daniel, Elio Cohen, and Mike Frantz, Daniel Products Co.

(Apr. 6)—FEDERATION VISIT.

(May 5)—MANUFACTURING SEMINAR.

Piedmont

(Dec. 16)—"FILM SURPRISES OR IRREGULARITIES IN WATER-BORNE AND HIGHER SOLIDS INDUSTRIAL SYSTEMS"—Speaker from Cargill, Inc.

(Jan. 20)—"Environmentally Acceptable and Energy Efficient Epoxy Resin Coatings"—Dr. Ron Bower, Shell Development Co.

(Feb.)—Joint Dinner/Dance with Piedmont Paint & Coatings Association.

(Mar. 17)—"Compliance—Solvent Options"—Speaker from Dow Chemical Corp.

(Apr.)—Joint Meeting with Virginia Section.

(May 20)—"Computer Selection of Solvent Blends"—Dr. Albert Rocklin, Shell Development Co.

(June 16)—"Economic Recovery of Solvent Vapors"—Larry J. Durr, DCI Corp.

Pittsburgh

(Jan. 4)—"Stabilization of Pigment Dispersion—How Can Science Help?"—Dr. G.D. Parfitt, Carnegie-Mellon University.

(Feb. 1)—"Surface Tension/Wetting"—Dr. George Gerhardt, Mobil Chemical Co.

(Mar. 1)—"The Whys and Wherefores of Cartridge Filtration in the Coatings Industry"—Donald S. Onnen, AMF Cuno Div.

(Apr. 5)—"Environmental Update"—Dr. Hugh M. Smith, Sun Chemical Co.

(May 3)—"Design Consideration for High Solids Reactive Coatings"—Dr. Loren W. Hill, Monsanto Plastics and Resins Co.

St. Louis

(Jan. 19)—Education Night. Coordinator Dr. Herman Lanson, Lan-Chem Resins Corp.

(Feb. 16)—Valentine's Night and Federation Visit.

(Mar. 16)—"Microbiological Spoilage of Latex Emulsions, Causes, and Prevention"—John A. Jakubowski, Merck and Co.

(Apr. 20)—"Pigment Selection and Evaluation"—David Wisnewski, Industrial Finishes Laboratory.

(May 18)—"The Whys and Wherefores of Cartridge Filtration in the Coatings Industry"—Donald S. Onnen, AMF Cuno Div. "Effective Paint Waste Treatment"—Edward M. Antonucci, Drew Chemical Corp. "Dispersion Equipment"—Speaker to be announced.

(June)—Joint Kansas City/St. Louis Societies Meeting.

Western New York

(Dec. 15)—"Exposure Evaluation: Quantification of Changes in Appearance of Pigmented Materials"—Joseph Kettenacher, Ciba-Geigy Corp.

Constituent Society Meetings and Secretaries

BALTIMORE (Third Thursday—Eudowood Gardens, Towson). Joseph D. Guisto; Lenmar, Inc., 150 S. Calverton Rd., Baltimore, MD 21223.

BIRMINGHAM (First Thursday—Calthorpe Suite, Edgbaston). D. H. Clement, Holden Surface Ctgs. Ltd., Bordesley Green Rd., Birmingham B9 4TQ, England.

CHICAGO (First Monday—meeting sites in various suburban locations). John R. Ingram, DeSoto, Inc., 1700 S. Mt. Prospect Rd., Des Plaines, IL 60018.

C-D-I-C (Second Monday—Sept., Jan., Apr., June in Columbus; Oct., Dec., Mar., May in Cincinnati; Nov., Feb., in Dayton). Robert A. Burtzlaff, Potter Paint Co. of Ind., P.O. Box 265, Cambridge City, IN 47327.

CLEVELAND (Third Tuesday—meeting sites vary). Donald C. Denison, Jr., Hilton Davis Chemical Co., 5254 Berkshire Dr., N. Olmsted, OH 44070.

DALLAS (Thursday following second Wednesday—Steak & Ale Restaurant). T. Leon Everett, Dan-Tex Paint & Ctg. Mfg., Inc., P.O. Box 18045, Dallas, TX 75218.

DETROIT (Fourth Tuesday—meeting sites vary). Sheila G. Drake, Wyandotte Paint Products, Inc., 650 Stephenson Hwy., Troy, MI 48084.

GOLDEN GATE (Monday before third Wednesday—Alternate between Sabella's Restaurant on Fisherman's Wharf and the Sea Wolf at Jack London Square, San Francisco). Ken E. Trautwein, Sherwin-Williams Co., P.O. Box 23505, Oakland, CA 94623.

HOUSTON (Second Wednesday—Sonny Look's, South Main). George Schwartz, Cook Paint & Varnish Co., P.O. Box 3088, Houston, TX 77001.

KANSAS CITY (Second Thursday—Cascone's Restaurant). Mel Boyer, Patco Coatings Products, 3947 Broadway, Kansas City, MO 64111.

LOS ANGELES (Second Wednesday—Steven's Steak House). Earl Smith, Spencer Kellogg Div., Textron, Inc., 4220 Long Beach Blvd., Long Beach, CA 90807.

LOUISVILLE (Third Wednesday—Hasenour's Restaurant). E. D. Thomasson, Louisville Varnish Co., 1400 Maple St., Louisville, KY 40207.

MEXICO (Fourth Thursday—meeting sites vary). Teresa Suarez, Sherwin-Williams Co., Mexico, D.F., Mexico.

MONTREAL (First Wednesday—Bill Wong's Restaurant). Eric Templeton, NL Chemicals Can., Inc., 2140 Sun Life Bldg., Montreal, Que., Can., H3B 2X8.

NEW ENGLAND (Third Thursday—Fantasia Restaurant, Cambridge). N. Bradford Brakke, Lilly Chemical Products, P.O. Box 188, Templeton, MA 01458.

NEW YORK (Second Tuesday—Landmark II, East Rutherford, NJ). H. Ellis, D. H. Litter Co., Inc., 116 E. 16th St., New York, NY 10003.

NORTHWESTERN (Tuesday after first Monday—Edgewater East Restaurant). Herbert Davidson, Spencer-Kellogg Div., Textron, Inc., 525-25th Ave. S.E., Minneapolis, MN 55414.

PACIFIC NORTHWEST (Portland Section—Tuesday following second Wednesday; Seattle Section—the day after Portland; British Columbia Section—the day after Seattle). William Shackelford, Gaco-Western, Inc., P.O. Box 88698, Seattle, WA 98188.

PHILADELPHIA (Second Thursday—Valle's Steak House). Ralph Myers, Del Vac Ink & Color Co., 1301 Taylors Ln., Riverton, NJ 08077.

PIEDMONT (Third Wednesday—Howard Johnson's Coliseum, Greensboro, NC). James E. Husted, Mobil Chemical Co., P.O. Box 2438, High Point, NC 27261.

PITTSBURGH (First Monday—Skibo Hall, Carnegie Mellon Univ.). Michael Gillen, Van Horn, Metz & Co., Inc., 400 Keystone Dr., Carnegie, PA 15106.

ROCKY MOUNTAIN (Monday following first Wednesday—Gusthaus Ridgeview, Lakewood, CO). Donald Shillingburg, Union Chemical Div. of Union Oil, 1535 W. 13th Ave., Denver, CO 80204.

ST. LOUIS (Third Tuesday—Salad Bowl Restaurant). Robert J. Giery, Spatz Paint Industries, Inc., 1601 N. Broadway, St. Louis, MO 63102.

SOUTHERN (Gulf Coast Section—Various Dates; Central Florida Section—Third Thursday after first Monday; Atlanta Section—Third Thursday; Memphis Section—Second Tuesday; Miami Section—Tuesday prior to Central Florida Section). J.E. Geiger, Sun Coatings, Inc., 12295 75th St., N., Largo, FL 33540.

TORONTO (Second Monday—Mayfair Restaurant). R. Kuhnen, Tioxide Canada, Inc., 1 Eva Rd., Etobicoke, Ontario, Canada M9C 425.

WESTERN NEW YORK (Third Tuesday—Lord Amherst Restaurant, Williamsville, NY). Michael C. Kaufman, Bisonite Co., Inc., P.O. Box 84, Kenmore St., Buffalo, NY 14217.

Elections

BIRMINGHAM

Active

Davies, Alun R.—Blythe Colours Ltd., Staffordshire, England.

Field, Peter—Postans Ltd., Birmingham B7, England.

Associate

Gregory, Brian James—B.T.P. Tioxide Ltd., Manchester, England.

Lane, Geoffrey W.—Laporte, Ind., S. Humberside, England.

Wallace, Eric Charles—Berger Resinous Chemicals, Kidderminster, England.

C-D-I-C

Active

Connelly, Fredrick J.—DAP Inc., Dayton, OH.

Krotchen, Jeanne M.—Hilton-Davis Chemical Co., Cincinnati, OH.

Roberts, Steven D.—Lilly Industrial Coatings, Indianapolis, IN.

Associate

Bryan, Tom—W.T. Bryan & Assoc., Cincinnati, OH.

Coniglio, Philip R.—Nalco Chemical Co., Cincinnati, OH.

Hach, Wayne F.—Diamond Shamrock Corp., Fairfield, OH.

Huffner, Stan F.—Sun Chemical Corp., Cincinnati, OH.

CHICAGO

Active

Beedle, Ellen C.—Rust-Oleum Corp., Evanston, IL.

Capra, Shari—Rust-Oleum Corp., Evanston.

Chrystof, Michael—Rust-Oleum Corp., Evanston.

Cohen, Allan H.—The Enterprise Cos., Wheeling, IL.

Fabian, Henry R.—Specialty Ctgs. Co., Elk Grove Village, IL.

Gardon, John L.—The Sherwin-Williams Co., Chicago, IL.

Harper, Roger—The Sherwin-Williams Co., Chicago.

Johnson, Monroe A.—Sheboygan Paint Co., Sheboygan, WI.

McCormack, Sara E.—Ottawa Silica Co., Ottawa, IL.

Murray, Kevin P.—DeSoto Chemical Co., Des Plaines, IL.

Neems, Jack M.—Specialty Ctgs. Co., Elk Grove Village, IL.

Pelulis, Joan E.—Columbian Chemicals Co., Itasco, IL.

Piet, Paul J.—Strauch Chemical Dist., Inc., Chicago, IL.

Strauch, Marvin J., Jr.—Strauch Chemical Dist., Inc., Chicago.

Stumpf, Martin P.—Neville Chemical Co., Glenview, IL.

Associate

Baldin, Edward J.—Spencer Kellogg Div. Textron, Inc., Des Plaines, IL.

Lapshansky, John F.—J.L. Associates, Joliet, IL.

Merrall, Diane M.—Hilton-Davis Chemical Co., Des Plaines, IL.

Peart, Alvin R.—ICI Americas Inc., Wheeling, IL.

Poklacki, Erwin S.—DeSoto, Inc., Des Plaines, IL.

Porter, David L.—The Valspar Corp., Chicago, IL.

Rieth, Theodore J.—Masonite Corp., St. Charles, IL.

Riley, Clinton—The Valspar Corp., Chicago, IL.

Rose, James—Rust-Oleum Corp., Evanston, IL.

Serketich, John E.—Sheboygan Paint Co., Sheboygan, WI.

Welge, Richard, K.—The Valspar Corp., Chicago, IL.

Yousuf, Mohammed K.—Specialty Ctgs. Co., Elk Grove Village, IL.

KANSAS CITY

Active

Becker, Robert T.—Earl Campbell Mfg. Co., North Kansas City, MO.

Bussjaeger, Stephen—Davis Paint Co., North Kansas City.

Manco, Hugo R.—Douglas Stiles Co., Kansas City, MO.

Associate

Carter, Kim D.—Archway Chemical Co., Kansas City, MO.
Danaher, William J.—Chemtech Ind., Inc., Kansas City.
Eaton, Ray N.—Solvent Supply Co., Riverside.
Sotta, Anthony E.—Solvent Supply Co., Riverside.

LOUISVILLE

Active

Baki-Hashemi, Hamid—Devoe & Raynolds Co., Inc., Louisville, KY.
Jackey, George A.—Louisville Varnish Co., Louisville.
Lagan, Robbie L.—Devoe & Raynolds Co., Inc., Louisville.

Associate

Bennett, John H.—Chemetron Processing Equipment, Louisville.
Long, Jack L.—Union Carbide Corp., Atlanta, GA.
McFerran, Robert P.—Rohm and Haas Co., Louisville, KY.
Schmidt, Mark H.—Mooney Chemicals, Inc., Palatine, IL.

PIEDMONT

Active

Jones, Gerald S.—Inmont Corp., Morganton, NC.
Kraus, Wayne A.—Spruance Southern, Inc., Winston-Salem, NC.

Associate

Cranford, George—Chemical & Solvents Co., Greensboro, NC.
Kemp, William, Worth Chemical Corp., Greensboro.
Sugg, Leonard—Chemical & Solvent Co., Greensboro.
Wenner, Jack H.—DuPont Chemical Co., Greensboro.

TORONTO

Active

Delplace, Steven—Ashland Chemicals, Mississauga, Ont., Can.
Dirkes, Carl C.—Steep Rock Calcite Co., Toronto, Can.
Narancic, Nada—Wyandotte Paint Ltd., Rexdale, Ont., Can.

Associate

Davis, Robert L.—A.S. Patterson Co., Ltd., Toronto, Ont., Can.
Levy, Edward I.—Frank E. Dempsey, Toronto.
Martin, David F.—Graco Canada Ltd., Milton, Ont., Can.
Mealia, Larry—Celanese Canada Inc., Mississauga, Ont., Can.

Technical Articles in Other Publications

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

Organic Coatings and Plastics Chemistry

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

Vol. 45 August 1981

Recent Developments in Electrodeposition of Paints (8 papers)
General Papers and New Concepts in Applied Polymer Science (15 papers)
Polymer Alloys and Blends (26 papers)
Computer Applications in Coatings and Plastics
  Polymerization Process Modelling and Control (12 papers)
  Instrument Automation for Rheological Analysis and Modelling (6 papers)
  Instrument Automation for Thermal Dynamic Mechanical, Dielectric and Light Scattering (6 papers)
  Mathematical Modelling of Thermal-Mechanical Data, Kinetics, and Solution Properties (6 papers)
  Mathematical Modelling, Experimental Deisgn, Coatings Formulation and Data Management (6 papers)
Solvent-Property Relationship in Polymers (17 papers)
Use of Renewable Resource Materials for Polymer Applications (22 papers)
Waterborne Industrial Coatings Package and Stability, Procedures and Performance (7 papers)
Polymer Fatigue And Nonlinear Behavior (19 papers)
International Symposium on Physicochemical Aspects of Polymer Surfaces (abstracts only)

For information regarding the price and availability of this publication, please contact ACS Division of Organic Coatings and Plastics Chemistry Treasurer G.G. Shurr, at Sherwin-Williams Research Center, 10909 Cottage Grove Rd., Chicago, IL 60628.

Pigment and Resin Technology

Vol. 10 No. 3 March 1981

Chandra, S. and Batra, K.—"Blends of Polybisphenol phthalate and Alkyds"; 11-14.
Walton, A.J.—"Application of Gas Chromatography in Paint and Allied Industries. Part 4: Binder Resins"; 15-18.

Vol. 10 No. 4 April 1981

Anon.—"Coatings Update: Some New Proprietary Products" (Literature review); 12-14.
Walton, A.J.—"Applications of Gas Chromatography in Paint and Allied Industries. Part 5: Environmental Studies"; 15-19.

Polymer Preprints

Published by American Chemical Society, Division of Polymer Chemistry

Vol. 22 No. 1 March 1981

Cyclopolymers and Polymers with Chain-Ring Structures (39 papers)
Dynamical Properties of Polymer Fluids: Solution, Gel and Melt (29 papers)
Witco Award Symposium honoring E.J. Vandenberg: Coordination Polymerization (9 papers)
Aqueous Polymer Systems (12 papers)
Polymeric Reagents (12 papers)
Special Topics Poster Sessions (38 papers)
Macromolecular Secretariat—Instrumental and Physical Characterization of Macromolecules (58 papers)

Vol. 22 No. 2 August 1981

Polymer Science and Engineering Lecture Series
  Crystallinity and Orientation in Polymers (3 papers)
  Introduction to Elastomers and Rubber Plasticity (2 papers)
Polymers in Energy Conservation—Polymers in Enhanced Oil Recovery (29 papers)
Cure and Characterization of Thermosetting Resins (17 papers)
Elastomers and Rubber Plasticity (39 papers)
Advances in Polymer Composites
  Interface (5 papers)
  Reinforcing Phase (5 papers)
  Matrix Resins (5 papers)
  Mechanical Properties (6 papers)
  Chemical and Mechanical Analysis (5 papers)
Molecular Dynamics in Solid Polymers (20 papers)
Creative Polymer Chemistry Award honoring L.J. Fetters (7 papers)
Special Topics—Poster session (49 papers)
Special Topics in Polymer Chemistry (6 papers)

For information regarding the price and availability of this publication, please contact ACS Division of Polymer Chemistry Treasurer S.C. Israel, at Chemistry Dept., University of Lowell, Lowell, MA 01854.

UMR Short Courses Expand to West Coast

"Estimating for Paint Contractors and Maintenance Engineers" workshop and "The Refresher for Painting Contractors and Maintenance Engineers" short course are being sponsored by the University of Missouri-Rolla in San Mateo, CA and St. Louis, MO.

The three-day workshop is designed to help painting contractors, crew foremen, architects, and maintenance engineers make the estimate that gets the job and makes a profit. In this comprehensive program, one will work with actual plans in a nearly real-life situation, practicing bidding skills taught in class. Also featured will be blueprint reading, specifications, quantity take-off, pricing structure, and an estimating exercise. The fee for the workshop is $400, which will be held May 18–20 at San Mateo, CA Villa Hotel, and November 16–18 at the Sheraton St. Louis Hotel, St. Louis, MO.

The refresher short course is an intensive three-day program designed to provide the newest available information on materials, equipment, and methods of preparing surfaces and applying and maintaining paint. Subjects featured in the session will include paint composition, surface preparation, cementicious, wood and metal surfaces, application methods, drywall systems, and restrictive government regulations. The session will be held February 2–4 at the Villa Hotel, San Mateo, CA and November 9–11 at the Sheraton St. Louis Hotel, St. Louis, MO. Fee for the refresher is $400.

To register or for more information contact: Norma R. Fleming, Coordinator, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401, 314-341-4201.

Montreal Society Sponsors Organic Coatings Course

The Montreal Society for Coatings Technology has sponsored this fall, "Organic Coatings I", an introductory course in coatings technology. This new course was designed to meet the needs of individuals entering the coatings industry or for those who want to up-date their knowledge in the field.

The course objective is to provide specific information about protective coatings and a basic understanding of the raw materials used as well as the techniques of formulation, manufacture, and quality control. Through a series of lectures given by C. Craib and Walter Kolanitch, of Sherwin Williams Canada Ltd., the groundwork is laid for the student to assimilate to help him understand the complexities of coatings and the part they play in our daily lives.

Featured are guest lecturers who will discuss pigments, vehicles, solvents, mechanism of film formation, principles of formulation and coating calculations, coating manufacture, paint characterization, principles of colorimetry, lacquer coatings, new coatings and resins, and environmental regulations.

UMR to Sponsor Industrial Market Research Seminar

The Chemistry Department of the University of Missouri-Rolla is sponsoring "Industrial Market Research for the Chemical Industry", a seminar designed to give an overview of market research and hands-on experience in gathering data and evaluating market research reports. The three-day seminar will be held in March and May in San Mateo, CA and Chicago, IL, respectively.

On the first day, students will learn what market research is and how it compares with consumer market research; how to evaluate external market research; how to do one's own market research; and how to manage the marketing function. Analytical skills used in industrial market research will be presented on the following day. Skills featured include: data gathering with emphasis on questionnaires and interviewing techniques; estimating the variable and forecasting; developing information on privately and closely held companies; and improving the cost-benefit ratio of market research. On the third day, participants will be given a market research assignment, which will be done at the workshop; the results will be presented and evaluated, and compared to estimates of costs.

The course fee is $495, which includes textbook, course notes and all other classroom materials. The course will be held March 15–17 at the Villa Hotel, San Mateo, CA and May 4–6 at the Raphael Hotel, Chicago, IL.

For additional information or to register, contact Norma Fleming, Arts & Sciences Continuing Education, University of Missouri-Rolla, Rolla, MO 65401.

CALL FOR PAPERS

Symposium on Color in Protective Coatings

April 1982
Montreal and Toronto

The Chemical Institute of Canada, Protective Coatings Division is sponsoring the symposium to be held in Montreal and Toronto respectively, on two consecutive days.

Papers are invited on any developments and trends in the chemical, physical, technological, and environmental aspects of color as related to protective coatings.

Inquiries should be addressed to D.S. Wiersma, Celanese Canada Inc., 2 Robert Speck Prky, Suite 900, Mississauga, Ont., L4Z 1H8 Canada.

NPCA Seminar to Cover Production/Inventory Topics

A "Production Planning and Inventory Management Seminar will be held by the National Paint and Coatings Association in Atlanta, GA, March 8–10.

The seminar, which is limited to 12 participants, will consider the conflict of paint manufacturers in providing maximum customer service with minimum inventory investment and maximum plant efficiency.

Dr. Gene Groff, of Georgia State University, author of NPCA's "Production Planning and Inventory Management Manual for the Paint Industry," will conduct the seminar.

Cost of the seminar is $350.

Further information and registration may be obtained from NPCA, Meetings and Convention Div., 1500 Rhode Island Ave., N.W., Washington, D.C. 20005 (202) 462-6272.

American Oil Chemists' Society Seeks Methods Specialist

The American Oil Chemists' Society is seeking a person to become the society's first Director of Methods Development.

The new staff position is being created to enable the society to continuously update and revise its internationally recognized book of *AOCS Official and Tentative Methods,* used by industries working with animal and vegetable fats and oils.

Specifically, the new director of methods development will organize and then implement a program for collection, evaluation, and publication of analytical methods in the field of animal and vegetable fats and oils. This will involve maintaining communication with individuals and groups interested in analytical methodology as well as coordinating the work of the society's own technical committees that develop new methods.

Applicants with advanced education and experience in analytical chemistry should send a complete resume, including salary history, and a sample of writing, to: Search Committee, c/o E. G. Perkins, Chairman, AOCS, 508 S. Sixth Street, Champaign, IL 61820.

The AOCS is a professional society of approximately 4,000 members who work in the chemistry, biochemistry, nutrition, or processing of animal and vegetable fats and oils, and other oilseed products.

CALL FOR PAPERS

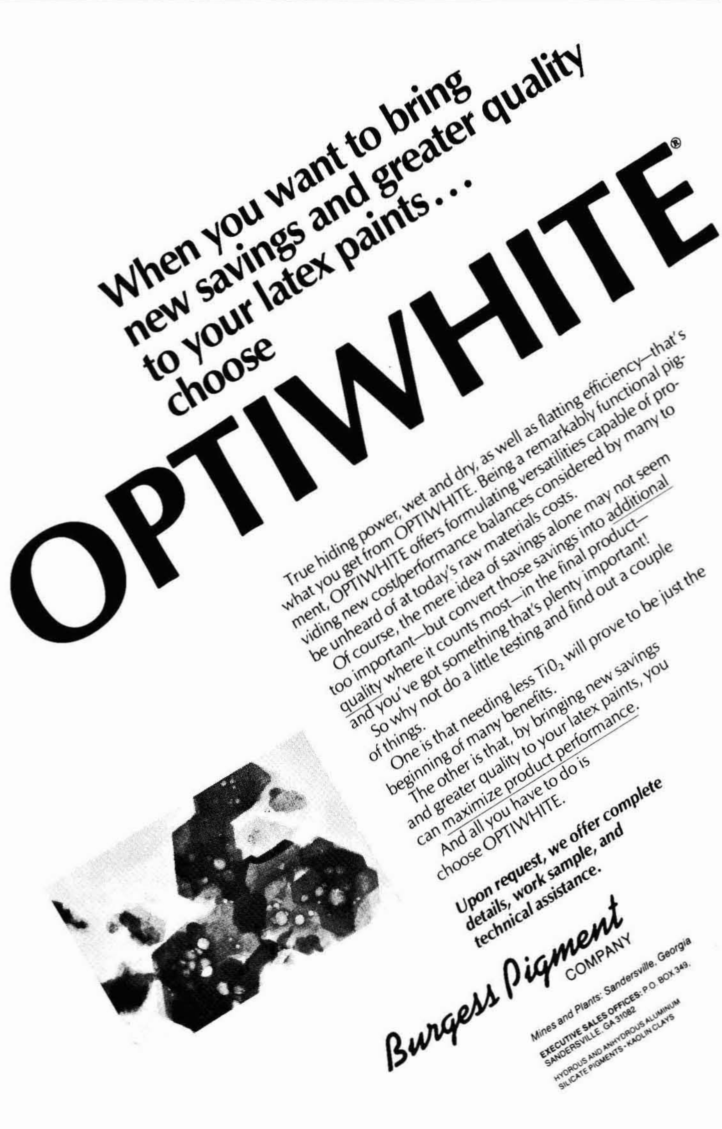
Eighth International Conference on Organic Coatings Science & Technology

July 12–16
Athens, Greece

Those interested in presenting papers are invited to submit abstracts on subjects related to the science and technology of organic coatings. These abstracts will be used only for a review by the Scientific Committee. Authors will be notified by March 15 of the acceptance and the length of time allotted for the presentations. Complete manuscripts will be needed by May 1.

The Conference is designed to bring together scientists, engineers, and educators in an international forum to discuss recent research and development work covering all aspects of organic coatings.

Abstracts should be mailed by February 15, to: Dr. Angelos V. Patsis, Director, Institute in Science and Technology, State University of New York, New Paltz, NY 12561.



People

The Negley Paint Co., San Antonio, TX, has announced the retirement of **Alfred R. Rowe, Jr.,** as President. A 53-year veteran of the paint industry, Mr. Rowe is a member of the Houston Society for Coatings Technology, the American Chemical Society, and is a registered professional engineer.

Succeeding Mr. Rowe as President is **Richard C. Barnes,** formerly of Devoe & Raynolds Co., Inc. He is a Houston Society member.

Deer-O Paints and Chemicals, Ltd., has announced the appointment of **H. Dale Krog** as President of the Phoenix, AZ based paint manufacturing firm. Mr. Krog was formerly Vice-President for the firm.

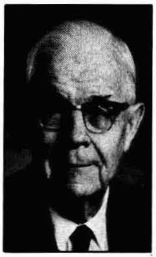
Michael Kent Hentschel has been named Manufacturing Manager for the Buckman Laboratories, Inc., plants located in Cadet, MO.

The Color Corporation of America, a division of The Valspar Corp., has announced the promotion of **Mark Nelson** to the position of Technical Director. Mr. Nelson will be responsible for all colorant research development and technical service support for the firm, headquartered in Rockford, IL. He is a member of the Chicago Society.

Dr. Lionel B. Luttinger has been appointed to the position of Project Manager, Petroleum Specialties and Maintenance Chemicals, at Drew Chemical Corp., Boonton, NJ.

Dr. Brian M. Rushton, has joined Air Products and Chemicals, Inc., as Vice-President of Research and Development. He succeeds **Dr. J. Robert Lovett,** who was recently appointed President of the firm's European operations. Dr. Rushton was Vice-President of Technology for the Celanese Corp., and, since 1975, was President of Celanese Research Co.

Michael J. Watkins has been named Principal Research Chemist at Battelle's Houston operations. In his new position, he will be responsible for conducting coatings and specialty polymer research, including coatings and elastomers used in oil and gas production, pipeline coatings, and polymers used in tertiary oil recovery processes. Mr. Watkins is a member of the C-D-I-C Society.



A.R. Rowes, Jr.

R.C. Barnes

D. Higgins

J.J. Kelly

Dan Higgins, formerly the National Sales Manager for EZ Paintr Corp., has been promoted to the office of President for Dixon Applicators, Ltd., Canada.

Also announced by EZ Paintr Corp. was the appointment of **Bob Briggs** to the position of Southeastern Regional Manager.

Sun Chemical Corp., Pigments Division, has announced the appointment of **Dr. Peter A. Lewis** as Tecnnical Services Manager, headquartered in Cincinnati, OH.

Robert D. Jerabek has been named Senior Scientist in the PPG Industries, Inc., Coatings & Resins Division, Research and Development Laboratory, Allison Park, PA. Mr. Jerabek is a member of the Pittsburgh Society.

Also announced by the firm was the appointment of **Dr. Kenneth J. Madonia** as Senior Engineering Associate, at the R&D Laboratory, Springdale, PA.

The Board of Directors of Witco Chemical Corp. have elected **Henry Sonneborn III,** currently President, and **William J. Ashe,** currently Senior Executive Vice-President, to new positions. Mr. Sonneborn has been promoted to Vice-Chairman of the firm and Mr. Ashe will assume the positions of President and Chief Operating officer.

Noel A. Marzulli has been promoted to Manager of the Eastern division of Kelco, a division of Merck & Co., Inc. Mr. Marzulli was previously Sales Manager of Kelco Specialty Colloids in Canada. He is a member of the Toronto Society. Replacing Mr. Marzulli as Sales Manager is **Robert L. Durgan**. He is responsible for managing the sales of the firm's food and industrial products in Canada.

James J. Kelly has been promoted to Vice-President of Technology for The O'Brien Corp., South San Francisco, CA.

Dr. Lee Gilman has joined Micromeritics, Norcross, GA, as Product Specialist, Particle Technology. In his new position, he will provide particle technology customers with instrument applications and technical assistance and information relating to materials' physical properties behavior.

Midland Division, the Dexter Corp., has announced the promotion of **Scott Schneider** to the position of Senior Coatings Chemist, General Industrial Laboratory. He served previously as a Project Chemist.

Also announced by the firm, was the appointment of **John Ledford** as Project Chemist in the area of solvent-based coil coating.

The Mearl Corp., Scarsdale, NY, has announced the appointment of **Fred LoFaso** to the position of Vice-President, Sales and Marketing for their pigment division.

Joseph M. Quinn has been appointed Group Vice-President at Grow Group, Inc. He will assume responsibility for the direction and performance of the Devoe Marine Coatings Co. and U.S. Paint divisions of the corporation. Mr. Quinn will be based in Louisville, KY.

Also announced by the firm was the appointment of **Walter Foote** to the position of Manager—Government Marketing, for the Devoe Marine Coatings Co. Named to the positions of Plant Managers were **Jim Judlin** and **Paul Kelly**. Mr. Judlin is headquartered at the trade sales facility of Devoe & Raynolds Co., Houston, TX, and Mr. Kelly is based at the division's Pennsauken, NJ facility.

The Golden Jubilee of her association with the coatings industry is being celebrated this year by **Mrs. Alma M. Gooel,** Vice-President and Secretary of Standard Detroit Paint Co., Detroit, MI.

A native of Detroit, Mrs. Gooel joined the industry in 1931 when she also joined Mr. Gooel (Bert) in matrimony. At the time, he was the manager of the Detroit branch office of a Cleveland paint manufacturer.

They formed Standard Detroit in 1934 and since have formed these divisions which they operate in the State of Michigan: Standard Wallcovering, Ford Paint & Varnish Works, A.C. Johnson Equipment Co., and Wallpaper Works.

Bert and Alma Gooel are familiar faces at conventions of both the NPCA and FSCT, having attended 36 of them. When the Federation held its 1971 Annual Meeting in Detroit, they served as co-chairmen of the Spouses Program Committee. They have also been active in the affairs of the Detroit PCA.

Dr. Alfred N. Dunlop has been appointed Manager, Chemical Coatings, for the Glidden Co. Div. of SCM (Canada) Ltd. In this position, Dr. Dunlop will direct the marketing and administrative activities of coatings manufactured for Canadian industry.

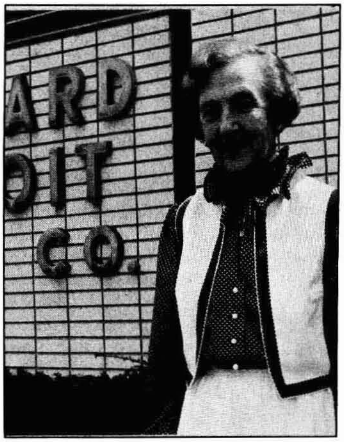
Gary J. Schofe has been named Resin Plant Manager at the Columbus, GA facility of Glidden Coatings & Resins, SCM Corp.

The promotion of **Harry Smith** to the position of Director of Western Operations was announced by Day-Glo Color Corp. Also, **Brent Lloyd** has expanded his sales management activities as Western Manager to include Pacific Dispersions, Inc., a subsidiary of Day-Glo Color.

DeSoto, Inc., Westland, MI, has appointed **Phillip G. Phillips,** Market Manager for the Argo Automotive Coatings Division.

The Minerals & Chemicals Division of Engelhard Corp. has named **William B. McGregor** to the position of Director of Manufacturing for its Catalysts & Chemicals Group. In this position, Mr. McGregor assumes responsibility for all manufacturing activities at the firm's plants in Little Rock, AR, Cleveland, OH, Strasburg, VA, and Attapulgus, GA.

The Valspar Corp. has appointed **John Ostrowski** as Research Director, Chemical Coatings, headquartered in Minneapolis, MN.



Alma Gooel

Joy Turner Luke, professional painter and owner of Studio 231, Sperryville, VA, was named the 1981 recipient of the Henry A. Gardner Award by the American Society for Testing and Materials. Ms. Luke was cited for her outstanding contributions in the organization and management of Subcommittee D01.57 on Artist Paints and Related Materials.

As chairman of Subcommittee D01.57, Ms. Luke is involved with the development of test methods, specifications, and labeling requirements for artists' paint. In addition to her membership in ASTM, Ms. Luke is a member of the Artists' Equity Association, the Inter-Society Color Council, the Optical Society of America, and the Editorial Board of *Color Research and Application.*

Cargill Inc., Minneapolis, MN, has announced the election of **James F. Lawrence** to the position of President, Chemical Products division.

Also announced by the firm was a major restructuring program that created new operating groups and included the election of group Vice-Presidents. **John P. Cole** was appointed Vice-President of the Trading Group; **James A. Howard** was elected to the Commodity Marketing Group; **Cary H. Humphries** was elected to the Industrial Group; **Donald L. Leavenworth** was appointed to U.S. Oilseed Processing; and **Gerald M. Mitchell** was named Vice-President of Milling.

Donald W. Dreisig has joined the staff of the American Chemical Society's Chemical Abstracts Service as Manager of Marketing Planning, a position in which he assumes responsibility for identifying and developing new services and exploring new business opportunities.

Cook Paint and Varnish Co., Kansas City, MO, has named **Charles H. Leinenkugel** as Manager of Purchasing.

Two new sales assignments in the pigments department have been announced by the Hilton-Davis Chemical Co. **Diane M. Merrall** and **Jeffrey P. Johnson** have been assigned to call on customers in the paint, plastics, and printing ink industries in the Midwest. Ms. Merrall, who was a sales representative in St. Louis, MO has been transferred to Chicago, IL, and Mr. Johnson, who has joined the firm, will replace her in St. Louis. Ms. Merrall is a member of the St. Louis Society.

Obituary

Elry L. Fleisher, 69, died on July 22 in Minneapolis, MN. A graduate of North Dakota State University, Polymers and Coating Department, Mr. Fleisher was a past-president (1942) and retired member of the Northwestern Society for Coatings Technology.

Forrest Ray Gross, 51, a Chemist for Welco Manufacturing Co. and a past-president of the Kansas City Society for Coatings Technology, died on August 25.

D. Wesley Skillern, 73, died on August 27. Mr. Skillern retired in 1972 from Cron Chemical Co. after ten years of service. He most recently served as Vice-President for the firm. He was a past-president for both the Houston Society for Coatings Technology and the PCA.

M.M. "Mac" Hemphill, 65, Vice-President—Research of Southern Protective Products Co., Atlanta, GA, died September 2.

Mr. Hemphill was associated with Southern for 10 years, previously serving as Chief Chemist for Minnesota Paints and the Valspar Corp., and as formulator for F.J. Cooledge & Sons. A 36-year veteran of the paint industry, Mr. Hemphill was a member of the Southern Society for Coatings Technology and the American Society for Testing Materials.

William Rupp, 48, died on September 19. He was Vice-President and General Manager of Tenneco Chemical's Polymers group.

Frank Pirok, 56, General Manager of Chicago Boiler Co., died on September 20. Mr. Pirok, joined Chicago Boiler shortly after serving in World War II. He played a key role in the design, engineering, and marketing of the firm's Red Head media mill.

Literature

Aerosol Lubricant

A new, dry film aerosol lubricant, specially formulated for the aluminum building industry, is the subject of recent literature. This handy maintenance product can be easily sprayed on windows, tracks, slides, latches, rollers, etc., and prevents sticking and reduces friction. For free literature, write ORB Industries, Inc., 2 Race St., P.O. Box 1067, Upland, PA 19015.

Latex

A new, unique acrylic/styrene latex, for use in the production of ceramic tile adhesives, is featured in recent literature. By using this latex in the manufacture of ceramic tile adhesives, a solvent-free water-based product which shows outstanding early water resistance, can be offered. For a copy of the literature, write Pacific Scott Bader Inc., John Bax, 1145 Harbour Way South, Richmond, CA 94804.

Spray Putty

A one-step bond, used in applications to bare metal and other materials to provide a ready surface for painting a top coat with minimal sanding, is the subject in recent literature. Characteristics, uses, and applications of this one-step putty are detailed. For information, contact Leylyn Ltd., Mr. A. Crossley, Quadrant House, 21–25 Highfield Rd., Doncaster, South Yorkshire DN1 2LA England.

Monomer

Allyl methacrylate, a functional monomer which can be polymerized as well as used as a crosslinking agent, is the subject of recently published literature. Described are applications such as in the coatings, printing, inks, adhesives, plastics, rubber, chemical specialties, and textile industries. Further information can be obtained from Union Carbide Corp., Specialty Chemicals and Plastics Div., Dept. M1552, Danbury, CT 06817.

Thickness Gauge

Literature is available announcing a new digital coating thickness gauge, used to simplify the measurement of nonmagnetic dry film coating thickness such as paints, enamels, epoxies, plating, and galvanizing when applied to ferrous (steel) substrates. For more information, contact Frank Rueter, Marketing Manager, Zormco Corp., P.O. Box 444, Dept. C-4, Cleveland, OH 44125.

ASTM Publications

Updated ASTM Standards are now available in Part 27–29 of the *1981 Annual Book of ASTM Standards.* In these three updated books, more than 630 authoritative ASTM Standards supply reliable information on pigments, fatty oils, and related coatings and components. For additional information, contact R.P. Lukens, ASTM, 1916 Race St., Philadelphia, PA 19103.

Rubber Enamel

A technical bulletin has been published introducing a chlorinated rubber enamel that allows for easy and economical care of concrete swimming pools. It provides a glossy waterproof barrier to protect concrete pools from deterioration and erosion by the various chlorine compounds used for disinfection. For a copy of the technical bulletin, write Steelcote Manufacturing Co., 3418 Gratiot, St. Louis, MO 63103.

Dispersing Agents

Information is available featuring dispersing agents, with anti-foaming characteristics and effective rapid dispersion of pigments in aqueous solution. Described are the uses of these agents in latex paints, paper coatings, adhesives, textile treatments, and other industrial applications. For information, write Seaboard-Martin, 920 Southwest 21st Terrace, Fort Lauderdale, FL 33310.

Spectrocolorimeters

A new series of spectrocolorimeters for precise and quantitative measurement is the subject of recent literature. Features, advantages, and capabilities of the new series are described and detailed. For more information, contact Hunter Associates Laboratory, Inc., 11495 Sunset Hills Rd., Reston, VA 22090.

Copolymer Antifoulings

A new, 14-page technical bulletin introducing a line of self-polishing copolymer antifoulings is now available. The bulletin documents the product's performance on over 400 vessels and illustrates graphic comparisons and statistical tracking in comparing the product with traditional antifouling coatings. Operating costs, benefits, formulations, and specific applications are also featured. For copies of the brochure, contact the International Paint Co., Inc., Morris and Elmwood Ave., Union, NJ 07083.

Triallyl Trimellitate

Literature has been published featuring triallyl trimellitate, which is a high boiling liquid suitable for a variety of crosslinking and reactive diluent applications. For more information, write Alcolac Inc., 3440 Fairfield Rd., Baltimore, MD 21226.

Liquid Evaporator

Literature is available featuring a pneumatic liquid evaporator, initially designed to eliminate damaging liquids from pneumatic air lines in the industrial and commercial painting industries. For more information, contact La-Man Corp., P.O. Box 32, Tekonsha, MI 49042.

Test Kit

Information is available introducing a portable/bench electronic test kit for integrity testing of sterilizing filters. Features and operations of the test kit are detailed. Write Pall Corp., Glen Cove, L.I., NY 11542.

Soiling of Paint Films

A new "Special Publication" on the soiling of paint films is available from the Paint Research Association. Its 100 pages, including nearly 150 references to relevant literature, contain a comprehensive review of published work followed by a detailed account of laboratory work carried out at the PRA. This work studied the factors involved in the dirt pickup of paint, comparing 20 different paints for their ability to resist soiling by dirt and staining. The final section deals with the ease of cleaning by a number of domestic cleaning agents. Special Publication No. 16 is available from PRA, Waldegrave Rd., Teddington, Middlesex TW11 8LD, England.

Bibliography

A comprehensive bibliography for analytical pyrolysis has recently been published. After a computerized worldwide search was conducted, a technical staff segmented the listings into categories most useful to synthetic and natural polymer chemists, geochemists, mass spectroscopists, and gas chromatography specialists. For additional information, write Chemical Data Systems, Inc., 7000 Limestone Rd., Oxford, PA 19363.

Mixing Lab

Literature has been published which features a redesigned version of a mixing lab, designed to maximize accuracy of scale-up to large production runs, and to be used as production equipment where small, closely controlled batches are needed. These machines have uses in the coatings, sealants, adhesives, plastics, and chemical industries. For information, write Hockmeyer Equipment Corp., P.O. Box 113, 610 Worthington Ave., Harrison, NJ 07029.

Scale

A new bulk bagging scale which achieves high accuracies with speeds up to 24 bags/minute on any free-flowing material is the subject of recent literature. The scale is an all-new design utilizing full load cell suspension, eliminating scale beams, pivots and knife edges, leading to long-term accuracy. For information, write Dept. E-55, Howe Richardson, HCR International, 680 Van Houten Ave., Clifton, NJ 07015.

Microscopes

Literature is available introducing a new series of pocket-sized inspection and measuring microscopes, ideal for simple quality checks and precise measurement of diameters of tubing, stress cracks, etc. Write, Frank Rueter, Vice-President Marketing, P.O. Box 25468, Dept. H-24, Cleveland, OH 44125.

Geochemical Analysis System

A new product brochure detailing a system for geochemical analysis and research has recently been published. Features and capabilities of the system are described. For more information, contact Chemical Data Systems, Inc., 7000 Limestone Rd., Oxford, PA 19363.

Artificial Weathering Cycles

A report has been published comparing the durability of paint films from nine different media, after exposure to various artificial weathering cycles and to various natural environments. For additional information, write Paint Research Association, Waldegrave Rd., Teddington, Middlesex TW11 8LD, England.

PRA Publication

The Paint Research Association has published a brochure which summarizes the microbiological services available. For further information contact Robert Springle, Microbiology Lab., PRA, Waldegrave Rd., Teddington, Middlesex TW11 8LD.

Epoxy Coating

A new epoxy polyamide coating with the corrosion resistance of coal tar epoxy, but without its application or toxicity problems, is featured in new literature. Applications, recommended uses, and advantages over conventional coal tar epoxies are highlighted. For more information, contact Devoe/Prufcoat, Devoe & Raynolds Co., Div. of Grow Group, Inc., P.O. Box 7600, Louisville, KY 40207.

Cadmium Pigments

Information is available introducing a new line of cadmium pigments designed for thermoplastic and thermoset resins. Features such as excellent heat stability, light-fastness, and chemical resistance are detailed along with recommended uses and applications. For more information, write Harry Sarvis, Color Div., Ferro Corp., P.O. Box 6550, 4150 E. 56th St., Cleveland, OH 44101.

Strainer

Literature is available describing the advantages of using a strainer to strain polyvinyl acetate (PVA), a latex-base paint. Results of tests are provided which revealed improved production and quality and immediate efficiency improvement, with this pressure-fed strainer, equipped with a 150-mesh strainer element. For information, contact C-E Bauer, Div. of Combustion Engineering, Inc., P.O. Box 968, Springfield, OH 45501.

NTIS Newsletters

The National Technical Information Service has made available a series of newsletters covering a variety of subjects. Information is provided on adhesives and sealants; carbon and graphite; ceramics, refractories, and glass; coatings, colorants, and finishes; composite materials; corrosion and corrosion inhibition; elastomers; fibers and textiles; iron and iron alloys; materials degradation and fouling; nonferrous metals and alloys; plastics; solvents, cleaners, and abrasives; and wood and paper products. Subscription inquiries to this weekly newsletter should be sent to NTIS, 5285 Port Royal Rd., Springfield, VA 22161.

CLASSIFIED ADVERTISING

Letters to the Editor

Need for "History of Paint" Expressed

To The Editor:

In these days when we are trying to persuade young people to enter the Paint Industry, it would be most helpful if we had a comprehensive "History of Paint" to give them as background information.

While there appears periodically articles on various phases of paint development, I am not aware of any single volume which will take us from the cave paintings in Spain and France to the present time. It is difficult to inspire young people to enter an industry when we cannot even tell them about the progress of our industry! We *need* a "History of Paint" (not manufacturing, but only technology) to show people, to tell people that we have a wonderful, highly technical industry that is an ideal challenging area in which to work!

I can't write the book alone, but I'll be glad to help. We need a committee to start this, and I will be glad to get it organized. This committee can be sponsored by the Federation, any one (or more) of the individual Societies, or it may operate independently of all of the above. Since this must be an extracurricular project on my part, I am asking all those who are interested in such an endeavor to contact me at my home address: Joseph H. Boatwright, 6412 Mills Creek Lane, North Ridgeville, Ohio 44039.

I welcome any and all response!

Joseph H. Boatwright
The Sherwin-Williams Co.
Cleveland, OH

Coming Events

FEDERATION MEETINGS

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

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

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(Oct. 12–14)—61st Annual Meeting and 48th Paint Industries' Show. Queen Elizabeth Hotel, Montreal, Quebec, Canada. (FSCT, 1315 Walnut St., Suite 832, Philadelphia, PA 19107).

SPECIAL SOCIETY MEETINGS

(Feb. 17–19)—Water-Borne and Higher-Solids Coatings Symposium sponsored by Southern Society for Coatings Technology and University of Southern Mississippi—Department of Polymer Science. Hyatt Regency Hotel, New Orleans, LA. (Mr. Fred M. Ball, Eastman Chemical Products, Inc., P.O. Box 431, Kingsport, TN 37662).

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

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

(Apr. 21–23)—Southwestern Paint Convention. Shamrock Hilton Hotel, Houston, TX.

(May 6–8)—Pacific Northwest Society. Annual Symposium. Bayshore Inn, Vancouver, B.C. (Barry Lamb, Harrisons & Crosfield, Ltd., 810 Derwent Way, New Westminster, B.C. V3M 5R1).

(May 19–20)—New England Society Coatings Tech Expo '82. Sheraton Inn, Boxborough, MA.

1983

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

OTHER ORGANIZATIONS

(Jan. 17–21)—American Society for Testing and Materials Committee D-1 Meeting on Paint and Related Coatings and Materials. Monteleone Hotel, New Orleans, LA. (Jane M. Turner, ASTM, 1916 Race St., Philadelphia, PA 19103).

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

(Feb. 10–11)—"Engineering Innovations for Coatings R&D Laboratories" Seminar. Fort Lauderdale, FL. (Norma Fleming, Arts & Sciences, Continuing Education, University of Missouri—Rolla, Rolla, MO 65401).

(Feb. 22–24)—The Adhesion Society's Annual Technical Meeting. Mobile, AL. (Pat Dreyfuss, Institute of Polymer Science, The University of Akron, Akron, OH 44325).

(Mar. 3–5)—"The Versatile Thermosets" RETEC, Society of Plastics Engineers, Inc. and the Thermoset Division. Marriott Oakbrook Motor Hotel, Oakbrook, IL. (Paul Fina, College of DuPage, Box P, Riverside, IL 60546).

(Mar. 8–10)—National Paint and Coatings Association's Marine and Offshore Coatings Conference. Grand Hotel, Point Clear, AL. (Armand P. Herreras, NPCA, 1500 Rhode Island Ave., N.W., Washington, D.C. 20005).

(Mar. 8–10)— Production Planning and Inventory Management Seminar. Atlanta, GA. (National Paint and Coatings Association, Meetings and Conventions Div., 1500 Rhode Island Ave., N.W., Washington, D.C. 20005).

(Apr.)—Symposium on Color in Protective Coatings sponsored by the Chemical Institute of Canada, Protective Coatings Division. Montreal and Toronto. (D.S. Wiersma, Celanese Canada, Inc., 2 Robert Speck Pkwy., Suite 900, Mississauga, Ont., L4Z 1H8 Canada).

(Apr. 19–20)—Inter-Society Color Council. Annual meeting. Charlotte, N.C.

(Apr. 21–28)—Hanover Fair '82 for Surface Treatment and Coatings Technology Equipment and Materials. Hanover, West Germany. (The Hanover Fairs Information Center, P.O. Box 338, Whitehouse, NJ 08888).

(Apr. 27–29)—Oil & Colour Chemists' Association's 34th Annual Exhibition, "International Forum for the Surface Coatings Industries." Cunard International Hotel, Hammersmith, London, England. (R.H. Hamblin, OCCA, Priory House, 967 Harrow Rd., Wembley, Middlesex, HAO 2SF).

(May 9–14)—XVIth Congress of FATIPEC, Brussels, Belgium.

(May 11–13)—Powder & Bulk Solids Conference/Exhibition. O'Hare Exposition Center, Rosemont, IL. (Cahners Exposition Group, 22 W. Adams St., Chicago, IL 60606).

(May 17–21)—"Dispersion of Pigments and Resins in Fluid Media" Short Course. Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., Kent State University, Kent, OH 44242).

(June 7–11)—"Adhesion Principles and Practice for Coatings and Polymer Scientists" Short Course. Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., Kent State University, Kent, OH 44242).

(June 13–16)—Dry Color Manufacturers' Association Annual Meeting. The Greenbrier, White Sulphur Springs, WV. (P.J. Lehr, DCMA, Suite 100, 1117 N. 19th St., Arlington, VA 22209).

(June 20–23)—American Society for Testing and Matrerials Committee D-1 Meeting on Paint and Related Coatings and Materials. Sheraton Center, Toronto, Canada. (Jane M. Turner, ASTM, 1916 Race St., Philadelphia, PA 19103).

(June 21–25)—"Applied Rheology for Industrial Chemists" Short Course. Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., Kent State University, Kent, OH 44242).

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

1983

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

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

(Act of August 12, 1970; Section 3685, Title 39, United States Code)

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  Managing Editor—None
Owner: Federation of Societies for Coatings Technology, 1315 Walnut St., Philadelphia, PA 19107
Federation Officers:
  President—William H. Ellis, P.O. Box 97, El Segundo, CA 90246
  President-Elect—Howard Jerome, 1601 N. Broadway, St. Louis, MO 63102
  Treasurer—A. Clarke Boyce, 371 Wallace Ave., Toronto, Ont., M6P 3P1, Canada
  Executive Vice-President—Frank J. Borrelle, 1315 Walnut St., Philadelphia, PA 19107

Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding One Percent or More of Total Amount of Bond, Mortgages, or Other Securities: None

The Purpose, Function, and Nonprofit Status of This Organization and the Exempt Status for Federal Income Tax Purposes: Have Not Changed During the Preceding 12 Months

Extent and Nature of Circulation:

	Average No. Copies Each Issue During Preceding 12 Months	Actual No. of Copies of Single Issue Nearest To Filing Date
A. Total No. of Copies Printed *(Net Press Run)*	9385	9318
B. Paid Circulation		
1. Sales Through Dealers and Carriers, Street Vendors and Counter Sales	0	0
2. Mail Subscriptions	8883	8821
C. Total Paid Circulation	8883	8821
D. Free Distribution by Mail, Carrier, or Other Means, Samples, Complimentary, and Other Free Copies	198	197
E. Total Distribution	9081	9018
F. Copies Not Distributed		
1. Office Use, Left Over, Unaccounted, Spoiled After Printing	300	300
2. Returns From News Agents	0	0
G. Total	9381	9318

I certify that the statements made by me above are correct and complete. (signed) Robert F. Ziegler, Editor

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'Humbug' from Hillman

Diary of a First Time Conventioneer

Day Two (morning)

Awaking at 7:05, I feel like I've been on a diet of sawdust and shredded wheat after last night's room hopping. This feeling is presently replaced by an urge to visit American Standard. But I left a wake-up call for 7:10 and I don't want to make the operator mad, so I wait . . . and agonize.

7:10—no call . . . 7:15—No Call . . . 7:20—NO CALL. I must retreat and, sure enough, the phone starts to ring. I can't answer. It keeps ringing and I still can't answer. "My God," I mutter, "they'll think I'm dead and come pounding on the door!" The phone finally stops.

After dressing and scheduling the day I go to the elevator and find about 15 people waiting ahead of me. Elevators go up and elevators go down but they don't stop at our floor. Waiting, we become good friends and wonder if our starved bodies will be found when the elevator finally stops at our floor. No fear—for we at last secure an elevator and crowd in after only 15 minutes. We start down amid much noise and many jokes. Like a vertical can of sardines we descend. The elevator stops at every floor (from the 12th down). No one gets off. No one gets on. No one can *move*. It's getting hot. The jokes stop about the 10th floor.

Eventually we squeeze out into the lobby and I rush to Ye Olde Eat Shoppe for breakfast. About 20 men and women are in line. I make several more friends and start feeling like I belong here. After a while I make my way to the counter and the waitress starts treating me like the Invisible Man. At last—either her vision improves or I have lost my invisibility—I have my pancakes.

I get to the Convention Hall and realize that I forgot to pre-register. Another long line awaits me at the registration area, all pushing and shoving, maneuvering to get up front. I make no friends here (In fact, I think I lost a few friends).

I get my badge and rush to the meeting room. A very imposing gentleman is giving the keynote address. I quietly sit down and listen intently. I want to impress my boss with what I am learning, however, my mind wanders and my eyes blink as I remember how late I got to bed this morning. "Now if someone will dim the lights," he says, "I would like to present some slides I'm certain you will find interesting." The room turns gray and then black and . . . .

• • •

Our President and most reliable contributor, Howard Jerome, is feeling the effects of Father Time and is keeping the following notes:

How to Know You're Growing Older

Everything hurts, and what doesn't hurt doesn't work.

You feel like the night before, and you haven't been anywhere.

Your little black book contains only names ending in M.D.

You begin to outlive enthusiasm.

You decide to procrastinate but never get around to it.

You know all the answers, but nobody asks you the questions.

You look forward to a dull evening.

Your favorite part of the newspaper is "Twenty-Five Years Ago Today".

You turn out the light for economic rather than romantic reasons.

You regret all those temptations you resisted.

After painting the town red, you have to take a long rest before applying a second coat.

Dialing long distance wears you out.

The best part of your day is over when the alarm clock goes off.

A fortune teller offers to read your face.

The little old gray-haired lady you help across the street is your wife.

You sit in a rocking chair and can't get it going.

Howard is really only admitting to trouble with the rocking chair. As more signs develop, however, we will keep you advised.

Our dear friend and Heckel Award winner, Sid Lauren, found time to collect some award winning contributions.

Forbes Law On Executives (according to T.L. Martin, Jr.)—As everyone knows, an executive has practically nothing to do, except to decide what is to be done; to tell somebody to do it; to listen to reasons why it should not be done, why it should be done by someone else, or why it should be done in a different way; to follow up to see if the thing has been done; to discover that it has been done incorrectly; to point out how it should have been done; to conclude that, as long as it has been done, it might as well be left where it is; to wonder if it is not time to get rid of a person who cannot do a thing right; to reflect that he probably has a wife and a large family, and that certainly any successor would be just as bad, and maybe worse; to consider how much simpler and better the thing would have been done if one had done it oneself in the first place; to reflect sadly that one could have done it in twenty minutes, and as things turned out, one has to spend two days to find out why it has taken three weeks for someone else to do it wrong.

The cure for the malaise reflected in Forbes Law is *Nordby's Nostrum*—

> Yea, though I walk through the valley
> Of the shadow of death,
> I shall fear no evil,
> Because I'm the meanest son-of-a-bitch
> in the organization.

Definition of a Consultant—A man who knows less about your business than you do, and gets more for telling you how to run it than you could possibly make out of it if you ran it right, instead of the way he told you.

—Herb Hillman

Shining Examples:

Reynolds Aluminum Pigments put more glow into your metallics.

If the new cars look especially rich in their finishes, with a higher gloss and a softer-glowing color, there's a good reason. So many of them are finished in metallics made with Reynolds Stain Resistant Aluminum Pigments.

Reynolds has extremely rigid controls on particle size and uniformity for its non-leafing pastes. And these controls give you lower seed levels, better reflectivity and brightness.

In effect, the Reynolds Pigments add depth and eye appeal by maintaining maximum gloss in both straight metallic and polychromatic coatings. They don't mask the colors; they enhance them. There's a big family of these Reynolds Stain Resistant Pigments, including coarse, fine and medium particle sizes. And any one of them might be the answer to your more perfect finish.

For details and technical data, write to Reynolds Metals Company, Post Office Box 35030-PD, Louisville, KY 40232.

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