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**JOURNAL OF THE
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Factors involved in the formulation of anti-corrosive high build vinyl coatings
S. Pila

Permeability properties of surface coatings towards chloride ion
J. D. Murray

Microbiology in the paint industry
D. E. Hughes

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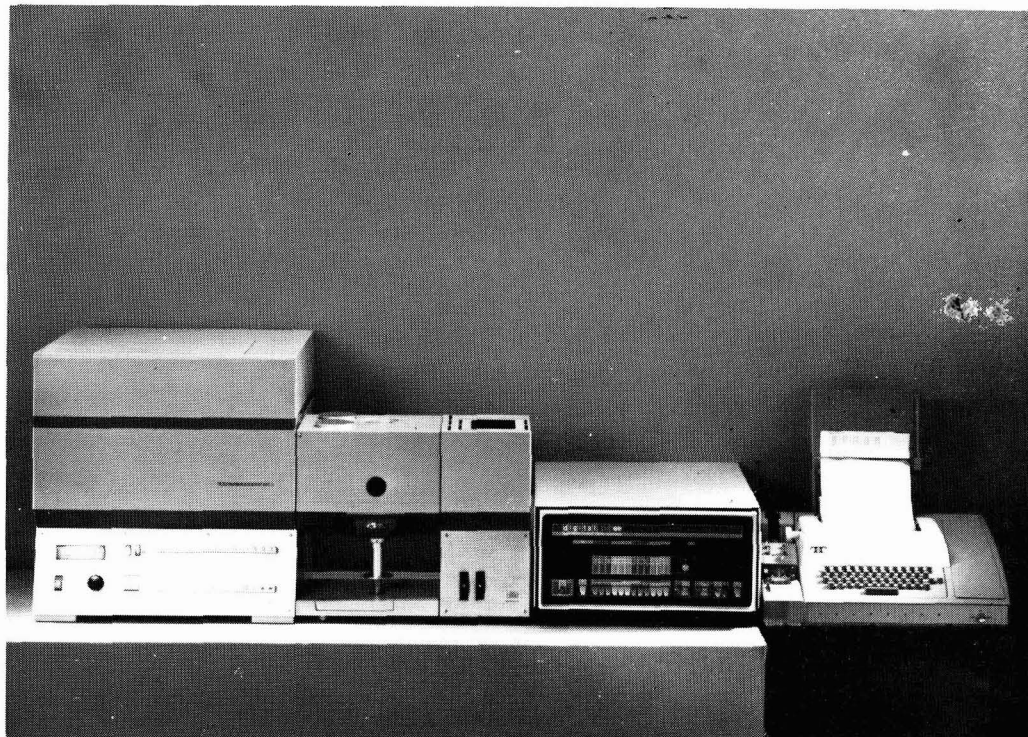
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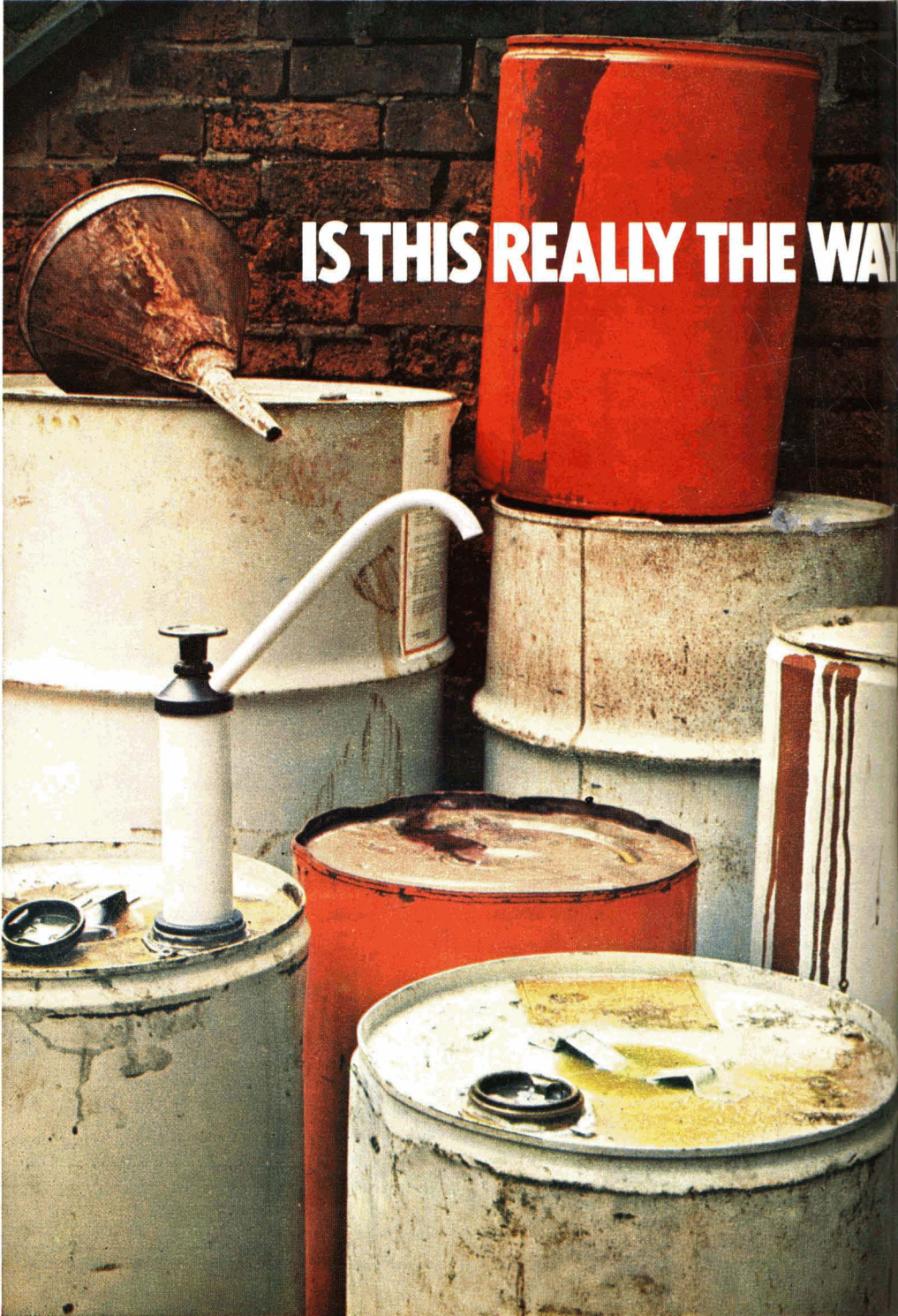
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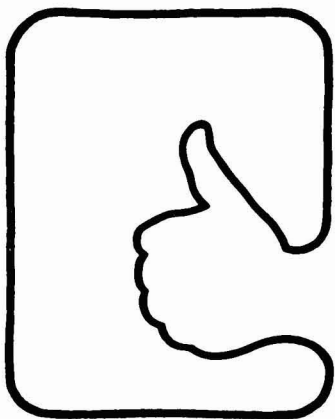
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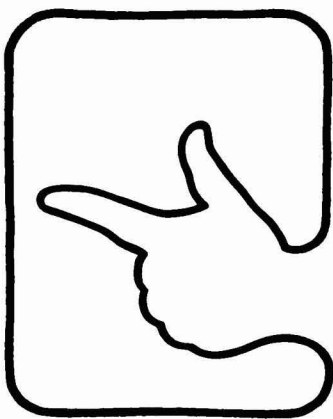
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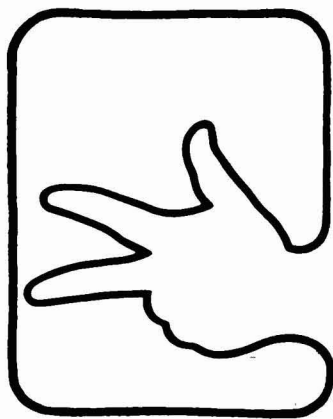
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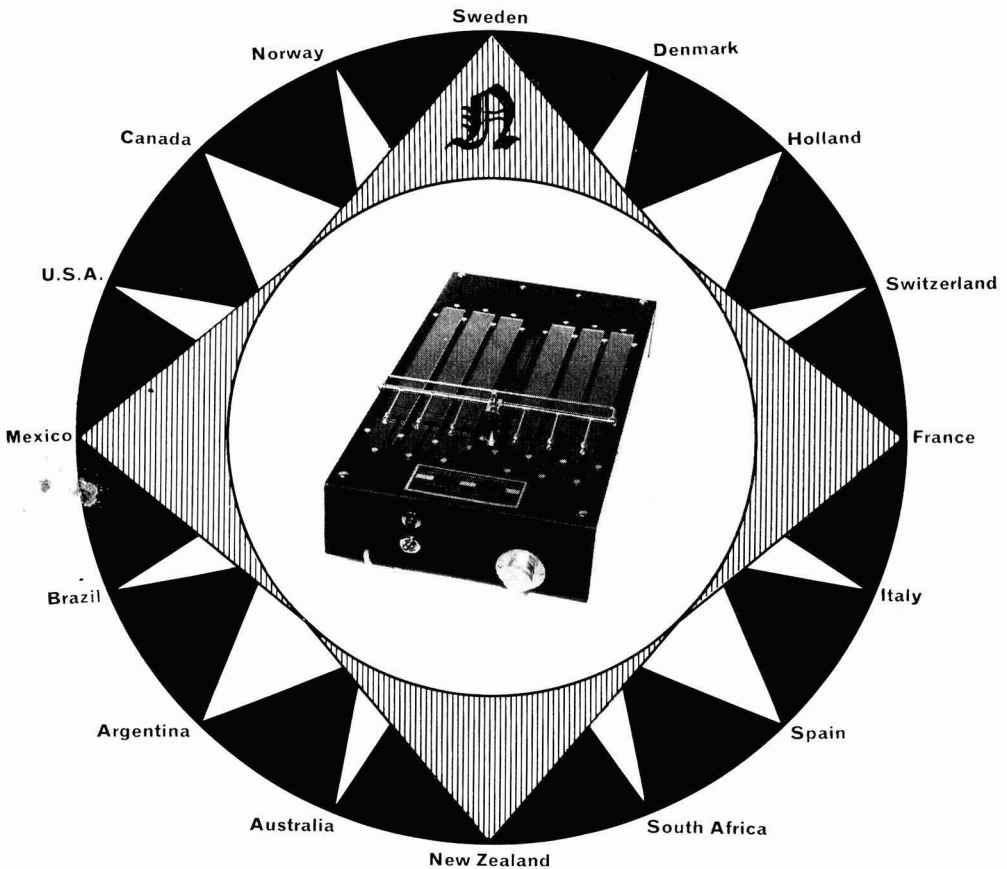


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Contents

Vol. 56 No. 5

May 1973

Transactions and Communications

**Factors involved in the formulation of anti-corrosive
high build vinyl coatings** 195

S. Pila

**Permeability properties of surface coatings towards
chloride ion** 210

J. D. Murray

Microbiology in the paint industry 216

D. E. Hughes

Section Proceedings 222

Notes and News 225

Preview of OCCA-25 225

Forthcoming Events 235

Register of Members 236

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Y

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Transactions and Communications

Factors involved in the formulation of anti-corrosive high build vinyl coatings

By S. Pila

Union Carbide Europe SA, 5 Rue Pedro-Meylan, 1211 Geneva 17, Switzerland

Summary

A new approach to the formulation of high build anti-corrosive vinyl coating systems is described.

The use of vinyl chloride-vinyl acetate copolymers prepared in solution makes possible the formulation of coatings with substan-

tially increased non-volatile content and suitable for application at high film thickness by airless spray equipment.

Formulation parameters are reviewed and suggestions for formulae and manufacturing procedures for such a system are described.

Keywords

Types and classes of coatings and allied products:

high build
vinyl solution coating

Process and methods primarily associated with application of coatings and allied products:

airless spray

Facteurs ayant une influence sur la formulation des revêtements vinyliques "high-build" et anti-corrosifs

Résumé

On décrit un nouvel abord à la formulation des revêtements vinyliques "high-build" et anti-corrosifs.

L'utilisation de copolymères de chlorure de vinyle-acétate de vinyle offre la possibilité de formuler les revêtements d'une teneur en matière non-volatile fortement augmentée et convenable à

être appliquée (par pistelage "airless") à une épaisseur de feuille élevée.

On passe en revue les paramètres touchant la mise au point des formules et l'on propose les procédés de fabrication et les formules également à l'égard d'un tel système.

Bei der Zusammensetzung Antikorrosiver Dickschichtiger Vinyl Lacke Mitsprechende Faktoren

Zusammenfassung

Beschreibung eines neuen Weges zur Rezeptierung von dickschichtigen, antikorrosiven Vinyl lacksystemen.

Die Anwendung von in Lösung hergestellten Vinylchlorid-Vinylazetat Kopolymeren ermöglicht die Rezeptierung von Lacken mit erheblich höherem Gehalt an Nichtflüchtigem, sodass sich diese

für das Auftragen mittels luftlosem Spritzgerät in grosser Filmdicke eignen.

Rezeptparameter werden betrachtet und Vorschläge für Rezepturen und Herstellungsverfahren solcher Systeme gewacht.

Факторы связанные с формуляцией противокоррозийных виниловых покрытий

Резюме

Описывается новый подход к формуляции систем высокоструктурных противокоррозийных виниловых покрытий.

Применение хлористо-виниловых ацетатных сополимеров изготовленных в растворе, допускает возможность формуляции покрытий с значительно более высоким содержанием нелетучих и подходящих для приложения при высокой тол-

щине пленки, применяя безвоздушное распылительное оборудование.

Обозреваются формуляционные параметры, предлагаются формулы и описываются промышленные приемы для такой системы.

Introduction

Solution vinyl resins have been used in maintenance paints ever since the excellent combination of their properties of chemical resistance, toughness, water resistance, and exterior durability became known in the late 1930s. Most of the basic formulations and systems used during the following 25 years were developed during World War II. Their high quality has been proven over the years under the most aggressive conditions possible.

After the war, the reputation of these systems was firmly established, and they became the corrosion and chemical protection standards in industry.

In recent years the situation in the maintenance coatings area has changed radically. Labour costs have increased steadily and the prices for coating materials have remained practically stable, to the extent that today labour costs are, by far, the major component of the total painting costs. (In most countries the paint costs amount to only 20 per cent of the total, whereas the remaining 80 per cent correspond to labour costs.)

This has led paint users to seek, increasingly, paint systems which, by reducing the number of coats and giving longer life, would minimise the ever increasing labour costs.

In response to that demand, paint manufacturers have

been obliged to develop coatings capable of depositing thick layers of paint per coat (high build systems), and equipment manufacturers to develop faster methods of application per coat (airless spray).

Structural steel, after sandblasting or grit blasting, has a very rough and uneven surface. In some cases, and depending on the particle size of the sand used, the "maximum height of profile," or the "peaks" over the "valleys," can reach 120-140 microns. Corrosion tests have demonstrated that to obtain effective protection of steel, a minimum film thickness of approximately 125 microns is required above surface peaks. This means that, in practice, a total of 250 microns total dry film thickness of coating is required.^{1, 2}

The majority of vinyl formulations were developed for application by the conventional air spray method and, due to the high molecular weight of the vinyl polymers traditionally used, the average film thickness obtained was between 20 and 30 microns per coat. This meant that seven to 12 coats had to be applied to obtain the thickness required, with a corresponding increase in labour costs.

The multi-coat application requirement was not a severe handicap to vinyl maintenance paints in the past. However, over the years, vinyl systems gradually became uneconomical and were finally considered to be too expensive.

Extensive laboratory research and a new approach to the formulation of maintenance vinyl coatings has led to the development of high build vinyl coatings.

These newly-developed coatings have been designed to possess the following properties:

1. They can be applied by the airless spray method and can be "touched-up" by brushing.
2. They do not sag and show minimal solvent retention at dry film thicknesses of 200 microns and over.
3. They have excellent anti-corrosive properties and chemical resistance.
4. They have a substantially increased non-volatile content.

The most important parameters for the formulation of such systems are discussed.

Composition and characteristics of vinyl resins for high build anti-corrosive systems

The high molecular weight of the copolymers traditionally used in maintenance vinyl paints results, generally, in a low solids content if manageable viscosities are to be obtained.

Vinyl copolymers with lower molecular weights have been developed in recent years. Extensive laboratory and exterior exposure tests³ have shown that the differences in performance between the lower and the higher molecular weight vinyl resins are negligible and that it is principally the purity of the resin that will influence the performance.

Solubility is the most important factor to be considered when choosing a vinyl resin for the formulation of high build maintenance coatings because of the necessity of obtaining a relatively high solids content and, at the same time, a relatively low viscosity.

One of the most serious problems of high build coatings which dry solely by evaporation is solvent retention. The

solvent trapped in a film causes blistering and decreases chemical resistance and overall performance. Traditionally, vinyl resins are dissolved in solvent mixtures based on ketones and aromatic hydrocarbons. It has been found, however, that vinyl films retain ketones for much longer than they do ester solvents, so that it is possible to minimise solvent retention by using esters as solvents instead of ketones.

Since esters are poorer solvents for vinyls than are ketones, these systems can only be formulated with resins having a very good solubility.

Influence of the manufacturing process on the solubility of vinyl copolymer resins

Vinyl chloride-vinyl acetate copolymers used in the maintenance coatings field can be classified into three main types: vinyl chloride-vinyl acetate; vinyl chloride-vinyl acetate, maleic acid modified; and vinyl chloride-vinyl acetate hydroxyl modified. These copolymers can be manufactured by two fundamentally different methods, the batch suspension process or the continuous solution process.

In the batch suspension process, the liquified monomer mix is dispersed into discrete droplets in a water phase using a monomer soluble catalyst and a water soluble colloid and/or surface-active agent. Polymerisation then takes place with the formation of polymer droplets. When monomers of widely different reactivity are used, such as vinyl chloride and vinyl acetate which have reactivity ratios of approximately 2.3 and 0.3 respectively, the resultant copolymer formed is non-uniform in its compositional distribution, one portion having a high vinyl chloride content and the other portion a high vinyl acetate content. Normally, the polymerisation is conducted to a high degree of conversion.

In the solution process, the resin formed is soluble in the solvent used. The process can be operated continuously, the monomers being fed into the "steady-state" polymerisation vessel to maintain a constant ratio of one monomer to the other and a constant ratio of monomers to solvent. In this manner, a uniform copolymer of relatively narrow molecular weight distribution can be produced. Further, as no water soluble surface-active material needs to be employed, the polymer is completely free from such impurities.

The differences in compositional heterogeneity of vinyl chloride/vinyl acetate copolymers prepared by the above two processes have already been demonstrated in earlier studies^{1, 2} and it can be concluded that vinyl copolymers prepared by the batch suspension process show a much broader distribution of molecular weights than do those prepared by the continuous solution process.

The molecular parameters and characteristic molecular weight distribution ratio (ratio of average molecular weight calculated by weight and by chain length) for vinyl copolymers prepared by the two processes are shown in Table I. As can be seen from this table, suspension-prepared copolymers show a much greater molecular weight distribution ratio than the solution-prepared copolymers. This means that the latter have a much narrower molecular weight distribution with lower percentages of the lower and higher molecular weight fractions. The presence of high molecular weight species enormously affects the solubility of the resin in ester solvents. Table 2 shows two vinyl copolymers of very similar composition, modified with maleic acid. However, one was prepared by the solution process and the other by the suspen-

Table 1
Molecular parameters and characteristic molecular weight distribution ratio (\bar{M}_w/\bar{M}_n) for vinyl copolymers prepared by suspension and solution processes

Resin	VCl %	VAc %	Other	Process	\bar{M}_n^*	\bar{M}_w^\dagger	\bar{M}_w/\bar{M}_n ratio
A	85.4	14.6	—	Solution	15.200	22.700	1.493
B	89.5	5.0	5.5(a)	Solution	15.300	22.800	1.490
C	83.0	16.0	1.0(b)	Solution	13.900	20.800	1.496
D	86.0	14.00	—	Suspension	15.300	50.500	3.300
E	84.2	14.6	1.2(b)	Suspension	12.120	40.638	3.353

(a) Percentage of polyvinyl alcohol. (b) Percentage of maleic acid.

* Calculated by vapour phase osmometry. † Calculated by light scattering.

Table 2
Maleic acid modified vinyl chloride-vinyl acetate copolymers

Resin	VCl %	VAc %	Maleic acid %	Process	\bar{M}_n^*	\bar{M}_w^\dagger	\bar{M}_w/\bar{M}_n ratio
VMCC	83.0	16.0	1.0	Solution	13.900	20.800	1.496
E	84.2	14.6	1.2	Suspension	12.120	40.638	3.353

* Calculated by vapour phase osmometry.

† Calculated by light scattering.

sion process. The solubility of these two resins in methyl isobutyl ketone (MIBK) is shown in Fig. 1 and the solubility in n-butyl acetate is shown in Fig. 2. As can be seen from

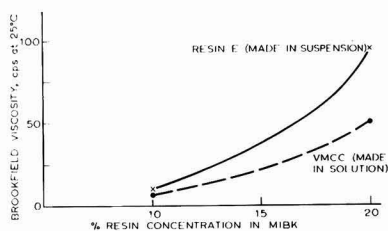


Fig. 1. Solubility of maleic acid modified vinyl chloride-vinyl acetate copolymers prepared by solution and suspension processes in methyl-isobutyl ketone

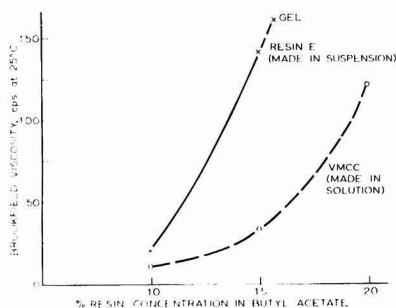


Fig. 2. Solubility of maleic acid modified vinyl chloride-vinyl acetate copolymers prepared by solution and suspension processes in n-butyl acetate

these figures, the copolymer prepared in solution shows a better solubility which is, however, more evident in n-butyl

acetate than in MIBK. A 16 per cent solution of the copolymer prepared in suspension is a gel, whereas the viscosity of the copolymer prepared in solution at the same concentration is as low as 40 cps. It is obvious that the ketone is better than the n-butyl acetate in dissolving the higher molecular weight fractions present in the suspension-prepared vinyl copolymer. The high molecular weight distribution ratio of the suspension-prepared resin indicates a high content of the higher molecular weight species which is responsible for its poor solubility in ester solvents.

Composition and characteristics of vinyl chloride-vinyl acetate copolymers for high build anti-corrosive systems

The three types of vinyl copolymer suitable for the formulation of high build coatings are described in Table 3.

Table 3
Vinyl chloride-vinyl acetate copolymer for high build anti-corrosive systems

Vinyl chloride %	Vinyl acetate %	Other properties	
83	16	1.0(a)	Due to the presence of carboxyl groups, has adhesion to metals and must be used to formulate primers Hydroxyl modification provides adhesion to most coating vehicles, especially wash primers Good chemical resistance and weatherability. Adheres only to vinyl coatings. Must be used for finish coatings
91	3	6.0(b)	
86	14	—	

(a) Percentage of maleic acid. (b) Percentage of polyvinyl alcohol.

Varying in the ratio of vinyl chloride to vinyl acetate and the degree of polymerisation produces a wide range of vinyl copolymers with distinctive properties. The amount of vinyl acetate present mainly influences the solubility of the copolymer. An increase in the acetate content widens the range of solvents which can be used. Resins with a high vinyl chloride content produce strong, tough films with excellent water and chemical resistance. Full adhesion of straight vinyl chloride-vinyl acetate resins to bare metal surfaces only develops after baking. Adhesion to metal by air drying may be achieved by blending straight vinyl chloride-vinyl acetate resins with a maleic acid modified vinyl resin. If adhesion to vinyl butyral wash primers or other resinous primers is desired, hydroxyl modified vinyl resins should be used as the blending resin.

Solvents

Ketones are the most suitable primary solvents for vinyl resins. Compared with other solvents, they yield solutions with higher resin concentrations and lower solution viscosities at equivalent total solids content. They tolerate greater dilution with non-solvents and exhibit good storage stability. It is for this reason that vinyl resins were used traditionally as solutions in mixtures of ketones and aromatic hydrocarbons. It is a well-known fact that all coatings, for reasons which sometimes are difficult to explain, tend to retain solvents. This solvent retention occurs particularly with air-drying coatings and it is very evident in coatings applied at high film thicknesses. Weigel and Sabino⁶ have demonstrated that the solvent retained in a clear vinyl film is almost directly proportional to its film thickness. It is believed that solvent retention is associated with the relatively slow diffusion of the solvent to the surface of the coating and, obviously, the greater the film thickness, the more difficult it will be for the solvent to evaporate completely.

Solvents are released from a film in an anomalous manner⁷ which cannot be related to their boiling points or evaporation rates. There is a tendency for the resin to retain some types of solvents and let others escape. Normally, a resin will retain the solvent in which it is soluble and the non-solvents will tend to evaporate faster than the solvent. This is shown in Fig. 3 where the solvent retained in a vinyl resin has been

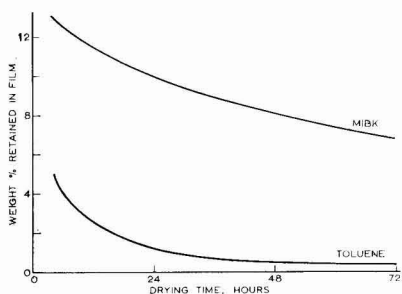


Fig. 3. Solvent retention of film cast from a 20 per cent solution of vinyl resin (83 per cent vinyl chloride, 16 per cent vinyl acetate) in solvent mixture 50 per cent mibu—50 per cent toluene. Dry film thickness approximately 30 microns

measured qualitatively and quantitatively using a gas-liquid chromatograph (GLC).⁸ Although MIBK and toluene were present in equal proportions in the original solvent mixture, the solvent retained in the vinyl film after 72 hours drying contains approximately 93 per cent of MIBK.

The tendency of vinyl resins to retain ketones is shown also in Fig. 4 where the solvent retention of films cast from solutions of vinyl resin in MIBK, n-butyl acetate, cyclohexanone, and "Cellosolve" acetate, is shown. Since, in this case, determination of the composition was not necessary, the solvent retained was determined by a simple gravimetric method.⁹ It is obvious, upon comparing the distillation ranges and relative evaporation rates of the selected solvents used, that ester solvents can escape more easily from a vinyl film than can ketones. Contrary to what could be expected, the solvent which is retained least in the vinyl film, "Cellosolve" acetate, is slower evaporating. This fact can be used to advantage in the formulation of high build vinyl coatings to be applied by airless spray. Such coatings should contain a fair amount of slow-evaporating solvent. Airless application tends to give dry spray, or "cobwebbing," since the paints applied by this system contain less solvent and the distance from the gun to the substrate is usually greater than for the conventional air spray method. Furthermore, as everyone familiar with airless spray knows, films applied by this method tend to show "bubbling" and other defects. The presence of a slow-evaporating solvent helps to release the air trapped in the film, thus allowing it to coalesce properly.

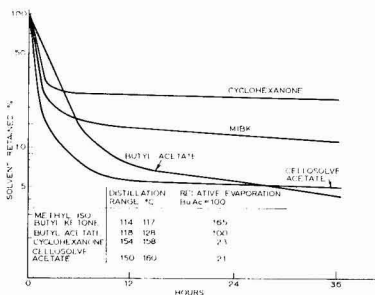


Fig. 4. Solvent retention of films cast from a 25 per cent solution of vinyl resin in different solvents. Dry film thickness approximately 90 microns

Ester solvents have a milder odour and are less toxic than ketones. Ester solvents are fully permissible when, due to air-pollution regulations, the use of branched-chain ketones is limited.⁹ Unfortunately, because of their low solvent power, esters have to be used in admixtures with ketones if a relatively concentrated resin solution is to be obtained

It is a well-known and accepted characteristic of high build paints that they always produce films that are porous to a greater or lesser extent and they show a high degree of solvent retention. Paints giving very porous films have an apparent advantage since, due to the volume of the bubbles, they produce the illusion of yielding a thicker film. No specific performance data is yet available to assess exactly the effects of porosity and solvent retention on performance, but it seems likely that a dense film with a minimum of pores, relatively free from trapped solvent, would have the best chance of withstanding corrosive environments.

Extensive laboratory and practical airless spray tests, carried out in order to find an ideal solvent combination for high build vinyl coatings, showed the best solvent combination to be:

"Cellosolve" acetate	70% by weight
MIBK	10% by weight
Xylene	20% by weight

According to the ambient temperature during application, the "Cellosolve" acetate can be replaced partially by butyl acetate which is faster evaporating. Using this solvent combination, high build vinyl coatings can be formulated which, when applied by the airless method, give films free from porosity and dry relatively fast, even at a dry film thickness of 200 microns or more.

For some types of high build coating, in order to minimise solvent retention, a pigmentation level near the CPVC is required. This is not true for high build vinyl coatings formulated with the optimum solvent combination.

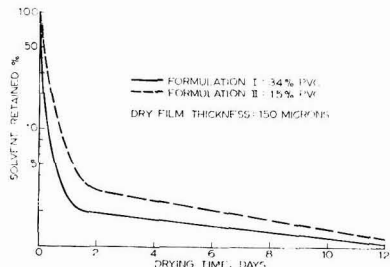


Fig. 5. Effect of the PVC on the solvent retention of high build vinyl coatings

Fig. 5 shows the solvent retention of two high build vinyl coatings. Formulation I has a 34 per cent PVC and formulation II a 15 per cent PVC. (Both formulations are given in the Appendix). Using the same pigmentation and the same vinyl resin, the CPVC is at 35 per cent. As can be seen from Fig. 5 there is a difference in the solvent retained by the two formulations in the early stages of the drying process. However, the difference in solvent retained after 12 days is negligible. The hardness test, which is sometimes used as a rough measure for solvent retention, is shown for both formulations in Fig. 6. Here, again, the difference in the Persoz hardness of the two formulations is too small to be considered. A remarkable fact about these formulations is that they release the solvent very rapidly and attain a high degree of hardness after 48 hours drying even though the film thickness is high, 150 microns, and 70 per cent of the solvent combination is the slow-evaporating "Cellosolve" acetate.

Thixotropic agents for high build vinyl coatings

The choice of a thixotropic agent will have a decisive influence on the spray properties and film thickness of a high build vinyl coating.

Since high build coatings are usually applied by airless spray, before evaluating thixotropic agents some consideration of the rheology of this application process is necessary.

The behaviour of high-build coatings during airless spraying

The properties of high-build paints can be explained when the rheological requirements of the airless spray method are considered at each step of the operation. Fig. 7 represents an

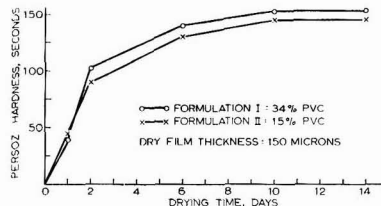


Fig. 6. Effect of the PVC on the solvent retention of high build vinyl coatings

airless unit spraying a paint on to a substrate, and below it, two qualitative graphs show the changes in viscosity and shear rate at the different stages of the process. The object of the process is to deposit a thick dry coating on the substrate in one pass. Since the systems under consideration all have a solids content (by volume) of about 33 per cent, it follows that the wet coating, when just applied, should be about three times as thick as the dry film thickness desired. In maintenance paints this means a wet thickness of about 375 microns, or slightly less, allowing for some solvent evaporation between the spray gun and the substrate. This thickness will tend to produce severe sagging on vertical surfaces, since it can be demonstrated that the volume of paint sagged is proportional to the cube of the wet thickness.¹⁰ The only force that can prevent sagging is structural viscosity. High paint viscosity, however, is undesirable because it affects sprayability. High viscosity may be obtained on the

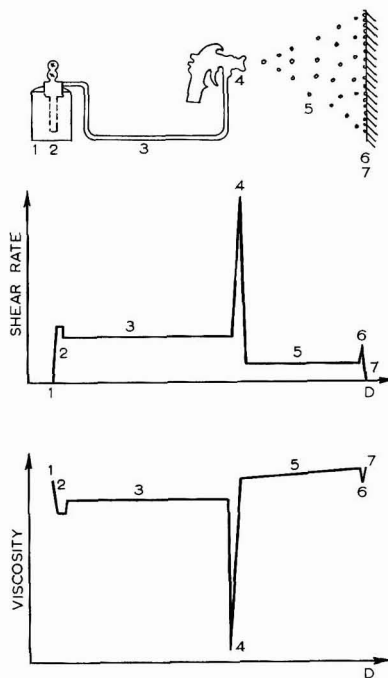


Fig. 7. Viscosity relationships during airless spraying a high build paint

substrate by the use of thixotropic agents which produce a false viscosity or "body" through particle-to-particle interactions (usually of polar type) which can be easily broken by shear.

Sagging is due only to gravitational force; the shear rate generated is therefore extremely small (of the order of 0.1 to 1.0 sec⁻¹). This condition is represented in Fig. 7 by point No. 7.

The other critical site during the process is the nozzle (point No. 4 of Fig. 7). The output of a typical airless spraying unit operating at about 150 kg/cm² and having a nozzle of 500 microns in diameter is about 0.850 litres of paint per minute. Computing the linear speed corresponding to those conditions of flow, a velocity of about 240 km hr⁻¹ is obtained.

If fluids of lower viscosity were used, such as solvents, linear velocities close to the speed of sound could be obtained. The intensity of the friction between the fluid and the walls of the orifice is such that the nozzle must be made of tungsten carbide to retard wear by erosion. Even so, the nozzle does wear somewhat after a few hundred litres of paint have been sprayed, to an extent that may distort the spray pattern, and the effective diameter may alter. The very high linear speeds, combined with the very small opening of the nozzles, result in extremely high shear rates. The geometry of the nozzles are not known with absolute certainty due to peculiarities of the method by which they are made. Fig. 8 shows the configuration of a typical nozzle as described by one manufacturer. The most important aspect is that the length of the orifice at the point of nominal opening (dimension L in Fig. 8) is very small, about 0.25 microns.

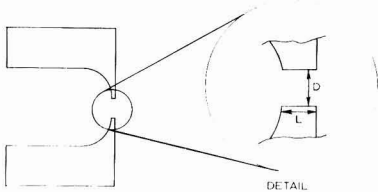


Fig. 8. Nozzle configuration

From the mathematical expressions for fluid flow in capillaries derived from Poiseuille's law,¹¹ it is possible to compute the shear rates developed at the nozzle. These equations apply only to Newtonian flow but most fluids become Newtonian when submitted to high shear rates. The shear stress in kg cm⁻² is:

$$\tau = \frac{PR}{2L} \dots \dots \dots (1)$$

and the shear rate:

$$\dot{\gamma} = \left[\frac{V}{t} \right] \left[\frac{8}{2\pi R^3} \right] \dots \dots \dots (2)$$

- where: *P*: pressure in kg cm⁻²
- R*: radius of orifice in centimetres
- L*: length of orifice in centimetres
- V*: volume of paint extruded in time *t*
- t*: extrusion time in seconds

Converting the volume to weight, equation (2) becomes:

$$\text{Shear rate (in sec}^{-1}\text{)} = \dot{\gamma} = \frac{4W}{\pi R^3 D t} \dots \dots (3)$$

- where: *W*: weight of paint extruded in time *t*
- D*: density of paint (gm cm⁻³)

Using equations (1) and (3) the shear stresses and shear rates have been computed from four runs, using two different nozzles. Results are shown in Table 4. As can be seen from this, the shear rate to which the paint is subjected at the nozzle is extremely high (3 × 10⁶ sec⁻¹). At that shear rate, the viscosity of the paint is affected by three major factors:

1. The particle-to-particle interactions of the thixotropic agents are destroyed.
2. The polymer chains are deformed and become streamlined so as to offer minimum resistance to flow, so decreasing the solution viscosity.
3. Some thermal development effect is likely, contributing to further lowering of viscosity.

These three effects superimposed result in a sharp net drop in paint viscosity, illustrated by point 4 of Fig. 7.

The change of viscosity in other stages of the process, therefore, follows a pattern opposite to that of the shear rate at that particular point.

- Point 1. The paint is in repose, so the shear rate is zero, and the viscosity maximum.
2. Pumping increases the shear rate; viscosity drops.
3. The paint flows in a relatively wide hose, so the shear rate is lower and the viscosity higher. Both are fairly constant until the paint reaches the gun.
4. The nozzle is the point of maximum shear and minimum viscosity, as explained above.
5. While travelling in the air, the paint droplets are subjected to a minimal, but finite, shear since they

Table 4
Calculation of shear stress and shear rate

Run number	Pressure kg cm ⁻²	L cm	R = D/2 cm	Weight extruded g	Time sec	Shear stress kg cm ⁻²	Shear rate sec ⁻¹ × 10 ⁶
1	182.8	0.00254	0.014	230	30	503.8	2.89
2	225.0	0.00254	0.014	450	50	620.1	3.39
3	154.7	0.00254	0.0179	325	21	545.1	2.99
4	144.1	0.00254	0.0179	169	15	507.9	2.18

must overcome the resistance of the air. The paint starts losing solvent, with a corresponding increase in viscosity.

- 6, 7. The paint droplets coalesce upon reaching the substrate, generating a minor shear; upon recovery, the paint film starts to dry.

High viscosity at low shear rate and low viscosity at high shear rate is characteristic of a plastic or pseudoplastic fluid. Both types of rheological behaviour have advantages and disadvantages with regard to high-build paints. In the case of a pseudoplastic paint, some movement is produced even with very small stresses, whilst a plastic material requires a stress greater than its yield value to initiate flow.

In terms of paint behaviour, flow at low shear rates determines the degree of levelling, which is a desirable property, and sagging, which is not.

Since freedom from sagging is an essential requirement of the application, some levelling must be sacrificed.

The preceding discussion clarified the nature of the process and offers plausible explanations for the lack of correlation between viscosity data obtained and sprayability. The paint has high viscosity at low shear rates because of the non-sagging properties required on the substrate, but the viscosity drops sharply at the nozzle. It is the rheological behaviour at this point that determines the spraying properties of the paint.

From a practical standpoint it is, therefore, very difficult to predict the airless sprayability of a paint from viscosity measurements.

Correlation of pseudoplasticity and airless sprayability

As mentioned in the preceding section, the shear rate at the nozzle of an airless spray gun is about $3 \times 10^6 \text{ sec}^{-1}$. None of the commercially available viscometers is able to measure viscosity at this ultra-high shear rate and to predict the sprayability properties of a high-build vinyl coating, therefore, it was necessary to find some correlation between the viscosity measured at shear rates lower than $3 \times 10^6 \text{ sec}^{-1}$ and the practicality of airless spraying.

For the characterisation of pseudoplastic liquids using a commercial rotational viscometer¹² (the Brookfield viscometer), the following equation is used:

$$\eta_H/\eta_L = X^Y \dots\dots\dots (4)$$

where: η_H is the viscosity measured at the highest angular velocity

η_L is the viscosity measured at the lowest angular velocity

X is the ratio of the two angular velocities in revolutions per minute obtained by dividing the higher of the two angular velocities used by the lower angular velocity

Y if $\eta_H < \eta_L$, the value of Y is negative, indicating that the liquid is pseudoplastic. The more the value departs from zero, the more pseudoplastic is the liquid. For Newtonian flow $Y = 0$.

This "Y" value can be calculated by means of any rotational viscometer capable of giving viscosity readings (in poise)

at various preselected and known angular velocities. A common example of this type of apparatus is the Brookfield viscometer.

Sample calculation

An example of the calculation of the "Y" value using a LVT Brookfield viscometer is as follows:

The higher rpm (revolutions per minute) and lower rpm given by this apparatus are 60 and 0.3 respectively. The viscosity of the paint in centipoises obtained at each rpm is 200 and 2.500 respectively.

Substituting these values into equation (4) gives

$$\frac{200}{2.500} = \left(\frac{60}{0.3}\right)^Y$$

and rearranging gives

$$Y = -0.476$$

The negative value indicates that the paint is pseudoplastic.

A series of high-build vinyl coatings was prepared, according to formulation III shown in the Appendix, in such a way that they presented decreasing "Y" values. This was obtained by adding increasing amounts of a thixotropic agent. Each formulation was applied with an airless spray unit operating at 150 kg cm^{-2} and having a nozzle diameter of 380 microns.

The correlation of the "Y" value with the practical sprayability tests is shown in Table 5. As can be seen from this Table, the best compromise between sprayability and sagging is obtained in the range of "Y" values between approximately -0.500 and -0.600. Trials with those paints whose "Y" value fell in this range showed them to possess excellent air-less sprayability and no sagging at a dry film thickness of 200 microns.

Table 5

Airless sprayability of high build vinyl paints with decreasing "Y" value

Paint number	η_L/η_H	X	"Y" value	Airless spraying	Sagging
1	1.1	62.9	-0.020	Goodspray	Severe
2	1.8	62.9	-0.250	Goodspray	Severe
3	4.0	62.9	-0.330	Goodspray	Severe
4	6.0	62.9	-0.430	Goodspray	Considerable
5	7.5	62.9	-0.480	Goodspray	Some
6	9.0	62.9	-0.525	Good spray	None
7	9.5	62.9	-0.550	Good spray	None
8	12.5	62.9	-0.615	Slightly coarse spray	None
9	16.9	62.9	-0.680	Coarse spray	None
10	21.2	62.9	-0.730	Coarse spray	None

It must be emphasised that this relationship can be used only for comparative purposes for this evaluation, in which all coatings are based on the same formulation.

Thixotropic agents

The main types of commercially available thixotropic agents can be classified as follows modified hydrogenated castor oils, silica gels, and montmorillonite.

The thixotropic agents selected for this evaluation are shown in Table 6. They were incorporated into the vinyl formulation III shown in the Appendix, according to the recommendations of the supplier. No attempt was made to determine the optimum amount of each product. The quantity of each thixotropic agent used was 2.5 per cent

*Table 6
Thixotropic agents*

Designation	Supplier
Aerosil 200	Degussa, Germany
Aerosil 300	Degussa, Germany
Aerosil 380	Degussa, Germany
Aerosil R972	Degussa, Germany
Bentone 27	Titangesellschaft GmbH, Germany
MPA-60	The Baker Castor Oil Co., USA
Rilanit Special ..	Henkel International, Germany
Sorbisil MSG23 ..	J. Crosfield & Sons Ltd., England
Thixatrol ST	The Baker Castor Oil Co., USA
Thixcin R	The Baker Castor Oil Co., USA

of the total weight of the formulation. This is the maximum amount which can be used in high-build vinyl formulations for reasons of both economy and performance. It was decided that a thixotropic agent for a high build vinyl coating should meet the following requirements.

1. Impart the pseudoplasticity required for airless spray application.
2. Have good viscosity stability on storage.
3. Be easy to incorporate.

Pseudoplasticity

Pseudoplasticity was measured by means of a Rheomat 15*, using the highest and the lowest angular velocities obtainable from this instrument. The computed "Y" values from equation (4) for each thixotropic agent evaluated are shown in Table 7. As can be seen, Aerosil 200 and Rilanit Special are the only ones having a "Y" value which falls in the range for good airless sprayability. Thixatrol ST and Thixcin R give too high a value of "Y" which indicates that the amount used (2.5 per cent on total weight formulation) was excessive.

All other thixotropic agents evaluated give a low "Y" value. Because of cost and performance considerations, however, it would not be recommended to increase their concentration in order to reach the desired "Y" value.

Table 7

Pseudoplasticity imparted by thixotropic agents in high build vinyl coating

Thixotropic agent	Weight fraction on total formulation %	"Y" value
Aerosil 200 *	2.5	-0.525
Aerosil 300 *	2.5	-0.350
Aerosil 380 *	2.5	-0.430
Aerosil R 972 *	2.5	-0.260
Bentone 27 **	2.5	-0.290
MPA-60	2.5	-0.150
Rilanit Special	2.5	-0.550
Sorbisil MSG 23	2.5	-0.250
Thixatrol ST	2.5	-0.680
Thixcin R	2.5	-0.730
None	0.0	-0.020

* According to the supplier's recommendations, ten per cent of Arquad 2HT-75 (Armour Hess Co.) calculated on the Aerosil content was added into the coating formulation.

** According to the supplier's recommendations, thirty per cent of methanol calculated on the Bentone content was added into the coating formulation.

The concentration of Thixatrol ST and Thixcin R was decreased so as to determine at what concentration a "Y" value in the range of -0.500, -0.600 would be obtained. Results are shown in Fig. 9. The optimum concentration for these thixotropic agents lies between 1.3 and 1.6 per cent for Thixcin R and between 1.9 and 2.2 per cent for Thixatrol ST.

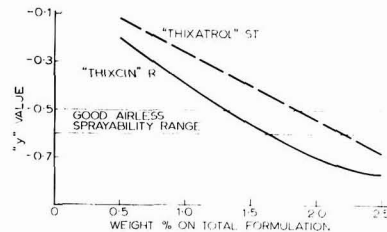


Fig. 9. Variation of pseudoplasticity with increasing Thixcin R and Thixatrol ST content in high build Vinylite formulation

Viscosity stability

The viscosity stability, or retention of pseudoplasticity, on storage of the high build vinyl formulation containing Aerosil 200, Rilanit Special, Thixatrol R has been measured over a period of six months. With Aerosil 200, ten per cent of a wetting agent Arquad 2HT 75, calculated on Aerosil

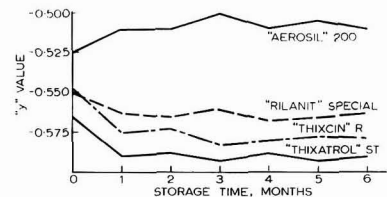


Fig. 10. Viscosity stability thixotropic agents in high build Vinylite formulation

*Manufactured by Contraves AG, Zurich, Switzerland.

content, was incorporated in order to obtain satisfactory viscosity stability. Fig. 10 shows the values of viscosity over the six months period. The modified hydrogenated castor oils give an initial increase in pseudoplasticity but the value levels out after the first month. With Aerosil 200, however, the pseudoplasticity initially decreases and then levels out.

Pigmentation of high build vinyl coatings

As mentioned in preceding sections, a dibasic acid modified vinyl copolymer should be used when direct adhesion to metal is required. This means that high build vinyl primers have to be based on that type of acid copolymer and at the same time have to contain an anti-corrosive pigment to obtain the optimum performance from the total system. The majority of anti-corrosive pigments are basic, however, and will react with this resin leading finally to coagulation of the paint.

Extensive screening trials were initiated in 1970 to find an anti-corrosive pigment which would not react with maleic modified vinyl copolymers.¹³ After two years storage, excellent viscosity stability has been shown by the following anti-corrosive pigments:

Zinc phosphate¹⁴ ($Zn_3(PO_4)_2 \cdot 2H_2O$)

Zinc phosphate¹⁵ ($Zn_3(PO_4)_2 \cdot 4H_2O$)

Chrome phosphate¹⁶

Chrome phosphate¹⁷

Organic—hexavalent chromium complex¹⁸

The anti-corrosive performance of all of the above pigments in vinyl primers was unknown. Accelerated laboratory corrosion tests were carried out in order to determine the optimum ratio of active/inert pigment for good anti-corrosive performance. As an inert pigment, synthetic iron oxide¹⁹ was selected. A series of primers, based on a maleic acid modified vinyl copolymer resin, and on a pigmentation consisting of varying amounts active/inert pigment, was prepared. The formulation used was similar to formulation IV (see Appendix). One exception was the organic—hexavalent chromium pigment whose optimum concentration

is given by the manufacturer¹⁸. A grade of zinc phosphate¹⁶ containing zinc hydroxide was also included in the evaluation, although it gave poor viscosity stability with the maleic acid modified vinyl resin.

The pigmentation of the primers evaluated was as follows:

1. No active anticorrosive pigment only iron oxide
2. Zinc phosphate¹⁵/iron oxide 25/75 by volume
3. Zinc phosphate¹⁵/iron oxide 50/50 by volume
4. Zinc phosphate¹⁵/iron oxide 75/25 by volume
5. Chrome phosphate¹⁶/iron oxide 25/75 by volume
6. Chrome phosphate¹⁶/iron oxide 50/50 by volume
7. Chrome phosphate¹⁶/iron oxide 25/75 by volume
8. Organic hexavalent chromium complex¹⁸/iron oxide 30/70 by volume
9. Zinc phosphate¹⁶/iron oxide 50/50 by volume
10. Zinc phosphate¹⁴/iron oxide 50/50 by volume
11. Chrome phosphate¹⁷/iron oxide 50/50 by volume

On the basis of comparison, and in order to keep the amount of work within reasonable limits, some active anti-corrosive pigments were evaluated at only one concentration in iron oxide.

All of the primers 1 to 11 were formulated at the same PVC of 33.8 per cent. They were applied on SA 2½ sand-blasted laboratory panels. The dry film thickness, for all primers, was 65-75 microns. Results were assessed by means of visual ratings of blistering and corrosion.

Results from the salt spray test are shown in Fig. 11, from the Kesternich test in Fig. 12, and from the humidity resistance test in Fig. 13. As can be seen from these Figures, the best results were shown by primers 3, 4 and 10, all containing zinc phosphate. There was no significant difference between the ratios 50/50 and 75/25 zinc phosphate/iron oxide, nor between the two grades of zinc phosphate.

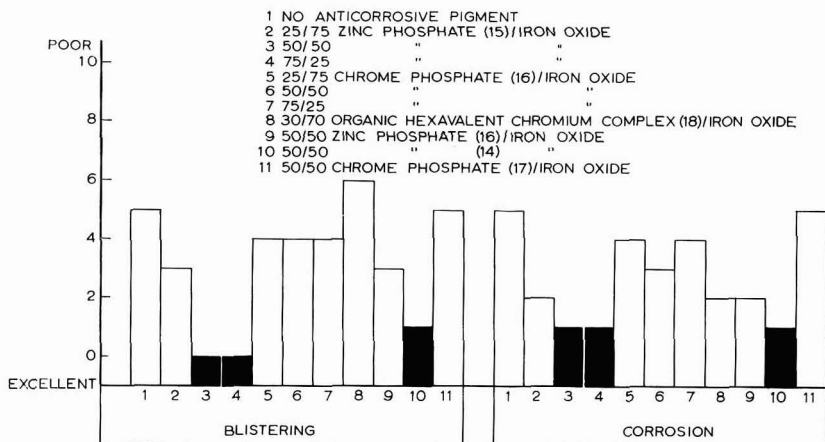


Fig. 11. Salt spray test ASTM B-117-61, 500 hours

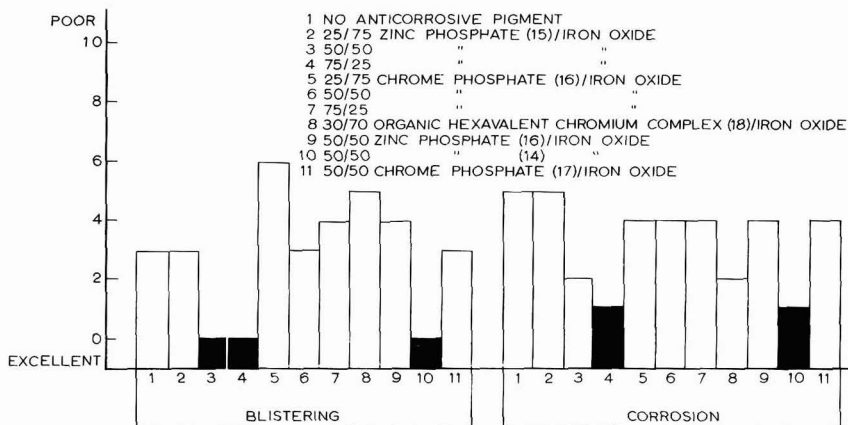


Fig. 12. Kesternich test din 50018 (2 litres SO₂), 10 cycles

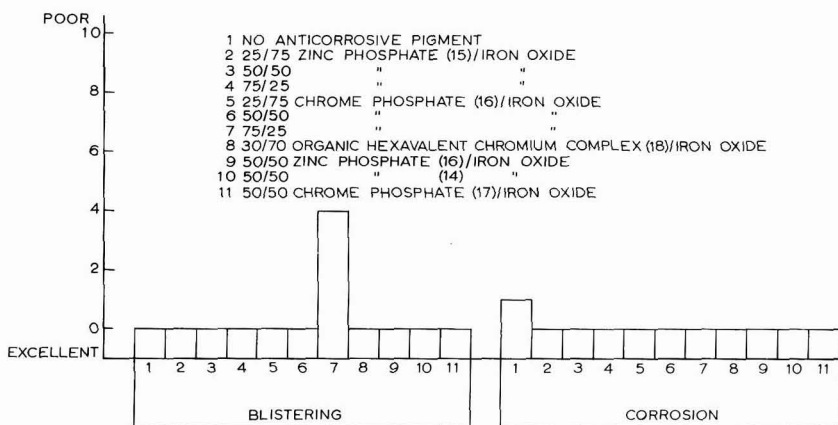


Fig. 13. Humidity cabinet test ASTM D-2247-66T, 800 hours

The results of an eight months outdoor exposure test on a chemical plant in Antwerp, Belgium, were found to be in agreement with the accelerated tests. Obviously, because anti-corrosive pigments are more expensive than inert pigments, it would be wasteful to include more anti-corrosive pigment than necessary. Therefore, the combination 50/50 by volume zinc phosphate/iron oxide can be considered the optimum and, on a weight basis, this corresponds to approximately two parts of iron oxide and one part of zinc phosphate.

Because zinc phosphate is completely innocuous, there has been considerable interest in this anti-corrosive pigment in recent years. Another of its advantages is its white colour and low opacity, making it adaptable to all colours by blending with other pigments. Several references can be found in the literature describing the properties of zinc phosphate.^{20, 22} Clay and Cox²³ claim that zinc phosphate, because of its insolubility and chemical inertness, is unlikely to give rise to intercoat adhesion difficulties and blistering. They find zinc phosphate comparable to zinc chromate, except that a higher concentration of the former is required to obtain the same anti-corrosive performance.

The pigmentation of high build vinyl coatings which do not contain a maleic acid modified copolymer offers no particular problems. With few exceptions,²⁴ most commonly used pigments can be employed successfully. White high-build vinyl top coats should be formulated with a good grade of non-chalking titanium dioxide when the maximum durability is required.

Extenders

Extenders may be included in the formulation for economy. It is better to use low oil absorption extenders since they allow an increase in the solids content of the formulations. Another important characteristic of an extender is its particle size. Coarse extenders are inadequate for maintenance applications since the interface between coarse particles and binder in the dry paint film provides a path for attack and for the penetration of environmental agents. The current trend to minimise grinding in order to increase plant output is another factor in favour of using pigments of the finest possible particle size.

Of all the extenders available to the formulator, barytes (barium sulfate) has the lowest oil absorption, and ultra-fine,

micronised grades are available. Furthermore, its excellent chemical resistance makes it appropriate for this application. The high density does not present a problem of settling in high build paints because their high pseudoplasticity ensures a very high viscosity during storage. This, coupled with the small particle size, eliminates pigment settling. The best choice is a micronised type which conforms with specification ASTM D—602-42.

Plasticisers for high build vinyl coatings

The inherent flexibility of vinyl resins is further increased by the addition of one or more suitable plasticisers. The plasticiser used for high build vinyl coatings should have some solvent action on the vinyl resin such that a relatively low viscosity is obtained. Traditionally, vinyl resins have been plasticised with monomeric plasticisers. Diisodecyl phthalate has been used extensively in maintenance paint formulations to replace tricresyl phosphate, which has been banned in some countries because of its toxicity. Diisodecyl phthalate shows an adequate balance of plasticising efficiency and performance; however, being an ester, it might be expected to be liable to hydrolysis under highly demanding conditions. The performance of other types of plasticisers in high build vinyl coatings has been thoroughly investigated.²⁵ Several commercially available plasticisers are listed in Table 8; they are either chlorinated paraffins or polyesters.

Table 8
Plasticisers for high build vinyl coatings

Designation	Remarks
Chlorinated paraffin ⁴⁰	—
Hordaflex LC ⁴⁰	Chlorinated paraffin
Hordaflex LC 60 ⁴⁰	Chlorinated paraffin
Paraplex G-41 ⁴⁰	Polyester
Paraplex G-62 ⁴⁰	Epoxidised polyester

Polymeric plasticisers of the polyester type have better gloss retention and pick up less dirt than do the monomeric plasticisers. They have excellent resistance to migration and impart a high resistance to oils and gasoline. High-molecular-weight oil epoxides provide heat and light stabilisation, low temperature flexibility and freedom from migration.

Following the recent prohibition of chlorinated biphenyls for ecological reasons, the only chlorinated plasticisers now available are chlorinated paraffins. These plasticisers should be used in cases where an extreme chemical resistance is required.

The proportion of plasticiser in a high build vinyl coating should be approximately 25 per cent. Important characteristics, such as solvent retention, water permeability, toxicity, etc. must be considered carefully before selecting a suitable plasticiser.

Effect of the plasticiser on the solvent retention of high build vinyl coatings

It is a well-known fact that monomeric plasticisers minimise solvent retention in vinyl films. It is believed that they retard the formation of a hard skin at the surface, thus allowing the solvent to escape.

The effect of the same selected plasticisers on the solvent retention in a clear, unpigmented vinyl film is shown in

Fig. 14. As would be expected diisodecyl phthalate gives the lowest solvent retention, whereas the chlorinated paraffins, especially "Hordaflex" LC 60, tend to retain solvent.

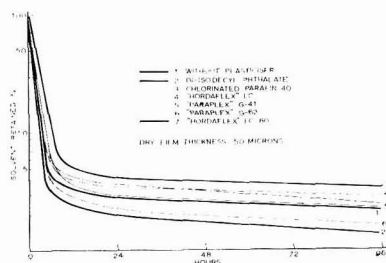


Fig. 14. Solvent retention in a vinyl film with different plasticisers

Influence of the plasticiser on the water permeability of high build vinyl coatings

One of the major requirements of maintenance coatings is resistance to weathering. This means its ability to withstand a series of environmental factors, one of which is penetration by water. Water can penetrate into a film and reach the substrate when the coating film, due to the nature of its binder, absorbs water, or when the film has a high degree of porosity or pinholing.

Penetration of water into coating films produces blistering, loss of adhesion and, when the coating has been applied to a metal surface (as in the case of almost all maintenance coatings) provides a means of ion transport through the film, thus making it electrically conductive. This allows the formation of corrosion currents or corrosion cells, which can severely impair the anti-corrosive properties of the coating film.

A number of papers^{26, 27} have dealt with the relationship between water absorption and corrosion protection by coating films. The conclusion of these is that good anti-corrosive films should show no change in conductivity after immersion in water.

The majority of procedures reported in the literature for measuring the water absorption or water penetration of coatings are based on methods which use free films and a diffusion cup.²⁸ These methods have two disadvantages:

1. It is very difficult and time consuming to obtain free films of some coatings.
2. The testing of a free film may not be representative of the performance of the same film when applied on a metal surface. It is well-known that a great number of physico-chemical reactions take place at the interface between paint and metal substrate.

It is, therefore, easier and more reliable to test the water permeability of coating films whilst it is attached to a substrate.

A test has been developed which makes possible the measurement of the water transmission of films adhering to metal substrates.²⁹ This test serves two purposes: it can measure the porosity or the pinholing, in a film and also its water absorption. Test apparatus is shown in Fig. 15. The maximum current intensity passes through the circuit when the platinum wire electrode is immersed in the sodium

chloride solution which is in direct contact with the metal panel. This intensity is adjusted to a suitable value by means of a resistance incorporated in the circuit. The current which passes when the platinum electrode is immersed in the salt solution which is in contact with the coating film is measured at periodic intervals till the value evens out. This value, as a percentage of the current given by the blank, gives a measure of the water penetration.

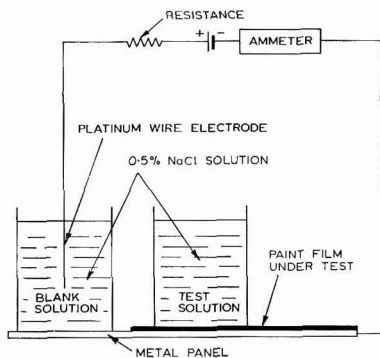


Fig. 15. Water transmission test

Vinyl chloride-vinyl acetate copolymers have a very low water permeability.³⁰ It is obvious, however, that addition of a plasticiser will tend to increase water permeability.

The influence of the plasticiser on the water permeability of a clear, unpigmented vinyl film is shown in Fig. 16. As can be seen from this figure, and as would be expected, diisodecyl phthalate shows the highest permeability index, whereas Hordaflex LC 60 imparts a very low permeability to the vinyl film. No explanation has been found for the anomalous behaviour shown by Paraplex G-41.

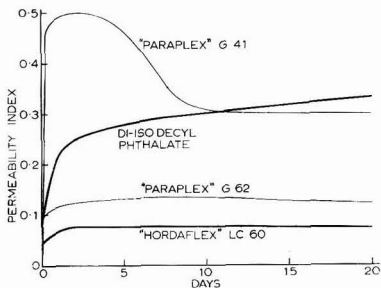


Fig. 16. Effect of different plasticisers on water permeability of a vinyl film. Dry film thickness 50 microns

Optimised plasticiser blends

As has been seen in the preceding sections, Hordaflex LC 60 shows a very low permeability but gives a high solvent retention. Another interesting property of this plasticiser is that it enhances the adhesion of vinyl coatings which have to be applied to difficult substrates, e.g. zinc-rich primers.

An attempt was made to test high build vinyl coatings plasticised with blends of Hordaflex LC 60 and Diisodecyl phthalate. Formulation III (see Appendix) was used throughout the evaluation. The effect of blending these two plasticisers

on the solvent retention of the high build vinyl coating is shown in Fig. 17, and the influence on the water permeability in Fig. 18. As can be seen from Fig. 18 the permeability of

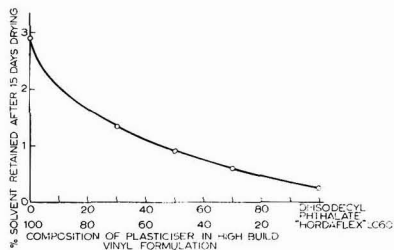


Fig. 17. Influence of plasticiser blends on solvent retentions of a high build vinyl formulation. Dry film thickness: 150 microns

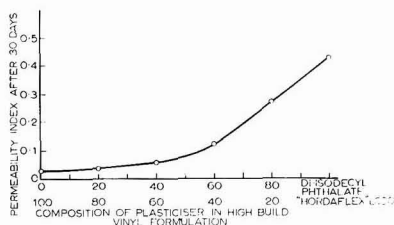


Fig. 18. Influence of plasticiser blends on water permeability of high build vinyl formulation. Dry film thickness: 150 microns

the films increases rapidly when the proportion of Diisodecyl phthalate exceeds fifty per cent. Fig. 17 shows that the solvent retained, for this 50/50 blend, is relatively low. Equal parts of each plasticiser can thus be considered as an optimised blend.

Formulation of high build vinyl coatings

Primers

High build vinyl primers are based on the maleic acid-modified vinyl copolymer. These primers adhere well to bare steel surfaces and provide maximum protection for general atmospheric use and immersion in fresh water. Primers which are to be applied directly on to metal must contain an anti-corrosive pigment. As mentioned previously the best results are obtained with a combination of red iron oxide and zinc phosphate. Corrosion tests have shown that the optimum ratio of these two pigments is an equal volume of each.

A formulation for a high build vinyl primer is suggested in the Appendix (formulation IV). This formulation is suitable for airless spray application without further thinning. A film thickness of 160-170 microns can be obtained in one coat without sagging. At this film thickness the primer will dry hard in approximately 48 hours and can be recoated after drying overnight.

Intermediate coats

Intermediate coats may be used to build up the film. Since adhesion to metal is not required, the maleic acid modified copolymer can be blended with other vinyl copolymers.

Best overall performance is obtained when the red iron oxide pigment is partially replaced by zinc phosphate.

A formulation suggested for a high build intermediate coating over vinyl primers is given in the Appendix (formulation V). The film thickness obtained and drying characteristics are the same as those of the vinyl primer.

A recent trend in the marine field is towards the replacement of organic shop primers by zinc rich primers. The most widely used zinc rich primers are based on inorganic silicates and epoxy resins. Most of the structural steel supplied is already protected by a zinc rich primer when delivered and, therefore, subsequent coats must adhere well to these types of primer. A maleic acid modified vinyl copolymer will adhere to both organic and inorganic zinc rich primers. Better adhesion to highly cross-linked epoxy zinc rich primers is obtained when a minor proportion on an oxirane containing vinyl terpolymer is incorporated. As mentioned before, the use of Hordaflex LC 60 will enhance the adhesion of the vinyl coat to the zinc rich primer.

A suggestion for a high build vinyl intermediate coat for zinc rich primers is given as formulation VI. A film thickness of 160-170 microns can be obtained in one coat without sagging. At this film thickness the coating dries hard in approximately 48 hours, and can be recoated after drying overnight.

Finishing

A high build vinyl topcoat should be based on an unmodified vinyl chloride-vinyl acetate copolymer which has the highest durability, water resistance and chemical resistance.

A formulation for a white high build vinyl topcoat is shown as VII the Appendix. A dry film thickness of 90-100 microns can be obtained in one coat without sagging. At this film thickness the coating dries hard in about 24 hours.

Manufacture of high build vinyl coatings

The manufacture of high build vinyl coatings offers no problems, other than the incorporation of the thixotropic agent.

Thixotropic agents can be incorporated into high build vinyl formulations by two procedures: the "master batch" process, and the "one-step" process.

The "master batch" process

The vinyl resin is dissolved in most of the blended solvents, retaining some of the diluents for final viscosity adjustment. The pigments and extenders are then dispersed in the resin solution by means of a pebble or sand mill. A small amount of soya lecithin, or other wetting agent, aids the dispersion process. The dispersion should be continued to a Hegman gauge reading of six, or higher, to allow good spraying through the fine orifice of the airless spray tip. Once the desired fineness, has been reached, the pigment grind is discharged from the mill and charged in a Cowles dissolver or its equivalent. The viscosity of the pigment grind should be so adjusted as to avoid splashing.

The thixotropic agent is added at this point as a previously prepared master-batch, and agitation is continued. When a modified hydrogenated castor oil is used, care should be taken to reach the exact recommended swelling temperature.

Using this technique the maximum thixotropy is developed about 24 hours later.

The thixotropic agent "master batch" is prepared by dispersing the thixotrope in all of the plasticiser using a high speed agitator (such as the Cowles) or a three-roll mill. The objective at this stage is only to disperse the thixotropic particles. With a modified hydrogenated castor oil it is better not to add any solvent to this master batch because a very stiff paste is then obtained, which is very difficult to incorporate into the final coating.

The recommended swelling temperature for each one of the modified hydrogenated castor oils evaluated in formulation III is as follows:

	Temperature limits (°C)	
	Minimum	Maximum
Thixcin R	45	50
Thixatrol ST	46	50
Rilanit Special	45	50

If these lower and upper critical temperatures are not observed, modified hydrogenated castor oils do not swell or dissolve properly and, consequently, cause the formation of unacceptably large particles (seeding).

A margin of safety can be obtained if 16 to 20 per cent of a wetting agent such as Arquad 2HT75³¹ (calculated by weight on the amount of thixotropic agent) is incorporated. The presence of such a wetting agent avoids seeding in most cases.

The master batch process has the following disadvantages: the operations are lengthy; and temperature control is critical.

The "one-step" process

This procedure consists in grinding thixotropic agent and pigments together. In high build vinyl formulations the polarity of the solvent, together with the shear forces developed during grinding, is sufficient to make modified hydrogenated castor oils gel without having to reach a critical swelling temperature.

Using this one-step procedure, the vinyl resin is dissolved in the solvent blend, all other ingredients are added and the mixture is ground on a sand mill, Attritor, or roll mill. When using high speed cavitation mixers (e.g. the Cowles dissolver) care should be taken to ensure that there is sufficient flow to permit dispersion. Due to the build up of structure, the flow at the walls and bottom of the vessel may be insufficient to produce good dispersion.

When using modified hydrogenated castor oils the addition of 16 to 20 per cent of "Arquad" 2HT75³¹ calculated on the weight of thixotropic agent, helps to avoid occasional seeding due to thermal shock.

This "one-step" procedure has the advantages that the operational time is relatively short and no temperature control is necessary.

Conclusions

The formulation of high-build vinyl paints having a maximum solids content and capable of being sprayed with airless equipment is described.

A high solids content and a relatively low viscosity is obtained using vinyl chloride-vinyl acetate copolymers prepared by polymerisation in solution. These resins are characterised by a very narrow molecular weight distribution, which gives good solubility and viscosity stability.

Solvent retention can be minimised by using a solvent combination containing a major proportion of ester which allows the application of coatings having a dry film thickness of over 200 microns per coat. Because slow-evaporating solvents can be used, films relatively free from porosity may be obtained. Coatings formulated with this optimised solvent combination show excellent levelling and release the solvent rapidly, so that overcoating may be carried out after air-drying overnight.

The formulation of high build paints must take into consideration the rheological requirements imposed on them by the objective of depositing a thick film and the implied requirement of airless spray application. It requires an understanding of the effect of the various parameters involved. This entails the measurement of viscosity at shear rates ranging from ultra-low to ultra-high. Although no single instrument has been found to encompass such a range, a correlation between pseudoplasticity and practicability of airless spray application has been found. These data can be used to forecast the spray-ability of a high build vinyl paint with sufficient accuracy and reproducibility. Modified hydrogenated castor oils are excellent thixotropic agents for high build vinyl coatings. Used at low concentrations, they impart the required rheological properties and they have very good viscosity stability on storage. A type of pyrogenic silica also gives as well excellent results but a higher concentration has to be used to obtain the same degree of pseudoplasticity.

The problem of formulating vinyl primers for application directly on to sandblasted steel has been solved by using zinc phosphate as the active anti-corrosive pigment. It does not react with the carboxyl groups of the maleic acid-modified vinyl copolymer, which adheres to metal and gives excellent corrosion resistance, both in practical outdoor exposure and in accelerated tests. It has also the advantage of being inert and white.

The plasticisers appropriate for high build vinyl coatings may be of the monomeric, polymeric or chlorinated type. Important characteristics such as toxicity, water permeability, solvent retention, etc., must be carefully considered before selecting a plasticiser. For most uses, blends of monomers with chlorinated paraffins are preferred.

Suggested formulations for high build vinyl coating systems, based upon these principles, are given.

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References

- Chandler, K. A., and Stanners, J. F., *FATIPEC Yearbook*, 1966, 256-262.
- Surface Preparation Specifications*, Section II, Bulletin of the Steel Structures Painting Council, Pittsburgh, USA.
- Ginsberg, T., and Merriam, C. N., *Union Carbide Corporation, Internal Communication*, November 1972.
- Fry, C. E., *VIPAG Newsletter* 1965, 1, (3).
- Brezinski, J. J., Koleske, J. V., and Potter, G. H., *FATIPEC Yearbook*, 1972, 327-334.
- Weigel, J. E., and Sabino, E. G., *J. Paint Technol.*, 1969, 41, 529.
- Tysall, L. A., and Snowden, A. J., *FATIPEC Yearbook*, 1968, Plenary lectures, 35-44.
- Technical Bulletin TBL-503*, Union Carbide Europe SA, Chemical and Plastics Laboratory.
- LA APCD*, Rule 66, 28 July 1966, Los Angeles, Calif., USA.
- Patton, T. C., "Paint Flow and Pigment Dispersion," Interscience Publishers, 1964, p. 130.
- Patton, T. C., "Paint Flow and Pigment Dispersion," Interscience Publishers, 1964, p. 16.
- Patton, T. C., "Paint Flow and Pigment Dispersion," Interscience Publishers, 1964, p. 420.
- Pila, S., "Evaluation of Anticorrosive Pigments for Primer/Intermediate Coats Based on the VMCC Resin." Union Carbide Europe SA, Chemicals and Plastics Laboratory, Internal Communication. May 1972, Ref. V-722.
- ISC Alloys Limited, Avonmouth, England.
- Société de Couleurs Zinciques, Aubervilliers, France.
- G. Siegle & Co GmbH, Stuttgart, Germany.
- Pierrefitte-Auby, Paris, France.
- Albright and Wilson Limited, England.
- Synthetic Iron Oxide 140 M, Bayer AG, Germany.
- Meyer, G., *Farbe und Lack*, 1962, 68, 315.
- Pepin, B., *FATIPEC Yearbook*, 1972, p. 171.
- Ruf J., *Farbe und Lack*, 1973, 79, p. 22.
- Clay, H. F., and Cox, J. H., *JOCCA*, 1973, 56, 13.
- "Bakelite vinyl resins for solution coatings and adhesives," Union Carbide Corporation Data Sheet Ref. J-2178 C 106-5, p. 11.
- Pila S., "Plasticizers for High Build Vinyl Coatings" Union Carbide Europe SA, Chemicals and Plastics Laboratory, Internal Communication, May 1972, Ref. V-722.
- Ulfvarsson, U., Khullar, M. L., and Wahlin, E., *JOCCA*, 1967, 50, 254-261.
- Khullar, M. L., and Ulfvarsson, U., *FATIPEC Congress Book*, 1968, Sect. 3, 165-175.
- Cherry, B. W., and Mayne, J. E. O., *Off. Dig.* 1965, 37, 13-17.
- "Method for determining water transmission through adherent organic coatings." Union Carbide Europe SA, Chemicals and Plastics Laboratory. Technical Bulletin TBL-502 09.72.
- Boxall, J., von Fraunhofer, J. A., Werren, S. C., *JOCCA*, 1972, 55, 24.
- Armour Ind. Co., England.
- Unmodified vinyl chloride-vinyl acetate copolymer. Union Carbide Corporation.
- Maleic acid-modified vinyl chloride-vinyl acetate Copolymer, Union Carbide Corporation.
- Diisodecyl phthalate. Union Carbide Corporation.
- The Baker Castor Oil Co.
- Johns-Manville International Corp.
- Degussa, Germany.
- Société des Couleurs Zinciques, France, or ISC Alloys Limited-England.
- Oxirane-modified vinyl chloride-vinyl acetate terpolymer. Union Carbide Corporation.
- Farbwerke Hoechst, Germany.
- Rohm & Haas Co.

Appendix

High build vinyl coatings

	Formulations. Percentage by weight						
	I Primer	II Primer	III Primer Airless	IV Primer Airless	V Intermediate for use on Zn rich primer. Airless	VI Intermediate for use on vinyl primer. Airless	VII White top coat. Airless
Vynlite VMCC ³³	16.00	20.00	7.22	16.00	14.50	10.90	—
Vynlite VYHD ³²	—	—	7.22	—	—	6.50	14.00
Vynlite VERR ³⁹	—	—	—	—	1.60	—	—
Titanium dioxide	—	—	14.44	—	—	—	14.00
Synthetic iron oxide ¹⁹	21.50	9.50	—	13.50	17.50	14.25	—
Zinc phosphate ³⁸	—	—	—	6.00	2.00	2.20	—
Barium sulphate	—	—	5.05	10.00	10.00	2.65	—
Celite 281 ³⁸	6.20	2.80	—	—	—	—	—
Aerosil 200 ³⁷	2.70	1.20	—	—	—	—	—
Soya lecithin	0.25	0.15	0.20	0.25	0.25	0.25	0.20
Thixotropic agent	—	—	2.50	—	—	—	—
Flexol 10-10 ³⁴	4.00	5.00	3.61	4.00	2.00	2.20	—
Hordaflex LC 60 ⁴⁰	—	—	—	—	2.00	2.20	—
Thixcin R ³⁵	—	—	—	1.50	1.50	1.50	1.60
Arquand 2HT 75 ³¹	0.25	0.15	—	—	—	—	—
Plasticiser*	—	—	—	—	—	—	3.50
Methyl isobutyl ketone	5.00	6.00	5.92	5.00	5.00	5.50	7.00
Xylene	10.00	12.00	11.98	9.00	9.00	9.80	13.50
Ethylene glycol monoethyl ether acetate †	34.00	43.20	—	34.75	34.65	20.50	36.70
Butyl acetate	—	—	—	—	—	16.50	9.50
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
PVC	34%	15%	—	33.8%	33.5%	28.8%	—
Non-volatile by weight	—	—	—	51.2%	51.3%	48.1%	33.3%
Non-volatile by volume	—	—	—	32.1%	31.2%	29.3%	—

*For rural atmospheres: Flexol 10-10³⁴For good resistance in polluted atmospheres: "Paraplex" G-41 or G-62⁴¹For good chemical resistance: Chlorinated paraffin 40 or "Hordaflex" LC-60⁴⁰

†"Cellusolve" acetate

Permeability properties of surface coatings towards chloride ion*

By J. D. Murray

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Summary

A method for directly following ionic permeation of polymeric films by means of an ion-selective electrode has been established. The experimental system is simple and designed to provide rapid rate determinations.

Three surface coatings media were examined, cellulose acetate, epoxy/polyamide (1 : 1 and 2 : 1) and polyvinyl chloride/acetate

copolymer, as films of thickness related to practice. Cellulose acetate gave a constant chloride ion permeation rate but epoxy/polyamide (1 : 1) showed a continued increase with time and epoxy/polyamide (2 : 1) and the copolymer gave a reducing rate. These behaviours are understood in terms of interaction between the aqueous media and polymer matrix.

Keywords

Properties, characteristics and conditions primarily associated with dried or cured films permeability

Processes and methods primarily associated with analysis, measurement or testing ion selective electrode

La perméabilité des revêtements superficiels aux ions chlore

Résumé

On a établi une méthode au moyen d'une électrode non-sélective pour apprécier la pénétration ionique aux feuilis polymères. L'appareillage est simple et a été conçu en vue d'assurer les déterminations rapides.

On a étudié trois types de milieu pour revêtements—acétate de cellulose, époxy-polyamide (1 : 1 et 2 : 1), chlorure de polyvinyle—

sous forme de feuilis d'une épaisseur conformément à la pratique usuelle. L'acétate de cellulose révélait un taux de pénétration constante de ions chlore, mais l'époxy-polyamide (1 : 1) montrait une augmentation progressive en fonction du temps, et l'époxy-polyamide (2 : 1) ainsi que le copolymère révélèrent un taux diminuant. Ces comportements se comprennent sous termes de l'interaction des milieux aqueux et de la matrice polymère.

Permeabilitätsverhalten von Beschichtungsmitteln Gegen Chlorionen

Zusammenfassung

Eine Methode, um ionische Durchdringung polymerer Filme direkt mit Hilfe einer ionenselektiven Elektrode zu verfolgen, wurde gefunden. Das experimentelle System ist einfach und dazu bestimmt, um rapid-schnelle Bestimmungen zu ermöglichen.

Drei Lackbindemittel werden geprüft—Zelluloseazetat, Epoxy-polyamid (1:1 und 2:1) und Polyvinylchlorid/Azetat Misch-

polymer—als Filme von in der Praxis üblichen Dicke. Das Ergebnis bei Zelluloseazetat war eine gleichmäßige Chlorionendurchdringung, Epoxy-polyamid (1:1) zeigte jedoch eine sich mit der Zeit erhöhende und Epoxy-polyamid (2:1) sowie das Mischpolymer eine rückgängige Durchdringungsgeschwindigkeit. Dieses Verhalten ist so zu verstehen, dass zwischen dem wässrigen Bindemittel und der Polymermatritze Zwischenreaktionen vor sich gehen.

Свойства проницаемости поверхностных покрытий к иону хлорида

Резюме

Формулируется метод исследования ионного проникновения полимерных пленок путем ионо-селективного электрода. Экспериментальная процедура [проста и рассчитана для быстрого определения величин.

Исследовались три среды поверхностных покрытий—ацетат целлюлозы, эпокси полиамиды (1:1 и 2:1) и хлористый поли-

винил ацетатный сополимер — с толщиной пленки соответствующей практике. Ацетат целлюлозы дал постоянную скорость проникновения хлоридного иона в то время как эпокси полиамид (1:1) обнаружил непрерывное повышение со временем, а эпокси полиамид (2:2) и сополимер дали пониженную скорость. Такое поведение объясняется взаимодействием между водной средой и полимерной матрицей.

Introduction

It is well known that water and oxygen play a major role in the corrosion of a painted metal surface. Ionic products arise in the corrosion reactions and movement of ions is necessary for attack at the anodic sites to continue. An understanding of the means by which ions are transported within an organic coating, and are carried through to the substrate from outside, is valuable and should lead eventually to the development of coatings with enhanced protective power. The ionic species present in atmospheres regarded as corrosive, such

as sodium, chloride, ammonium, and sulphate, should be considered.

The phenomenon of ions passing through a film of protective coating polymer has usually been studied by an indirect approach involving measurements of film resistance, conductivity or diffusion potential. Radio-tracer techniques have, so far, offered the most useful direct determination of ionic permeation¹⁻¹⁰.

A direct permeation method employing a solid-state

*Presented to the London Section on 11 October 1972.

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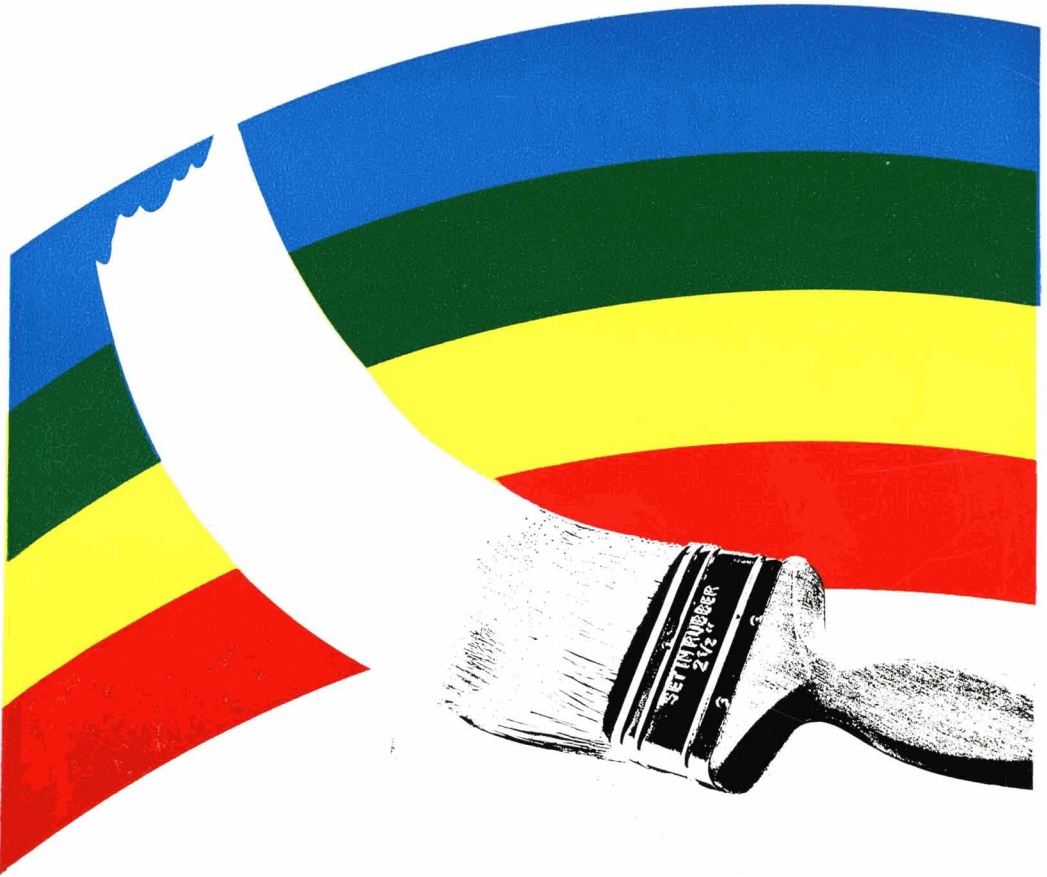
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Ibex House, Minorities, London, E.C.3.

chloride selective electrode, which should be applicable to a wide field of paints, varnishes and lacquers, is described in this paper. Whilst the majority of ion-selective electrodes are not as sensitive as radiation sensors, they are convenient to use and the complete experimental equipment is comparatively inexpensive. The advent of the Selectrode¹¹ will greatly extend the versatility of this analytical tool. The Selectrode is simply a solid-state electrode without any inner reference solution in which a very thin layer of electroactive material is applied to a graphite rod. The electroactive layer can be changed, as required, to suit the ion under consideration.

Much of the preliminary work was performed with cellulose acetate. This has not often been employed as a surface coating, but it offered the advantage of being a highly permeable medium and it was possible to compare results with available literature values and thus judge the validity of the measurements before examining other polymers more normally used as paint media.

Experimental

The system for permeation rate determinations is shown in Fig. 1. It was designed in order to optimise the measurement of the increase in Cl^- concentration on the exit side of the film.

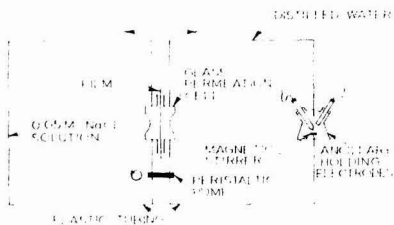


Fig. 1. Apparatus for permeation measurements

The liquid systems on both sides of the film were pumped continuously by the peristaltic pump at approximately 70ml per minute. Constant circulation was necessary to minimise boundary layer formation adjacent to the film's surfaces. If this is neglected the concentration gradient across the film, which is the driving force for the ionic permeation, will not correspond to the difference in concentrations in the bulk of the solutions.

With the outlets of the permeation cell vertically above the inlets and liquid flow in the opposite direction to gravitational flow, efficient mixing was achieved within the cell. (Tested by introducing a drop of dye into the streams.) Thus the film surfaces were in contact with a constantly changing layer of liquid.

The permeation cell, of internal diameter 7.5cm, was designed to provide maximum surface area of film with minimum solution volume. The overall volume on the exit side of the film, including the connecting tubing and ancillary electrode cell, was approximately 100ml. The electrode cell itself was designed to hold a minimum liquid volume whilst at the same time allowing efficient mixing in the region of the electrode tips by means of a plastic-coated stirrer magnet.

The permeation cell was maintained at 25°C by a thermostatically controlled water bath and the film was sealed

between ground glass joints with picein wax and a circular clamp around the edge.

The reference electrode was similar to that of Van Loon,¹² a calomel electrode housed in a jacket containing 4M ammonium nitrate solution with the tip plugged by agar jelly impregnated with ammonium nitrate. This arrangement minimised leakage of potassium chloride into the system.

The Cl^- electrode (Orion Solid State 94-17) must be calibrated at 25°C for use. A typical calibration relationship is shown in Fig. 2, where the electrode potential is plotted linearly against concentration on a logarithmic axis. The relationship follows a straight line to below 10^{-6} g ion/l and may be reliably employed down to concentrations approaching 2×10^{-8} g ion/l.

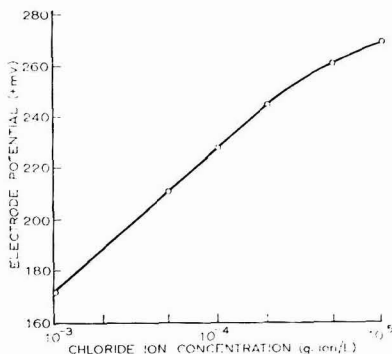


Fig. 2. Calibration curve for Cl^- solid state electrode

Because of the low concentration involved it was essential to avoid contamination and standard solutions were prepared by careful dilution from a stock solution of 2×10^{-2} M "Analar" sodium chloride using "A" grade glassware.

On each day that rate measurements were performed the Cl^- electrode was standardised with two or more standard solutions at 25°C. Although the calibration gradient is unchanged, the actual potential reading for a given solution can vary by up to ± 1 mV from day to day. The solutions were always stirred vigorously for several minutes after immersion of the electrodes and were presented in order of increasing concentration. Readings (to ± 0.1 mV) were taken on an expanded scale of a Pye 290 pH meter. During a run the liquid movement was arrested for precisely three minutes before a potential reading was recorded; the Cl^- electrode's response time is well within this period.

Three organic polymer systems have been investigated, cellulose acetate (CA), epoxy/polyamide (EP) and polyvinyl chloride/polyvinyl acetate copolymer (PVC/PVA), at film thicknesses related to those used in practice.

The preparatory details are listed in Table 1. All films were prepared by spinning on to 15×12.5 cm glass or aluminium panels. In every case two coats were applied. This is essential to avoid continuous imperfections through a film which would invalidate permeability determinations. Ageing at an elevated temperature is also necessary to remove entrained solvent which could affect film permeation properties.

Table 1
Film preparation details

Materials	Supplier	Grade	Solvent	Concentration	Substrate	Interval between coats	Ageing at 40°C
CA	Hercules	Lacquer	Dioxane	15% w/v	Chromated* hard Al	5 min	6 days
PVC/PVA ..	Bakelite Xylonite Shell	VYHH Epikote 1001	Acetone	30% w/v	Chromated* hard Al	5 min	6 days
{ Epoxide .. Polyamide	Cornelius	Versamid 115	Xylene/methyl isobutyl ketone (1 : 1) isopropanol/ toluene (1 : 1)	50% w/w	Glass	24 hr	10 days

*BS 3900, A3.

CA and PVC/PVA films were readily removed from their aluminium substrate; for EP films on glass panels dipping in distilled water for a few minutes was required to effect removal.

Fig. 3 shows the approximate formulae and mechanism of curing for EP systems. A quantitative description of the curing in terms of the proportion and type of amine groups reacting cannot be given. A stoichiometric combination would correspond to an E:P ratio of 9:5 by weight. However, the proportions may be varied within wide limits, and the weight ratios 1:1 and 2:1 were adopted.

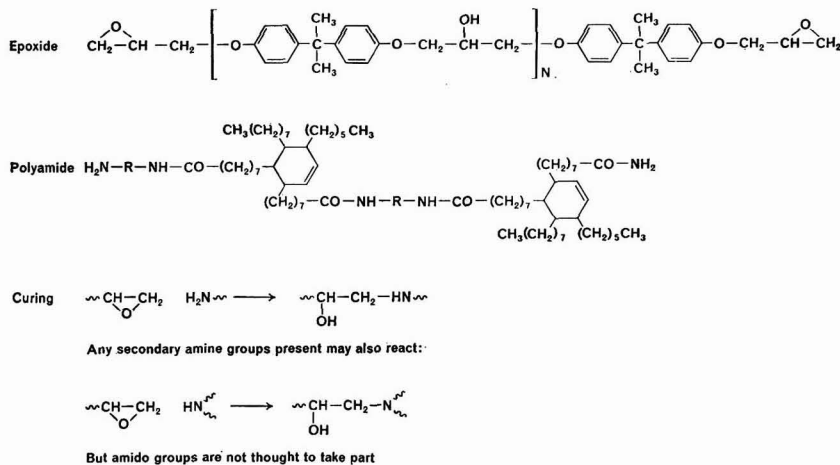


Fig. 3. Epoxy/polyamide system

Immediately after a permeation experiment the film thickness was measured with a Thomas Mercer Limited dial gauge calibrated in units of 0.002mm and having rounded point contacts. At least ten measurements were taken over the whole surface with the pressure between the contacts minimised to avoid indentation. In preliminary work, measurements were performed with a micrometer screw gauge having flat contacts of 0.3 cm² in area. Results thus obtained were significantly higher than with the standardised dial gauge indicating that a maximum value for the thickness over each 0.3 cm² area was being recorded. The percentage errors from this source are particularly serious with films of the order of 10 μm in thickness, where the error could be up to 30 per cent.

Permeation

Cellulose acetate

Cellulose acetate proved to be a medium allowing a relatively fast permeation of chloride ions and sufficient data for a rate determination could be obtained within a few hours. The same film can be used, if desired, repeatedly and reproducibly after thorough leaching by distilled water in between runs. Preconditioning a film in distilled water had little effect on the permeation rate, except for possibly eliminating an initial period (one to two hours) of non-uniformity.

Fig. 4 shows the result for a typical preconditioned film of thickness 10 ± 2 μm. The points correspond very closely to a straight line with an index of correlation of 0.998 and a constant permeation rate continued for several days.

When a steady transport rate is achieved, Fick's laws of diffusion are applicable and the equation shown below is obeyed.

$$Q = \frac{DA(C_1 - C_2)t}{l}$$

where Q is the amount of diffusing species involved in unidirectional flow through the film in time t , A is the film's surface area, l is its thickness, and C_1 and C_2 are the constant

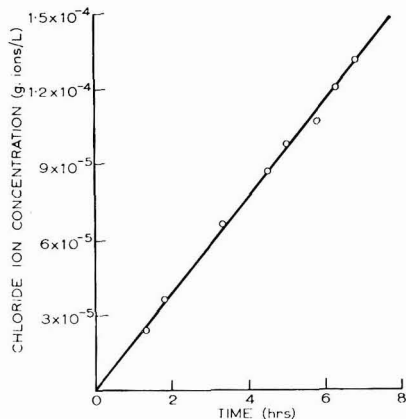


Fig. 4. Permeation of Cl^- through cellulose acetate

concentrations of diffusing species at its front and back faces. However, since the concentrations actually measured refer to the external solutions, then the proportionality constant derived is not D , the diffusion coefficient, but P , the permeability coefficient, which relates to the solution processes at the surfaces as well as to the passage of the penetrating species within the polymer system. Therefore, the above equation is used with P replacing D and with the assumption that $C_1 - C_2 \cong C_1$ for the typical data as shown in Fig. 4 where $C_2 < 0.00015M$. The calculated value of P agrees well with values reported in previous permeation studies on CA of surface coating thickness (see Table 2). It would not be reasonable to make too strict a comparison

time. A final steady permeation rate was not obtained after ten days, either with an unpreconditioned film or with one which had been soaked for three weeks in water. Thus, although the initial rate was slow and Cl^- penetration through the film was not detected until the third day, the film soon became "fast." Fig. 5 shows the curve for a typical unpreconditioned film of thickness $26 \pm 2 \mu\text{m}$, with the same concentration gradient applied as for CA. A value of P calculated for the last day of measurement had reached the same order as the constant value obtained for CA ($1.8 \times 10^{-10} \text{ cm}^2/\text{sec}$).

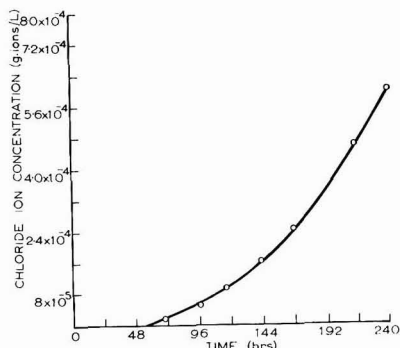


Fig. 5. Permeation of Cl^- through epoxy/polyamide (1 : 1)

The situation encountered with EP (2:1) is again different. Under the concentration conditions previously employed, any Cl^- permeation occurring was too low to detect over a period of two weeks. By raising the NaCl concentration to 10 per cent w/v (approximately 2M) an appreciable permeation rate of greater than $1 \mu\text{g Cl}^-/\text{hr}/\text{cm}^2$ of film was effected.

Table 2
Permeability coefficients of Cl^- through cellulose acetate

NaCl concentration	CA grade (% acetyl content)	Thickness (μm)	Temperature ($^{\circ}\text{C}$)	Mode of preparation; solvent	P ($\text{cm}^2 \text{ sec}^{-1}$) and reference
0.05M	39.1	10 ± 2	25	Spinning; dioxane	2.2×10^{-10} ; this work
0.85M	39.5	13 ± 5	Room	Cast; acetone	$*4.5 \times 10^{-10}$; Lonsdale ¹³
0.85M	39.5	15 ± 5	Room	Cast; acetone	$*2.3 \times 10^{-9}$; Lonsdale ¹³
0.85M	43.2	14 ± 5	Room	Cast; dioxane	$*2.2 \times 10^{-10}$; Lonsdale ¹³
0.05M	—	—	Room	—	$\dagger 1.7 \times 10^{-10}$; Glass ⁶

*Values actually described as NaCl permeability.

\dagger Calculated from the permeation rate, quoted for a nominal $25 \mu\text{m}$ thickness.

of the P values since the operating conditions were not identical.

Glass⁶ found that, for an unpreconditioned film, a long period (approximately two days) elapsed before a constant rate was achieved. It may be that the delay was a function of film thickness as the final steady rate is close to the result obtained here.

Epoxy/polyamide

An entirely different behaviour is exhibited for Cl^- permeation through epoxy/polyamide (1:1) where the rate increased with

However, the rate was found to decrease with time. Glass⁶ did not comment on any decreasing rate tendency with 2:1 EP lacquers, although he did find the Cl^- permeation rate to be slow (about 40 times slower than with CA).

Polyvinyl chloride/acetate copolymer

Polyvinyl chloride/acetate copolymer shows a permeation pattern towards Cl^- which is similar to that of EP (2:1). The initial rate with 0.05M NaCl was as high as that for CA, but thereafter a marked decrease took place as shown in Fig. 6 for a film of average thickness $37 \mu\text{m}$, which had been pre-conditioned in water for one day.

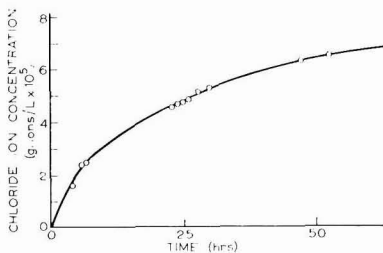


Fig. 6. Permeation of Cl^- through polyvinyl chloride/acetate copolymer

Discussion

For the surface coating media examined, three behaviour patterns have emerged. Cellulose acetate exemplifies the case where interaction between the organic system and the aqueous solution is either negligible or has no influence on the diffusion process. As shown in Fig. 7, the molecular formula approximating to the sample used has polar regions available although the extent of intramolecular hydrogen bonding may restrict the availability. From studies of water—CA interaction,^{14, 15} it appears that water is present as essentially isolated molecules which progress through the polymer system relatively unencumbered by attraction or repulsion from the polymer groups. It is reasonable to assume that Cl^- ions which have been shown to be partially hydrated¹⁶ take part in a similar, albeit slower, transport process.

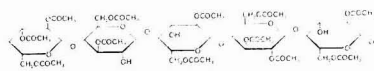


Fig. 7. One of the many theoretical cellulose acetates

For the unit shown, 12 of the 15 available OH groups from the cellulose molecule have been replaced by acetate groups

Epoxy/polyamide (1:1) illustrates a second form of permeation behaviour. This is a hydrophilic system (see Fig. 3) because of the molecular excess of polyamide which exists for this weight ratio, thus providing free amine groups. Consequently, it is not surprising that strong interaction occurs between the polymer matrix and the aqueous species. It is known that water itself prefers to associate with the polyamide system in nylon rather than with other water molecules.¹⁷ It is envisaged that a similar phenomenon occurs here whereby aqueous ions are attracted to polar sites so that the intermolecular, long range, polymeric bonding is diminished, segmental movement is increased and the system becomes plasticised. This effect can cause the permeability to increase in two ways: ionic diffusion through the film is facilitated; and also an increasing number of polar sites become exposed and hence available to charged ionic species. This latter process will raise the solubility of the species penetrating into the polymer medium and also promote further plasticisation.

The overall swelling of a film during a permeation experiment was not appreciable and cannot account for the progressive ease of Cl^- ion transport. Moreover, the fact that the

increasing Cl^- permeation rate still occurred after long immersion of a film in water suggests that the Cl^- ions are interacting with the polymer system, and it is the behaviour mechanism of the Cl^- which the data reveals and not simply the effect of aqueous ingress.

The third type of interaction is exhibited by epoxy polyamide (2:1) and polyvinyl chloride/polyvinyl acetate copolymer. The very noticeable slowing down of Cl^- permeation is indicative of clustering together of aqueous molecules within the matrix, which is a familiar phenomenon with hydrophobic polymeric systems, for example polyvinyl chloride.¹⁴ As the clusters fill the available free volume, penetrating entities find it increasingly difficult to pass through.

An explanation is required for the very low permeability of 2:1 EP towards Cl^- at dilute concentrations. This system is close to the stoichiometric ratio of 9:5 based on the epoxide and amine equivalents of the two components and, as such, will enjoy a higher degree of cross-linking than the 1:1 EP medium. This predominating factor will restrict aqueous ingress by offering limited free volume and limited "pathways" to the incoming penetrants. The other important factor is the absence of excess polyamide which in the 1:1 system has the effect of contributing hydrophilic character and a positive charge to the film in an aqueous environment ($-\text{NH}_2 \rightarrow -\text{N}^+\text{H}_3$). The positive charge of the 1:1 film is shown up even under concentrated salt conditions, where it was found by neutron activation analysis that Cl^- uptake was ten times as high as Na^+ absorption after a day's immersion and whilst the Cl^- concentration rose nearly four times after immersion for a week the Na^+ content increased only very slightly. A 2:1 EP film was found to bear a negative charge at neutral pH; a similar result was observed by Rudram and Sherwood.¹⁸ Consequently, cation entry will be favoured by EP 2:1, as was shown by Glass's work⁶ where the Cl^- permeation rate was approximately six times slower than that calculated from the measured permeation rate for Na^+ .

PVC/PVA⁵ and CA⁶ films also exhibit preference for cation transport, presumably due to the presence of impurities or contaminants such as carboxylic acid groups, which can weakly ionise to impart a negative charge on the fixed polymer system. However, when the external concentration is raised the fixed ion charge in these films is exceeded and the permselectivity disappears.⁵

In conclusion it may be stated that, whilst such factors as membrane charge and ionic size can affect the magnitude of the permeation rate, the overriding forces controlling the permeability behaviour arise from the interaction between the surface coating film and the aqueous environment. It is the nature, degree and consequences of this interaction which will be influencing the protective ability of the film.

Acknowledgments

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References

1. Nair, C. K. N., Sharma, P. G., and Aggarwal, J. S., *J. Sci. Industr. Res.*, **14B**, 1955, 549.
2. Clavilier, J., *Compt. Rend.*, 1959, **248**, 1508.
3. Tomashov, N. D., Lunev, A. F., and Gedgovd, K. N., *Trudy Inst. Fiz-Khim., Akad. Nauk, SSSR*, 1960, 264.
4. Sato, Y., *J. Electrochem. Soc. Japan (Overseas Supp. Ed.)*, 1960, **28**, E224.
5. Kumins, C. A., *Off. Dig.*, 1962, **34**, 843.
6. Glass, A. L., and Smith, J., *J. Paint Tech.*, 1966, **38**, 203; 1967, **39**, 490.
7. Deterding, J. H., and Wilson, R. W., *Proceedings of the European Meeting on Measuring Methods in Corrosion Control (EUROMESKOR)*, Prague, October 1968.
8. Rothwell, G. W., *JOCCA*, 1969, **52**, 219.
9. Glass, A. L., and Smith, J., *Isotopes and Radiation Tech.*, 1970, **8**, 60.
10. Svoboda, M., Kuchynka, D., and Knapek, B., *Farbe und Lack*, 1971, **77**, 11.
11. Ruzicka, J., and Lamm, C. G., *Anal. Chim. Acta*, 1971, **53**, 206.
12. Van Loon, J. C., *Analyst.*, 1968, **93**, 788.
13. Lonsdale, H. K., Merton, U., and Riley, R. L., *J. Appl. Polymer Sci.*, 1965, **9**, 1341.
14. Williams, J. L., Hopfenberg, H. B., and Stannett, V., *J. Macromol. Sci.-Phys.*, 1969, **B3 (4)**, 711.
15. Vieth, W., Douglas, A. S., and Bloch, R., *J. Macromol. Sci.-Phys.*, 1969, **B3 (4)**, 737.
16. Lakshminarayanaiah, N., *J. Macromol. Sci.-Phys.*, 1971, **B5 (1)**, 159.
17. Starkweather, H. W., *J. Macromol. Sci.-Phys.*, 1969, **B3 (4)**, 727.
18. Rudram, A. T. S., and Sherwood, A. F., *Paint Tech.*, 1966, **30 (10)**, 15.

Microbiology in the paint industry

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Summary

The biochemical and ecological characteristics of microbial growth in paints and other preservatives are described. It is suggested that close attention to modern developments in these fundamental

aspects could result in considerable improvements throughout the paint industry, and that the use of biocides, which are often toxic to man, should be considered as a last resort.

Keywords

Properties, characteristics and conditions primarily associated with dried or cured films:

degradation
mildew

Miscellaneous

micro-organism

La microbiologie dans le domaine de l'industrie de peintures

Résumé

On décrit les caractéristiques biochimiques et écologiques de la croissance microbienne en peintures et en autres préparations préservatrices. On suggère qu'une attention soutenue à l'égard de ces aspects fondamentaux pourraient assurer des améliorations

importantes parmi toute l'industrie de peintures, et que l'emploi des biocides, fréquemment toxiques à l'homme, ne devrait être considéré que le dernier ressort.

Mikrobiologie in der Lackindustrie

Zusammenfassung

Beschreibung der biochemischen und ecologischen Charakteristika des Mikrobewachstums auf Anstrichmitteln und anderen Schutzmitteln. Es wird vorgeschlagen, dass gewissenhafte Beobachtung moderner Entwicklungen dieser fundamentalen Gesichtspunkte zu

erheblichen Verbesserungen in der ganzen Lackindustrie führen könnte, und dass die Anwendung von Bioziden, die häufig für Menschen giftig sind, nur als letzte Zuflucht in Betracht gezogen werden sollte.

Микробиология в красочной промышленности

Резюме

Описываются биохимические и экологические характеристики микробного роста в красках и других консервирующих средствах. Предполагается что усердное внимание по отношению к современному развитию этих фундаментальных вопросов

может привести к значительному улучшению в красочной промышленности и что к применению биоцидов, которые часто являются токсичными для человека, следует прибегать только в крайних случаях.

Paints and other chemical preservatives, even those now produced by a sophisticated chemical industry, have in fact a long history. Indeed, they have a prehistory as the need to preserve natural materials in daily use was recognised by early man, and prehistoric artefacts indicate the extensive use of gums, waxes, tars and so forth for preservation.¹ The author has discussed elsewhere the idea that the control of microbes by early man was one pre-requisite for civilisation and that man, besides being a tool maker, is also a microbe tamer.² This early empirical recognition of the degradation and spoilage effects of microbes could not be based on a firm scientific foundation until the development of modern microbiology,³ and within the topics to be discussed in this symposium, it is evident that we still lack adequate techniques for the study and control of the activity of microbes in paint films, stored paints and other preservatives.⁴ An early intervention of microbiology into this field was the discovery that arsenical poisoning could be caused in humans by the action of the mould *Penicillium* growing in and behind wallpaper in which arsenical greens formed a part of the pattern. Subsequently, Raistrick and others showed that microfungi formed a range of volatile arsenical compounds, such as trimethyl arsine: similar compounds of selenium can also be formed during fungal metabolism.⁵ It should not, therefore, be too surprising that, more recently, organic mercurial compounds have been implicated as poisons in

man and that these arise from microbial metabolism, especially in the absence of oxygen. Just as the green arsenical pigments were withdrawn from general household use, there are increasing constrictions on the use of mercurial compounds, and these are affecting the paint industry as some of the most effective antifungal organo-mercurials cannot now be used as paint preservatives in some countries. These are particularly effective in damp conditions, such as cabins, where many other antifungal agents are leached out rapidly.⁶ Another recognised role of microbes in paint deterioration is the expenditure on biocides, mainly infungal, anti-algal and anti-bacterial agents by the paint industry which, in the USA alone, had reached the figure of \$12 million in 1968. An additional indication is the expenditure on research for new biocides by most chemical and pharmaceutical companies: the essential characteristics which these must possess for use by the paint industry are discussed briefly later. The thoughts lying behind these general introductory remarks are based on the ubiquity of microbes. Their wide ranging chemical activities and transformations may be illustrated by the findings of modern morticians, who have been plagued in recent years (as indeed were those in the ancient world) by bacteria now called *Pseudomonas cadaveris*, which can cheerfully degrade phenols and other preservatives used in order to perpetuate the "loved one."

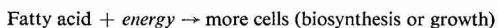
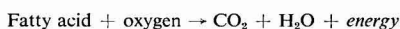
*This communication was presented as the Chairman's address at the Symposium on "Paint performance and the microbiological environment" held by the Manchester Section on 19 and 20 September 1972. Most of the papers presented at this Symposium will be published in *JOCCA* during the next few months.

Spoilage by microbes may be due to chemical transformation of the material, usually referred to as biodegradation. No transformation of the material may occur in other cases, but spoilage results, nevertheless, from staining or other forms of fouling which renders the material aesthetically, economically or otherwise unacceptable: this is generally referred to as biodeterioration and, as such, contains a judgement. For instance, the fungal spots on terylene sails do no harm for terylene is not, so far as is known, subject to biodegradation. Thus, the strength and stretch of the sail are probably unimpaired, but the stained and spotted sail is aesthetically unacceptable.

The recognition of specific microbes associated with particular types of spoilage is analogous to the recognition of a microbial agent of disease, and the process involves the use of the principles formulated by Koch. Firstly, the microbes, or groups of microbes, are always found in that situation. Secondly, they can be isolated and identified. Thirdly, they can, under controlled conditions, be re-introduced to the situation and are seen to have the same effects as previously. Lastly, they can be re-isolated and again shown to be the same microbes. These principles have often been found to be an over-simplification (for instance, they break down almost entirely in the case of virus diseases) but, nevertheless, they form a basic approach in the study of what can be considered as microbial diseases of materials. By such means, the three main groups implicated in spoilage generally, and in paints and films in particular, are the microfungi, or moulds (including yeasts), the algae, and bacteria. Protozoa and virus are of far less importance directly, but may play an important role in regulating populations in what is often a complex association or sequence of a large number of different kinds of microbes. Identification at the species level is often unnecessary, since the emphasis usually is on the role of the microbe in the spoilage process (that is, on what it does rather than what it is). Close identification, although time consuming, is often useful, however, for predictive purposes, especially when past case histories are available. Appropriate avoiding action can then be more readily designed into a product or into its method of application, storage, and so forth.

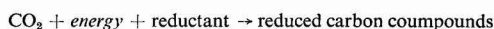
Some general biochemical principles will arise from the specific groups or species associated with any spoilage. The presence of a population of fungi, yeasts or, say, bacteria such a *Pseudomonad*, will suggest that the organisms are obtaining from the product a suitable organic source of carbon reduced more than carbon dioxide. On the other hand, the presence of algae alone, or bacteria such a *Thiobacillus*, would suggest that little organic carbon is available, and that carbon dioxide itself is being used as the carbon source, and that some other source of energy, such as sulphur or nitrate, may be available in the spoiled material.

The biochemical basis for this difference can be somewhat loosely expressed as follows. In the first case, the fungus, yeast or bacteria uses the reduced carbon source, say the fatty acid of a paint, for energy production, and at some time utilises the energy for transforming the remainder of fatty acid into the multiplicity of different carbon compounds in its cell:



That is, growth is achieved at the expense of a fatty acid. This process is referred to as chemoorganotrophy*, and

fungi, yeast and many bacteria are obligates in this respect. In the second case, energy is obtained by an oxidation process, independent of a carbon source. Thus, for a nitro-bacter, say, the situation is:



That is, biosynthesis and growth of more cells. This is the process of chemolithotrophy†. It must be stressed that for growth to occur by either process other materials must be present; for instance, there must be a source of suitable nitrogenous material, sulphur, phosphorous and trace elements, such as iron, magnesium, manganese, and these factors may limit growth even in the presence of adequate carbon.

In the case of the algae, the energy is obtained from photons due to irradiation in the visible spectrum, and the process is one of photolithotrophy. It will be appreciated readily that associations between the two groups may be formed; thus, photo or chemolithotrophy can supply reduced carbon compounds for those organisms which grow organotrophically. An example of a spoilage association, found universally on paint and other surfaces in the open, is that of a lichen, when fungus and algae grow symbiotically: the fungus grows at the expense of sugars produced by the algae, whilst the role of the fungus is thought to be that of an anchor, a water source, and a supplier of carbon dioxide. Note that in this association, say on paint surface, no chemical attack of the paint itself is necessary for growth. Spoilage may arise simply by the unsightly presence of the lichen or, more usually, the action of so-called "lichen acids" which leach out constituents of paint and may thus lead to failure of the film. Note also that the nitrite-nitrate transformation represents a change in redox potential typical of all bioenergetic processes and this in itself may lead to spoilage, particularly on metal surfaces, or possibly in or on metallised paints. To summarise this biochemical basis of the microbial spoilage of paints and other protective films quite briefly, it can be stated that the presence of microbes growing organotrophically will generally lead to biodegradation of the material due to growth at the expense of some carbon source in the formulation. Chemolithotroph activity may be associated with this, or take place quite independently when some inorganic constituent will be destroyed if the material is not exposed to sunlight. Spoilage, in both cases, can also be caused by the action of some waste product of metabolism of the microbe. The same type of activity, with the exception of phototrophy, may take place in stored paints and preservatives and, depending on the conditions and product, this can be extremely rapid and disastrous since, once started, growth, and hence chemical transformations, can proceed exponentially, according to the basic equation:

$$N_t = 2^k N_0$$

where N_t and N_0 are the numbers of cells at the end and beginning of growth respectively, and k is the exponential growth rate, which may also be expressed as the number of times the cell count doubles per unit time. Thus, faced with a spoilage problem, the question of which constituents of a paint are being used as microbial nutrients must be answered. These, in the case of lithotrophy, may be simple inorganic constituents, but in organotrophy they may be very complicated. It is not, therefore, surprising that many spoilage systems consist of a mixture of interdependent microbes, making up a complex ecosystem. These often need quite

(*†) Roughly equivalent to heterotrophy* and autotrophy†.

detailed studies for their understanding and modelling, and often stretch the present methods beyond their technical limits. Unfortunately, this also means that there is no single and simple answer to microbial problems. Solving such problems will be very much aided by fundamental studies on microbial growth, particularly by extending the studies on the regulation of growth and metabolism by both feed back and other inhibition systems and by the genetic controls of regulation during adaptation to the ever-changing environments that such associations represent.

It was implied previously that almost every known carbon compound is subject to microbial attack. This led to the idea of "microbial infallibility," an idea which has lately been defeated by man's ingenuity in the manipulation of organic chemistry.⁸ Thus there is an increasing range of products, such as synthetic polymers, used in the paint industry which are, apparently, quite stable to microbial attack; usually where microbes are found growing on them this is due to the presence of monomer impurities, fillers, or plasticising agents which can be used as carbon sources. In such cases, this does change the properties of the plastic which may become brittle or otherwise fail.⁹

It might be inferred from the foregoing discussion that the microbial spoilage of paints is always associated with growing microbes. Although this is generally so, spoilage in the absence of growth can occur and often rapidly. This is because many microbes, particularly bacteria, may continue to break down organic materials in the absence of growth, and indeed such breakdowns may be speeded up once the controls imposed on growing cells are released. Such a breakdown may be short-lived, but if accompanied by the release of cell components, such as the intracellular digestive enzymes, it may continue for a long time. An example of this is the breakdown of cellulose in canned paints by microbial enzymes released in the manufacturing process.

Besides considering the nutritional basis of spoilage in paints by microbes, those physical parameters that affect microbial growth have to be considered. Excluding sunlight, which has already been mentioned briefly and which may be considered as a nutrient, the parameters of most importance, other than the physical characteristics of the paint itself, are temperature and the water state of the system.

Although some microbes prefer to grow at about 0°C and others at temperatures as high as 80°C (and even higher), for the most part organisms are encountered which are not so restricted and which grow readily over a range 15°-45°C, usually somewhat faster at the higher temperature. In a temperature-restricted environment, say in a cold store, a narrow range of population would be expected and, moreover, this population would find it difficult to adapt to a higher temperature and would thus be replaced by a new population if the temperature were raised.

The water state of the system is of such overwhelming importance that it is difficult to understand why so few fundamental studies, especially in relation to paint surfaces, have been undertaken. In general, some free water must be available for all microbial growth. Some studies in Cardiff, Wales, on growth in nonpolar solvents, such as kerosine, suggest that water concentration may be far below that necessary for free water to appear, and that as the concentration is raised different populations of microbes appear, growing at the expense of the oxidation of hydrocarbons. This oxidation itself yields water as one of its products and the system becomes a water generator, thus allowing more growth of less restricted populations. Growth within rather

than on a paint coating will also depend on water availability. Recently, it has been shown that many polymers which form inclusion compounds (for example, polysaccharide) hold a lot of water bound by hydrogen bonding within the molecule. Whether or not this is available for microbial growth is uncertain. It is uncertain also whether the polymers in paint films hold water as inclusions. These are problems urgently needing attention, as does the question of water activity and microbial growth in nonpolar systems. Another consequence of water concentration is the effect of osmotic pressure. In general, most microbes do not control water entry, as do the higher animals and plant-life forms, but have developed walls of high tensile strength that prevents swelling and hence gross alteration in internal osmotic pressures. However, as is apparent by the preserving action of sugar in jam, osmolarity can affect microbial growth. This is unlikely to be of major importance in films, but can play a role in bulk storage.

The supply of free water by condensation, due to badly designed ventilation and to water percolation behind paint and other protective coverings, is a self-evident cause of spoilage and need not be discussed in detail. It is, however, a surprisingly common problem, especially in new housing estates, and still needs more attention paid to it, not necessarily, moreover, by the paint manufacturers who are so often asked to solve it.

Water, or rather desiccation, plays an important part in the survival of microbes, many of which can form especially resistant structures (such as spores and cysts), often in response to changes in water concentration or osmolarity.

Although much can be done to avoid microbial paint spoilage by considering the nutritional and physical requirements for microbial growth and metabolism, it is apparent from the use of, and search for, biocides, that eradication of growth is still not possible if the desired properties of the product are to be retained.

If biocides are to be used, then the ideal biocide must be of a wide spectrum of lethal or inhibitory activity; persistent (that is, it must not be leached from the film too quickly); non-lethal to man, animals and in certain situations, plants; and it should, when finally released, be ultimately biodegradable itself.

It is quite evident that there are few, if any, such biocides as yet. One of the outstanding problems with biocides for paints again concerns the water state of the system. Microbial growth occurs only when the conditions are such that water and solutes can pass into the microbial cells. Thus the biocide in paints must generally be held in a nonpolar phase yet be active in an aqueous phase. One possibility is to link biocides chemically so that in the water phase they will hydrolyse to yield active biocide at a sufficient rate to inhibit growth. Another is to orientate them at the surface so that even if they remain fixed they inhibit growth. This is believed to be the mechanism involved in the protection of the skin by cationic detergents. The problems are less severe in stored paint, but do arise if the solvent is completely nonpolar and when the microbe grows at the solvent/water interface; a similar problem arises in the development of biocides for jet fuels.¹¹

In this brief summary of the application of modern microbiology to the paint industry, the following points emerge. Infections leading to the spoilage of paint represent quite complex interactions between organisms and the paint constituents. Prevention of spoilage can be avoided by con-

sidering the basis of growth and metabolism of the infecting organisms with a view to reformulation. For instance, phosphate and nitrogen may not be necessary. If not, then growth can be inhibited by their omission. This approach, based on the understanding of growth and metabolism of microbes, should be thoroughly explored before adopting the rather empirical use of biocides.

[Received 26 January 1973]

References

1. *Genesis*, **5**, 11.
2. Hughes, D. E., "Microbes in action," 1965, University of Wales Press.
3. Stanier, R. Y., Doudoroff, M., and Adelberg, E. A., "General Microbiology," 3rd edition, 1971, London: Macmillan; Hakes, L. E., and Linton, A. M., "Microorganisms, function, form and environment," 1972, London: Arnold.
4. Hollingsworth, B. S., Eggins, H. O. W., and Allsop, D., Manchester Inst. Sci. and Tech. Symposium, 19-20 September 1972 (to be published in *JOCCA*).
5. Challenger, F. C., Higginbotton, C., and Ellis, L., *J. Chem. Soc.*, 1933, p. 95.
6. Hoffman, E., and Georgonsis, O., *JOCCA*, 1960, **43**, 779.
7. Miller, J. D. H., Aylesbury, M. T. P. (editors), "Microbial aspects of corrosion," 1971, UK.
8. Alexander, M., *Adv. Applied Microbiol.*, 1965, **7**, 35.
9. Walters, A. H., and Elphick, J. J. (editors), "Biodeterioration of materials," 1968, London: Elsevier.
10. Calley, A. G., *Proc. Biochem.*, 1967, **3** (11), 13.
11. Hill, E. C., *J. Inst. Petrol.*, 1972, **58**, 248.

Next month's issue

The Honorary Editor has accepted the following papers for publication, and these are expected to appear in the June issue:

Accelerated yellowing tests for white architectural enamels by *L. A. Hill and W. H. Hall*

The formulation of radiation curable paints by *P. G. Garrat*

Manchester Section Symposium on "Paint performance and the microbiological environment". Papers 2-5

Information Received

Touchin

Touchin Technical Laboratories announces that, in association with A. N. Fellows, BSc, microbiologist, it can now offer an independent comprehensive bio-technological service including advice on, and investigations into, the biodeterioration of materials, surfaces and coatings, identification of bacterial and fungal contamination, preservatives and microbiocides and microbial corrosion. Both site investigations and laboratory studies can be made, including development work on resistant systems and products.

Bayer introduces environment emblem



An emblem connecting Bayer AG with the environment will soon begin to appear wherever Bayer is active. A stylised leaf bearing the words "Bayer: research for a clean environment" will draw attention to the firm's intensive efforts to protect and improve the environment. The choice of a device representing nature in full health marks the firm's intention to retain its important role in the development of products and of manufacturing processes which will ease the burden on our surroundings.

Japanese paint companies buy new ICI process

ICI has licensed two major Japanese paint manufacturers to make its "Dispersymer" non-aqueous dispersion (NAD) automotive paints. They are the Kansai Paint Company and the Nippon Paint Company, both at Osaka. The most recent agreement, with Nippon, is still subject to formal approval by the Japanese government.

Kansai and Nippon supply a large proportion of the top coat paints used by the Japanese car industry.

Armour Hess moves London office

Over the last eighteen months Armour Hess Chemicals Limited has created a single head office in Harrogate by closing its Rochdale and Leeds offices.

On 31 March 1973 the London office was closed and staff moved to Harrogate. The address is Jesmond House, Victoria Avenue, Harrogate HG1 5RR.

New Readipac shade card from Fishburn

A new shade card has been issued by Fishburn Printing Ink Company to illustrate and describe its Readipac range of inks for letterpress and offset.

The eighteen colours within the range comprise the most popular shades taken

from the original Readipac colour guide and from the Fishburn Color Finder. The inks are intermiscible with one another and with the three listed blacks. An opaque white for letterpress and transparent whites for letterpress and offset are included. In addition, the card gives lightfastness and cellulose varnish ratings for each ink.

Buhler-MIAG

Buhler Brothers Ltd, Uzwil, Switzerland and MIAG, Muehlenbau and Industrie GmbH, Braunschweig, Germany announced their affiliation in September 1972, resulting from the transfer of the MIAG shares to the Buhler Group of Companies. It was decided recently that as from 16 February 1973 the UK subsidiary, Buhler Brothers (England) Ltd, would assume the sales and service activities for both Buhler and MIAG, and would operate under the new name of:

Buhler-MIAG (England) Ltd.
The Wood House, Games Road
Cockfosters, Barnet, Herts

Until the planned standardisation of the different machines in the Buhler-MIAG group is finalised, the complete manufacturing programme of Buhler and MIAG will continue.

British Decorators Association

The National Federation of Master Decorators of England and Wales has changed its name to The British Decorators Associa-

tion. This Association should not be confused with the National Federation of Master Builders, which still retains its same name.

Hamilton Hinshelwood

The Glasgow based company Arnold Hamilton Limited has changed its name to Hamilton Hinshelwood Limited. It is expected that this company, which is a member of the Beaver Group, will form close links with Hinshelwoods Limited, who were taken over by Beaver at the end of last year. Already, the majority of Hamilton's activities have been taken over by Hinshelwood's factory in Glen Park Street, Glasgow.

New Products

Portable Glossmeters

Wentworth Instruments Limited, the United Kingdom representatives of Gardner Laboratory Incorporated, have announced the availability of new design solid-state, high-performance portable glossmeters. The "Glossgard" series of portable glossmeters consists of lightweight, rugged and self-contained precision instruments for the measurement of gloss.

Five standard gloss geometries (20°, 45°, 60°, 75°, and 85°), with a practical precision of two per cent full scale, are available to cover applications in the paint, plastics, paper and ceramic industries.



Glossgard System GG-7260-A

Great-Cote concrete seal

"Great-Cote" is a solvent-based, liquid, concrete seal which penetrates into a concrete surface, and bonds with it to form a tough, hard wearing, decorative film. It will completely eliminate concrete dusting brought about by constant wearing and pitting of the surface. Moreover it is easily cleaned with light duty detergents, is resistant to oil and grease, and is water-proof. Great-Cote will withstand heavy wear without crazing or chipping, and provides a bright attractive finish. The product is marketed by Applied Chemicals Limited, Uxbridge, Middlesex.

New PJP mixing scheme

A new mixing scheme for automotive refinishing has been introduced by Pinchin Johnson Paints. Known as the "Flowline" mixing scheme, it has been designed to supersede PJP's "Doc" scheme. The tints are formulated so that, in general, no more than five are needed to make any one colour.

New surface active agents from Allied Colloids

Four new anionic surface active agents, based on sodium di-alkyl sulfosuccinate have been introduced by Allied Colloids Ltd., the Bradford speciality chemical company.

The new products, Alcopol OB, OS, OD and OX, are likely to find applications in paints, plastics and emulsion polymers.

They are general wetting agents with a high salt tolerance.

Perkin-Elmer spectrophotometer

Perkin-Elmer Limited, of Beaconsfield, Buckinghamshire, England, is expanding its range of low cost, ultra-violet/visible

spectrophotometers, the latest addition being a Model 54 digital spectrophotometer. A series of accessories, providing sample and data handling facilities, have been designed for users interested in automatic analysis.

Safflower oil from Jacobsen

Jacobsen Van Den Berg can now offer safflower oil in the UK on behalf of PVO International Incorporated. Three grades are available and are described according to NIOP regulations as follows: "crude" fraction, in 17 ton tanker loads, "non-break," also in 17 ton tanker loads, and "refined" in 450lb drums.

SCAN 500

The SCAN 500 is a new instrument to join the Joyce Loebel range of scanning microdensitometers. Previous microdensitometers have been designed primarily for measuring optical density of specimens in transmission. The SCAN 500 is specifically designed to measure optical density in reflectance with high resolution. The output is in the form of a graphical trace—reflected density plotted against position—and an integrator is fitted.

Literature**Polymers brochure from Unilever**

International technology in the field of synthetic resins is the theme of a new brochure produced by Unilever polymers division. The brochure describes the wide range of products manufactured by international companies in the division for application in many different industries.

Manufacturing companies in the division co-ordinate technological resources internationally under the name "Urachem" and there is a constant exchange of informa-

tion between the laboratories and manufacturing units. The "Urachem" companies comprise: Synthetic Resins Ltd. and Vinyl Products Ltd. in the UK; Scado BV, with plants in Holland, Germany and Sweden; Sheby SA in France; and Stabilitat SpA in Italy.

Common Market Report

A pamphlet "Common Market Report" has been launched by Scope Publications Limited. Prepared by a team of specialist business journalists, it provides a weekly summary of commercial, industrial, financial, statistical, legal and political news from and about the Common Market.

Conferences, courses, symposia**FSPT Annual Meeting and paint industries Convention**

The Annual Meeting and Convention of the Federation of Societies for Paint Technology will be held at the Conrad Hilton Hotel, Chicago, Illinois, from 14 to 17 November. The Chicago Society for Paint Technology, whose President is Mr K. H. Williams of Sherwin Williams Company, will be the host organisation. Attendance, based on figures for the last few years, is expected to be approximately five thousand.

Dispersion of pigments

From 9 to 13 July Kent State University will present a short course on "Dispersion of pigments and resins in organic and aqueous media." Instructional fee is \$190.00; breakfast, lunch and accommodation are obtainable for \$45.00 for the session. Details are available from Carl J. Knauss, Chemistry Department, Kent State University, Kent, Ohio 44242.

Auckland and Wellington



Delegates at the Wairakei Conference visiting the boiling coloured mud pools in Geysir Valley

Annual Conference

This year's annual conference, the tenth, was held at the Wairakei hotel once again. The Wellington Section organised the conference and over one hundred and sixty delegates and wives attended.

The business programme began at the combined committee meeting of the Auckland and Wellington Sections where members discussed the response to the proposed Professional Grade classifications. The Auckland Chairman, Mr O. E. Rutledge, reported on discussions with the Paint Manufacturers Association concerning joint seminars to be organised with the intention of improving liaison between the two organisations.

A cocktail hour on Friday night provided an opportunity for Members from both Sections to renew friendships and to meet new members of the industry. This was followed by an informal gathering in the Log Cabin where the Wellington Section Chairman, Mr M. D. Thompson, introduced guest speakers and the organising committee.

The technical session began on Saturday morning following the official opening by the Wellington Chairman, Mr B. W. Potter, from the Wellington Polytechnic, presented the first address and dealt with "Technical education and vocational training." The role of Technical Institutes in New Zealand's educational system was discussed, highlighting the flexibility required in order to meet industry's requirements.

A paper on the very interesting subject of "Polymeric beads: a new class of pigments" was delivered by Mr F. J. Lubbock of Dulux Australia Ltd. Mr Lubbock provided information on the development and applications of vesiculated polymer bead dispersions as pigments in latex systems.

Mr R. P. Colwell, of Ford New Zealand, spoke on "Electroplating" with emphasis on the techniques and problems of the adoption of this form of surface coating for components used in car assembly. He outlined the modern electrocoat system being planned for the new Ford plant in New Zealand.

The technical session began on Sunday morning with a very topical talk on the subject of some aspects of pollution

from Mr I. R. C. McDonald of the DSIR. The current state of pollution both in New Zealand and overseas was covered, together with legislation aimed at curbing further deterioration. Mr R. D. Bell, of Australian Titan Products, presented a paper on "Some factors affecting the opacity, colour and gloss of thermosetting powder coating."

The final paper of the session was given by Dr H. C. Sutton, of the DSIR, concerning the "Radiation Curing of Surface Coating." Laboratory evaluation had indicated that fast processing, with acceptable temperature control, could be achieved using high voltage radiation equipment. Problems of colour variation were experienced, but the technique might well prove to have commercial applications.

Members of the two Sections then worked on the preparation of a special feature about the conference for publication in the Journal "Chemistry and Industry in New Zealand". The paper on polymer beads was published in full in that Journal, with briefer accounts of the other papers. A membership list and a comprehensive "Suppliers guide" were featured in addition, together with an editorial by the New Zealand Vice-President of OCCA, Mr T. Whitfield, on Professional Grade Membership.

Professional Grade

Late in 1972, the first list of Members to be admitted to the new Professional Grades was received. Both the Auckland and Wellington Sections had been advised of Council's decisions, and, at separate ceremonies in both centres, the diplomas were presented to four Fellows and twelve Associates.

The Members honoured in this way were as follows. Fellows in the Technology of Surface Coating (FTSC)—D. G. Caldwell, T. W. Slinn, D. M. Taylor and T. Whitfield; Associates (ASTC)—F. J. Aitken-Smith, J. F. Beachen, R. S. Bluck, J. N. Eltringham, C. P. Evans, B. J. Greenall, R. A. P. Hodgkiss, A. MacDonald, R. A. Ness, P. F. Sharp, A. H. Sowerby and R. A. White.

One of the Vice-Presidents of the Association, Mr T. Whitfield, was the only member of the Auckland Section to qualify as a Fellow. He received his diploma from Mr S. C. Browning, President of the Paint Manufacturers' Federation, at the annual Ladies' Night social.

The Wellington Section presented the Fellowship and Associateship diplomas at a general meeting which was addressed by Mr H. A. Newnham, a former Treasurer and Chairman of the London Section and a past Vice-President of the Association. Mr Newnham toured New Zealand last year to deliver a paper about the protection of structural steelwork which emphasised the growing use of elemental lead as a pigment in anti-corrosive paints.

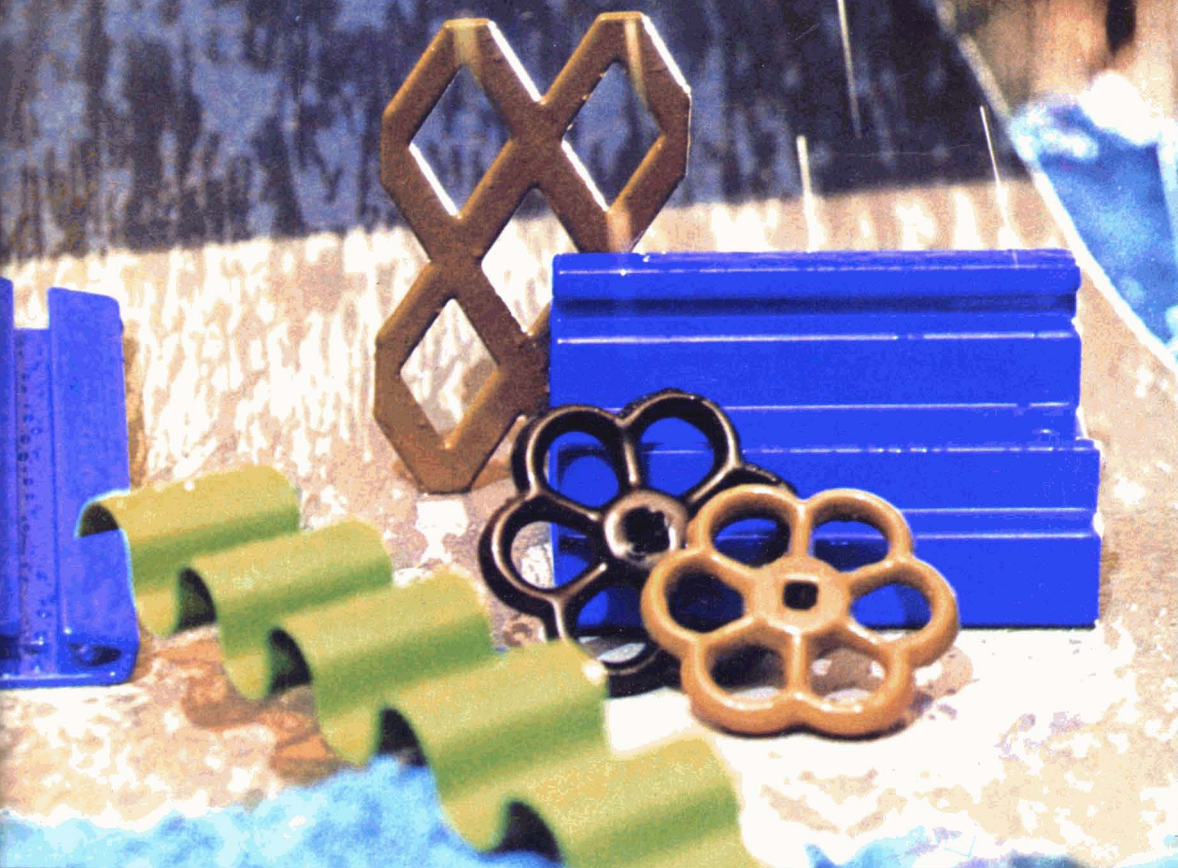
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From left to right: Mr T. Whitfield, Mr S. C. Browning and Mr O. E. Rutledge

Basic products and auxiliaries for surface protection

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CHEMICALS



For Coil Coating:

DYNAPOL® L

provides coatings eminently suitable for stamping and deep-drawing.

High-molecular, linear, saturated polyesters containing terephthalic acid.

DYNAPOL L types are suitable for the production of coatings having high stamping, deep-drawing and weather-resistant properties and which, in addition to having good adhesive strength, are scratch and impact resistant, and neither yellow nor chalk. DYNAPOL L types are best used for coil-coating. Coating surfaces can have a finish ranging from high gloss to matt as desired. Pigmentations of all shades are possible.

Main fields of use:

- Packaging,
- Packaging for foodstuffs (including sterilizable packaging),
- Fascia sections,
- Appliances

DYNAPOL L types are also suitable for single or double coat roller application on aluminium, steel or galvanized iron.

Technical data:

Sheen (Gardner)	max. 95 — 100 % approx.
Pencil hardness	max. H
Impact test	180 in. lbs.
T bend	max. depending on type up to T = O
Salt spray test	depending on type 400—1000 hours, unaffected
Kesternich test	Unaffected after 15—20 cycles

These details conform to the test standards of the ECCA (European Coil-Coating Association, Brussels).

PVF

Polyvinylfluoride
for long-life coatings

Wherever particularly long-life and outstanding weather resistance at both high and low temperatures are called for, PVF coatings are ideal. For they are corrosion proof, are resistant to chemicals and have excellent shaping properties.

PVF is, among other things, particularly suitable for coil-coating. Surface finishes may range from a silky gloss to matt as desired; they discourage dirt and the neither yellow nor chalk. Many shades are possible.

PVF should be used where the usual coatings afford insufficient protection against corrosion.

Main fields of use:

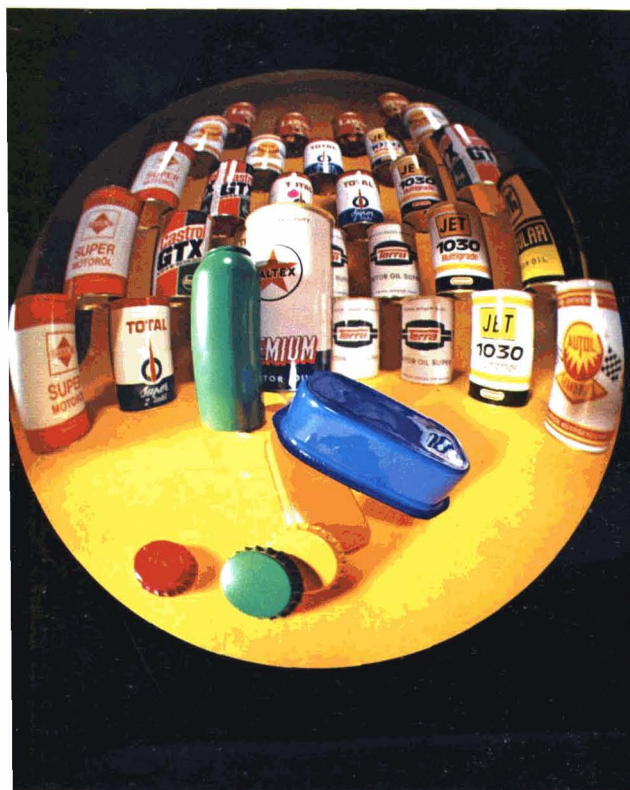
- Building units where industrial pollution is severe,
- Facings for industrial plant,
- Prefabricated building sections.

PVF is suitable for single or double coat roller application on aluminium, steel or galvanized iron.

Technical data:

Sheen (Gardner)	max. 80 % approx.
Pencil hardness	F — H
Impact test	180 in. lbs.
T bend	OT
Salt spray test	Unaffected after more than 1000 hours
Kesternich test	Unaffected after 30 cycles
Friction constant	0.136

These details conform to the test standards of the ECCA



For electrostatic powder-coating and whirl-sintering:

DYNAPOL® P

HARD PVC COATING POWDER

Saturated polyesters containing terephthalic acid for the production of powders both for electrostatic powder-coating and for whirl-sintering.

Powders with a DYNAPOL P base are suitable for coating all metals.

By virtue of their special properties (e. g. high resistance to weathering, yellowing and chalking) such coatings are equally suitable for external use.

Main fields of use:

- Metal furniture,
- Metal window frames,
- Garden furniture,
- Apparatus,
- Metal facings,
- Tubing,
- Household appliances.

Technical data:

Thickness of single coating 50 — 70 μ

Erichsen test 8 — 10 mm approx.

Pendulum test (depending on type) 175 — 185 sec. as per DIN 53 157

Indentation hardness 75 — 120 approx. (depending on type)

Sheen as per Lange. Angle of incidence 45°

80 — 115 (depending on type)

Adhesive strength: very good

Kesternich test up to 30 cycles (depending on type)

A plasticizer-free polyvinyl chloride compound in powder form for whirl-sintering and powder-coating.

Advantages:

- Surface toughness
- Weather resistance
- Enduring gloss
- Chemical resistance
- No tendency to brittleness

Advantages when processing:

- Pleasant to work with: no offensive odours due to plasticizer vapours,
- High sheen surfaces within seconds,
- No post-treatment necessary.

Can be used:

- In the streets: Sign boards, posts for traffic signs, street lighting,
- In industry: Housings, mountings, sectional units, tubing,
- In the building world: Profiles, fittings, fascias,
- In the household: Appliances.

Technical data:

Coating thickness depending on method of application 80 — 400 μ

Erichsen test 8 — 11 mm approx.

Pendulum test 170 — 185 sec. approx.

Sheen as per Lange. Angle of incidence 45°

120 — 140 %

Kesternich test. Unaffected after 40 cycles

Adhesive strength: with bonding agent, very good



For protection against corrosion even at high temperatures:

DYNASIL[®] H 500

A binder having a silicic acid ester base for inorganic zinc dust coatings. When it is a question of protecting iron and steel from corrosion, even at temperatures up to 400° C, zinc dust paints having DYNASIL as a binder serve the purpose admirably.

Zinc dust paints with a DYNASIL base are particularly suitable for industrial processing. They can be welded over; they can be applied either by air or airless spraying, brush or roller, and can be used alone as a one-coat process or serve as a foundation for covering with any of the usual colouring methods.

Main fields of use:

- Shipbuilding,
- Industrial plant construction,
- Power plant construction,
- Bridge building,
- Large steel structures,
- Mass produced building units.

Test results of DYNASIL based zinc dust coatings:
Salt spray test (DIN 50 021) Unaffected after 1000 hours.
Adhesive strength, grating as per DIN 53 151
Grating value 0.

Temperature loading resistance: Permanent load, maximum 400° C. Short term load, maximum 600° C



Dynamit Nobel
Aktiengesellschaft
Vertrieb Chemikalien
M 5

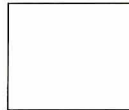
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Postfach 80 02 69

Company name: _____

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Dynamit Nobel
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Vertrieb Chemikalien
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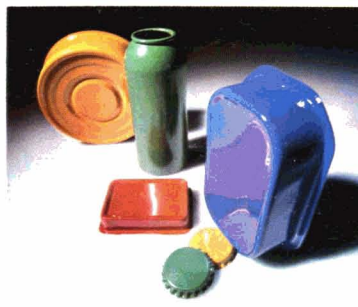
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- PVF
- DYNAPOL® P
- Hard PVC coating powder
- DYNASIL® H 500

samples of:



DYNAPOL L



PVF



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Please send:
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- DYNAPOL® L
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**HARD PVC
COATING POWDER**



DYNASIL H 500

Other tried and tested products for use in surface protection

Paint and varnish resins

HYDROXYESTER RESINS

Thermo-setting, branched polyester resins containing hydroxyl groups for coil-coating and conventional painting techniques and having excellent stamping and deep-drawing properties.

ICDAL®

Alkyd resins for making high-grade commercial and artists' paints, stove enamels and nitro cellulose combination lacquers.

Electrically insulating paint resins

ICDAL® TE/TI

Ester and esterimide resins, wire lacquer resins for producing insulated leads resistant to permanent temperature loads, resins for insulating impregnating lacquers.

Titanic acid esters

Reactive cross-linking agents for paint and lacquer resins, binders for high temperature lacquers.

Nitrocellulose

COLLODION COTTON
PLASTICIZED NITROCELLULOSE

Vanadyl alcoholates

Catalysts for polyurethane coatings with variable adjustment of setting times.

Plasticizers

WITAMOL®

for use with various lacquers. Special plasticizer for heat-sealing and non-toxic aluminium coatings.

Chlorinated paraffins

WITACLOR®

For making lacquers flame resistant.
For producing fascia paints.

Chlorophenoles

WITOPHEN®

Oil and dispersion paint additive for preventing fungus formation and decomposition during storage.
For the production of fungus-resistant wall paints.

Chlorinated hydrocarbons

DYNATRI® LQ, trichlorethylene. Solvents for paint and varnish resins for hot or cold dip coating processes

For the de-greasing of metals:

DYNAPER® perchloroethylene

DYNATRI® trichlorethylene

MECLORAN® 1.1.1. tri-ethane chloride

MECLORAN® D 1.1.1. tri-ethane chloride (vapour type)

For the de-greasing of light metals:

DYNATRI® LM trichlorethylene.

Special hard aggregates

TROCOR®

Electro-corundum as an aggregate for high-stress concrete pavings and for abrasive coatings having a synthetic resin base.

Blast mediums not conducive to silicosis:

REWAGIT®

Standard corundum, economical in use, low in dust, rustproof. For the cleaning or roughening of material surfaces.

DYNAMULLIT® — balls

for the matting and densifying of material surfaces.

Please contact us if you have problems or require further information. We shall be pleased to give you the benefit of our experience.

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Vertrieb Chemikalien M5
D-5 Köln 80, Wiener Platz 4, W-Germany
Telephone (0221) 82901, Telex 8873521

From the beginning of march 1973
our new address will be
D-5210 Troisdorf-Oberlar, Haberstraße 2,
Telephone (02241) 180-1, Telex 889401

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Dynamit Nobel
CHEMICALS

Manchester

Technological forecasting

Fifty-five members and guests attended at the Literary and Philosophical Society, George Street, Manchester on Friday 9 February to hear Mr H. Jones give a paper entitled "Technological forecasting and its potential in the surface coating industries."

Mr Jones started by defining the four elements of forecasting; qualitative, quantitative, time, probability.

The qualitative element was the narrative or "scene setting" phase. This would be followed by the quantitative when numbers, quantities, percentage of market and so forth, would be defined.

Time would define "imminence" in years, and probability the chance of success, expressed as a percentage.

The various techniques and methods (such as Relevance Trees, Delphi, Time Series, "S" Envelopes Curves, Cross Impact, etc.) were discussed briefly in the context of the four elements, showing how they referred to one or more of the elements.

Particular reference was made to Time Series in the quantitative element (demonstrated by a Time Series showing replacement of other white pigments by titanium dioxide), and to morphology, (shown as a two dimensional matrix in which the required properties of a development are listed vertically whilst the horizontal list consists of the ways in which these properties can be obtained). Study of such a matrix can yield new ideas by combinations of the various individual methods.

Considerable time was devoted to the Delphi method, which depends on fixing three of the four elements, usually qualitative, quantitative and probability and then asking a relatively large number of "experts" to forecast time. This enables a "most probable time" to be forecast and, taken over a number of projects, gives a priority list.

The discussion period was mainly concerned with questions clarifying points on the various methods, particular interest being shown in the Delphi method.

Dr F. M. Smith proposed the vote of thanks which was received with more than usual enthusiasm.

A.McW.

Student lecture

About thirty-five Members and guests attended the student meeting held at the Literary and Philosophical Society, 36 George Street, Manchester on Wednesday 14 February. Mr D. Pountain, of the Walpamur Company, gave a talk entitled "Stoving finishes."

The Speaker gave a good account of the various stoving resins available, covering alkyd amino, epoxy, acrylic vinyl and polyester based coatings. He went on to describe typical stoving condition for the various types and gave examples of the end uses for the systems. Some time was allocated for application methods, and for future trends.

Following a fruitful discussion period the vote of thanks was received with marked enthusiasm.

A.McW.

Midlands

Furnace blacks

A meeting was held at the Birmingham Chamber of Commerce on Friday 17 November 1972 with the Section Chairman, Mr A. S. Gay in the chair. An audience of forty-one Members and guests listened to a paper being presented by Dr N. Scott, pigment service manager of Cabot Carbon Ltd., concerning high-colour furnace blacks, prepared by a new technology, to replace channel blacks.

Channel blacks produced by direct impingement of natural gas flames had been, for many years, the basis of high-colour blacks giving low oil absorption and simple structure. Furnace blacks had suffered from the presence of large aggregates which gave rise to complex structure and poor "jetness" of colour. Channel black production was now to be curtailed as it was a wasteful process creating much atmospheric pollution (with black air-borne deposits up to fifty miles from the plant) and as the cost of natural gas was increasing.

Cabot's new technology involved a furnace process, with impingement of flames from the combustion of cheap fuel

oil. The plant was in full compliance with anti-pollution requirements, and was producing medium colour blacks to a new quality. The quantity of oxygen was carefully controlled and additives used to eliminate the possibility of the surface becoming basic, which it has a tendency to do, and to prevent the formation of large agglomerates. The product was, therefore, capable of producing low oil absorption and low structure blacks of a medium jetness. It was admitted that the high jetness of the best channel blacks had not so far been equalled.

These furnace blacks should be treated as new materials, and changes in technique might be necessary to obtain the full advantages. Mill charges should be calculated on the basis of equal viscosity (which would, in general, involve the use of a ten per cent greater weight loading with the new pigments). Similarly, the polarity of the medium should, in general, be higher, and the choice of dispersion agents might require re-investigation. After a discussion period, which largely centred on the probable production difficulties, a vote of thanks was proposed by Mr D. Kimber, and the Chairman closed the meeting.

R.J.K.

Newcastle

The evolution of alkyd resins

A meeting was held on Thursday 1 March at the Royal Turks Head Hotel when Mr T. I. Price presented a paper entitled "The evolution of alkyd resins."

This paper covered a long period of history, starting with the initial development of alkyds and including such topics as air drying, nitrocellulose and stoving finishes. In addition, the speaker mentioned more modern systems including polyamides and metallic additives for achieving thixotropy, styrenated and acrylated polymers for rapid drying, and

silicones for exterior durability.

The talk was concluded with Mr Price indicating the possible impact of environmental pollution, which might possibly lead to a greater use of powder coatings and to the development of a commercially acceptable water soluble system.

After the speaker had faced a barrage of questions, a vote of thanks was proposed by the Chairman, Mr A. A. Duell.

F.H.

Scottish

Eastern Branch

Adhesives

The third meeting of the current session took the form of a joint meeting with the BPBMA in the Carlton Hotel, Edinburgh on Wednesday 20 December. Mr D. L. C. Childs, of Harlow Chemical Co. Limited, spoke on adhesives for paper and board in packaging.

Mr Childs started by reviewing the types of adhesives currently in use.

Inorganic types: bitumastic and sodium silicate formed the basis of many low cost packaging adhesives for use in corrugation and tube winding. They had good bond strength and rigidity.

Natural organic adhesives: casein was used as a label adhesive and, combined with neoprene, for aluminium foil lamination. Starch/dextrine mixtures were the major adhesives used in corrugation.

Synthetic organic types: polyvinyl acetate was the most important adhesive in this class, and was the nearest material to a universal adhesive giving good adhesion in a wide range of applications, coupled with fast drying when compared with conventional adhesives. Polyvinyl alcohol was growing

in popularity and should be the cheapest synthetic water soluble polymer available in due course.

Hot melt types: the two major advantages of hot melts were firstly speed, and secondly that one hundred per cent adhesive could be used. The best types were based on ethylene/vinyl acetate co-polymers. A cheaper alternative was based on polyvinyl acetate but this suffered from degradation and long term lack of adhesion.

Mr Childs continued by describing the various methods of polymerisation. Emulsion polymerisation of polyvinyl acetate accounted for ninety per cent of the polymerisations carried out commercially. Mass polymerisation was used for solids (hot melts). Solution polymerisation was used to make polyvinyl alcohols.

Film formation of emulsions was then described. These set by the removal of water, which allows the particles to coalesce if the temperature is above the minimum film forming temperature (MFT) of the polymer. Finally, Mr Childs indicated some ideas for the future, including new polymer types and the use of radio frequency drying, which could allow a polyvinyl acetate emulsion to be processed at speeds comparable to those used with hot melts.

J.H.S.

West Riding

Whiteness

A joint meeting with the Northern Colour Group was held on Wednesday 21 February at Leeds University, when Mr Blakey and Dr Langdon, of British Titan Products Co. Ltd., presented two papers on the subject of whiteness.

Mr Blakey was concerned with the practical aspects of whiteness. After developing the concept of white as a comparative and relative term, particularly dependent upon the source of illumination, he commented on the standards available for comparison. Magnesium oxide and carbonate were difficult to standardise. Most manufacturers developed their own standards, which were different for, for example, vitreous tiles and photographic paper.

Many assessments were now made by colour meters, and it was preferable to define whiteness by a single number. Many scales had been devised, depending upon the materials being examined: the Y value (luminance) for flour, where brightness is regarded as synonymous with whiteness, whereas blue light reflectance was preferred for paper.

A colour index used for titanium oxides gave a function of the difference between red and blue reflectances, perfect whites having a zero index.

Improving whiteness by the addition a fluorescent material must be noted when colorimeters are used for standardisation, since the ultra-violet illumination of the white can be enough

to alter markedly the grading. Personal choice could be exemplified by regional bias, "good" whites being distinctly blue in Europe, but "cold" in the UK, where creams were described as "warm" and were more acceptable in some circumstances.

Both anatase and rutile had sharp absorption edges, just in the visible violet region of the spectrum. Both oxides absorb strongly in the 3000-4000 Å region, and this absorption activated fluorescent brightening agents. Consequently, these agents were useless in highly pigmented media, such as paints. Where pigmentation was less fluorescent bluing became possible.

Translucency of plastics and textiles was yet another factor to be considered during the grading of whiteness. When unscattered radiation was excluded, thin films appeared to be much bluer than thick films because there was increased red scatter due to aggregated pigment in the thick film.

During the discussion, Mr Blakey said that he used the whiteness index (Red-Blue)/(Green) expressed as a percentage of the magnesium oxide value. A luminance value should be included, otherwise the index refers to a series of greys.

Dr Langdon gave an account of the historical concept of whiteness, referring to its significance in mythological and dramatic literature.

R.A.C.

**Come and see
our novelties
at »OCCA 25«
London
may, 21st to
24th 1973
stand 10**

VEBA-CHEMIE AG will be showing diamines (IPD, TMD), polyamides, special acid anhydrides (PMDA, HHPA, MTHPA, MHHPA), diisocyanates (IPDI, TMDI) and newly developed derivatives for the following applications:

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powder spraying (EPS)**

**Polyurethane powder coatings
Epoxy powder coatings
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Spray painting

One component paints

moisture curing polyurethane systems
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Polyurethane systems
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two component casting resin systems

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floor coatings
sealing compounds
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Coating and finishing

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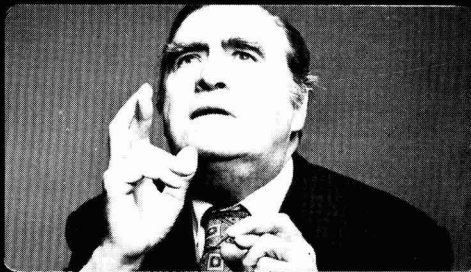
UK Representative:

Industria (Chemical Services) Ltd., Marbaix House, Bessemer Rd.
Basingstoke, Hampshire, RG21 3NT, Tel.: Basingstoke (0256) 61881-3

If you're using flammable liquids with a flashpoint below 90°F what are you going to do about June 21, 1973?



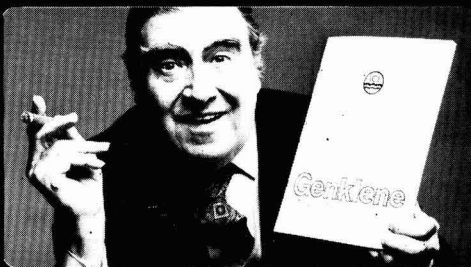
Close down the plant and emigrate?



Keep your fingers crossed and carry on as if nothing has happened



Build a bund wall, trundle your solvent tanks outside, remove all sources of ignition, and do all that's necessary to comply with the new "Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972"—effective from June 21, 1973?



Find out —today—how it may be possible to avoid all the extra expense and inconvenience by changing to 'Genklene' or to formulations containing this ICI non-flammable solvent.

ICI have produced a special new brochure called "Guidelines to Users of Solvents and Solvent-Based Formulations". It clearly explains the complexities of the new regulations, and shows how it is possible not only to meet them without disruption, but also to benefit by increased safety, efficiency and economy, by using 'Genklene'—the non-flammable low-toxicity solvent. And it invites you to make full use of the ICI Solvents Advisory Service.

Send for your free copy—today!



Genklene

the safer, non-flammable solvent

To ICI Mond Division, Solvents Advisory Service,
PO Box 19, Runcorn, Cheshire, WA7 4QF.

A copy of the new Genklene brochure, please

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Position _____

Company _____

Address _____

Phone _____



25th Technical Exhibition

21-24 May 1973
Empire Hall,
Olympia,
London

PREVIEW

103 Stands at the Silver Jubilee Exhibition

Over 150 companies on over 100 stands from the United Kingdom and eleven overseas countries (Australia, Belgium, Finland, France, Germany, Holland, Italy, Norway, Sweden, Switzerland and the USA) will be exhibiting the latest developments in the paint, printing ink, colour and allied industries at OCCA-25 (the Silver Jubilee) Exhibition of this Association at the Empire Hall, Olympia, London, from 21 to 24 May 1973. Of the exhibitors 13 have never shown at an OCCA Exhibition before and 32 more were not present at the 1972 Exhibition.

Represented in the Exhibition—as shown in graphic form later in this Preview—are manufacturers of resins, dyestuffs, pigments, solvents, plant and laboratory equipment, instruments, extenders, additives, oils and other miscellaneous items.

Aim of the Exhibition

The aim of the Exhibition has always been the presentation of technical advances in those industries supplying the Paint, Varnish, Printing Ink, Colour, Linoleum and other allied industries. The technical advances may relate to new products, new knowledge relating to existing products and their uses, or in suitable cases, existing knowledge which is not generally available in the consuming industries.

The Committee stipulates that exhibitors present a technical theme—that is display in a technical manner the technical developments in raw materials, plant or apparatus illustrated by experimental evidence. It is stipulated that a technically or scientifically trained person, who has full knowledge of the products displayed, is available on the stand throughout the official hours of opening.

Official Guide

Copies of the Official Guide have been despatched to all members of the Association, in the UK and abroad, to chemists and technologists in Europe, to technical colleges, to embassies and chambers of commerce and, through the courtesy of the trade associations, to companies in the paint, printing ink and pigment industries in the UK. Any intending visitor may obtain a copy of the Official Guide, without charge, from the Association's offices. (Telex: 922670 OCCA Wembley; Telephone: 01-908 1086).

Information Leaflets

Also available is a leaflet which gives information in six languages (French, German, Italian, Spanish, Russian and English) and copies of this have been sent separately to many paint and printing ink manufacturers in Europe and other countries. These are also available to intending visitors, and will be despatched without charge upon application to the Association.

Considerable interest has been aroused in the circulation of these leaflets in journals serving industries related to the surface coatings industries; large numbers of cards requesting copies of the Official Guide have already been received at the Association's offices from intending visitors from 35 overseas countries.

Visits

Much interest has been aroused by the suggestion that Sections of the Association in the UK should arrange coach parties, on the lines of works visits, to the Exhibition, since this would afford a much cheaper form of travel for many of the younger Members. Non-members will be able to take advantage of this facility if there were places available, and those wishing to have further information on this facility should write to the Association's offices as soon as possible, in order that they may be put into contact with the Section Secretary nearest to their place of residence.

Hotel accommodation

Details of accommodation being offered by the Grand Metropolitan Hotels for those attending the Exhibition will be included in a leaflet to be inserted in each copy of the Official Guide being sent overseas.

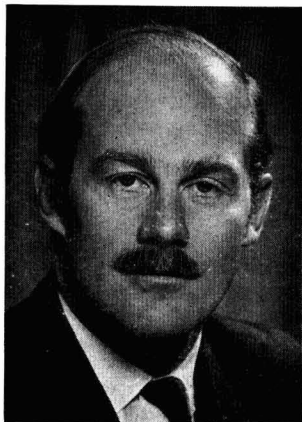
Travel

The Underground train service will operate at 10- to 15-minute intervals to Olympia from Earls Court (District and Piccadilly lines), the first train leaving Earls Court at 09.00 and the last train leaving Olympia at 19.00 hours. Olympia is situated

within easy access of West End hotels, which is particularly welcomed by overseas visitors, always prominent at OCCA Exhibitions, nearly 40 overseas countries being represented in the Visitors' Book at previous Exhibitions.

Exhibition Dinner

On the occasion of the Silver Jubilee Exhibition, the Committee has decided to hold a Dinner on the opening day, instead of the usual luncheon. It is felt that this arrangement will be of particular benefit to those exhibitors who have been unable to attend the Luncheon in previous years as they have been engaged in completing their stands. The Dinner will commence at 7.30 p.m. (with a reception at 7 p.m.). Informal dress (lounge suits) will be worn.



Lord Limerick

As already reported, Lord Limerick, Parliamentary Under Secretary to the Department of Trade & Industry, has accepted the Committee's invitation to be the Guest of Honour at the Exhibition Dinner which will be held at the Savoy Hotel, London, WC2 on 21 May, and to reply to the Address of Welcome by the President. Educated at Eton and New College, Oxford, Lord Limerick was an executive director of the merchant bankers Kleinwort, Benson Ltd., having joined the company shortly after qualifying as a chartered accountant. He has a great interest in overseas trade and was concerned with the Middle East and Australasian activities of Kleinwort Benson, as well as having been a member of the Overseas and Middle East and North African committees of the London Chamber of Commerce, prior to his appointment to the DTI in April 1972.

Principal officers of other scientific bodies, industrial research associations and organisations representing both suppliers and consumers have accepted invitations to attend. A form of application for tickets at £6.50 (plus 10 per cent VAT) each was enclosed in each copy of the Official Guide; further copies may be obtained from the Association's offices.

Admission

There will be no charge for admission to the Exhibition and, in order to assist the increasing number of both overseas visitors and exhibiting companies, interpreters will again be in attendance. Amongst the facilities available at the Empire Hall is the Empire Restaurant (with luncheon facilities) and two licensed buffets. A special bar is available for exhibitors. Escalators to and from the first floor will be operating throughout the Exhibition.

On this occasion a special visitors' admission ticket is being included in each copy of the Official Guide. Visitors should complete the reverse side of the form and hand it in to the commissionnaires at the entrance to the Hall. Further copies will be available at the Hall and all visitors are asked to co-operate in this manner.

Banking and Postal Services

National Westminster Bank Limited has been allocated Stand 17 where full facilities will be available, including the cashing of cheques and receipts of credit, and the encashment of foreign drafts and notes, travellers' cheques and letters of credit. Credits for the cashing of cheques should

News of Exhibitors

Since the list of exhibitors was last published in the February issue of this *Journal*, further space has been allocated to the following companies and entries are included in the *Official Guide*:

AB Metall & Bergproduktur

Anderman & Co. Ltd.

Fischer Instrumentation (GB) Ltd.

Instrumental Colour Systems Ltd.

Kingsley & Keith Ltd. (Olin)

Kingsley & Keith Ltd. (Sherwin Williams)

A. Strazdins Pty. Ltd.

A. P. V. Osborne Ltd. regretfully had to withdraw at the last moment from Stand 20, but the company hopes very much to be exhibiting next year. This Stand has now been allocated to the following company (whose exhibits are also described below):

Rank Precision Industries Ltd.

Microwave Instruments Walton Road, Ware, Herts.

Stand 20

Rank Precision Industries introduce the *Neotec* range of tristimulus colorimeters at the OCCA Jubilee Exhibition. On show will be the *Colormate* and *Ducolor* ranges of instruments, and the *Trucolor* which appears in public for the first time.

Incorporating the latest solid state circuitry and both CIE and colour difference formulae, these instruments have been designed for easy and accurate use by shift staff to bring quality control to the mill floor. Details of on line applications will be available.

be established at the West Kensington Branch of National Westminster Bank Limited, 85 Hammersmith Road, London, W14, through visitors' and exhibitors' own bankers.

A Post Office Self-Service Suite will be available in the Great Hall for the sale of postage stamps and letter cards. A postbox will also be provided and collections will be made at intervals during the hours of opening. Public telephones are situated by the escalators.

Technical Education

As in previous years, a Stand will be devoted to Technical Education, and invitations have been extended to schools to send parties of senior science students to the Exhibition on the mornings of 22, 23 and 24 May, when they will be given a short introductory lecture by Members of the Association in a separate lecture room before visiting the Exhibition. The Technical Education Stand will be staffed by representatives from the Association, technical colleges and trade associations, and details will be shown not only of courses available in the technology of the industries but also of the optional professional grade recently introduced by the

Since the printing of the *Official Guide*, several exhibitors have announced news items, both regarding their stand and on matters of a more general nature. Latest information is given below.

Cabot Carbon Limited

Stand 79

In addition to the new furnace blacks which were introduced by Cabot at last year's OCCA Exhibition, Cabot Carbon Limited and Cabot Europa are showing a new high quality oil furnace black on their stand at the 1973 Exhibition.

Cabot's new furnace black is *Monarch 880*, a high structure medium colour black, which has a very fine particle size, excellent masstone strength, and a very high tinting strength and blue tone combined with good dispersability. The main fields of application for *Monarch 880* are in plasticiser dispersions, pvc spread coatings, or direct compounding into plastics at low loadings.

D. H. Industries Limited

Stand 1

The following items will be featured in addition to those already mentioned in the *Exhibition Guide*.

1. An AMK/Ross motionless mixer, coupled

to a motorised metering pump unit, will be demonstrated under working conditions.

Information Centre and Overseas Visitors

The OCCA Information Centre (Stand 33) is placed opposite the main entrance with the Interpreters (Stand 32) on one side and the Technical Education Stand (Stand 34) on the other. In front of the Information Centre is one of the three seating areas which are a special feature of this Exhibition, allowing visitors an opportunity to read literature from the Stands and write notes at ease. Many overseas visitors find it convenient to meet their friends at the Information Centre and the OCCA staff and the interpreters will be only too pleased to assist them in this way. The use of the public address system to find visitors is restricted to one announcement each hour (on the hour) and those wishing to use this service should give in the name of the visitor(s) concerned to the OCCA staff and make a point of being at the Information Centre when the announcement is broadcast. Overseas visitors are particularly requested to sign the special Visitors' Book at the Information Centre.

to a motorised metering pump unit, will be demonstrated under working conditions.

2. In addition to the *Centrimill 50* and 250 litre machines, a 100 litre model, complete with rapid jet stream solvent washing device and hydraulic lid lifting gear, will be shown in operation.

3. The Sussmeyer totally enclosed, mechanically sealed, sand mill will have a new screen rupture device fitted. This ensures "cut-out" if there is a pressure build up in a secondary screen, indicating that the primary screen is ruptured.

Durham Raw Materials Limited

Stand 18

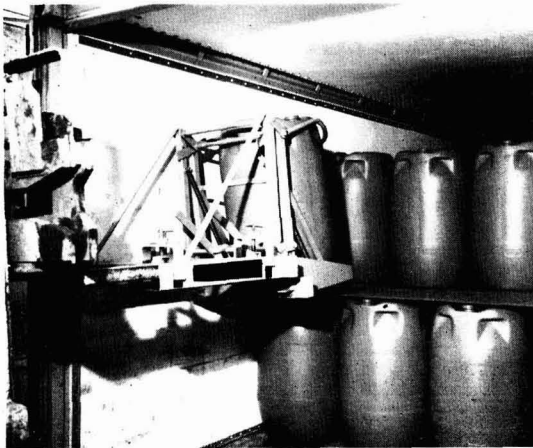
The company regrets to announce that it is unable to exhibit the *Cowles* hydraulic dissolver at this year's OCCA Exhibition as was originally stated in the Official Guide. The machine is being replaced by one of a new range of mechanical high-speed dissolvers.



The interior of an AMK/Ross motionless mixer

Eastman Chemical International
Stand 68

Video-tape presentations on Eastman techniques will be seen by visitors to the company's stand at OCCA-25. Subjects will include TMPD alkyds, the mechanics of spray drying, the formulation and properties of powder coatings, the synthesis and properties of CHDM glycol alkyds, the use of epolene in printing inks, CAB modified urethane coatings, and the use of CAB as an additive.



The handling device shown is one of several developed by Bowater for the speedy, safe and economic handling of the Bowater Mauser polyethylene drums

Stand telephone numbers:

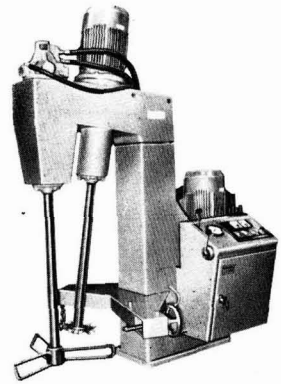
The following stand telephone numbers have been allocated since the printing of the Official Guide:

Stand	Exhibitor	Stand telephone number
53	Bowater Industrial Packaging Limited	01-371 5619
14	Degussa	01-371 8433
96	Elcometer Instruments Limited	01-401 6097
81	Imperial Chemical Industries Limited	01-401 6070
100	Kingsley & Keith Limited (Olin)	01-371 8431
103	Kingsley & Keith Limited (Sherwin Williams)	01-401 6149
98	Metall & Bergprodukter AB	01-371 8316
12	Mastermix Engineering Company Limited	01-371 5463
30	Meijer's, Rudolph, Inc.	01-931 1411
48	Plastanol Limited	01-401 5623
55	Rohm & Haas (UK) Limited	01-401 5861
58	Shell Chemicals UK Limited	01-401 6079
67	Union Carbide Europe SA	01-931 2718

These telephone numbers are only for use during the Exhibition; that is, from Monday 21 May to Thursday 24 May, inclusive.

Jacobsen Van Den Berg & Co. (UK) Ltd.
Stand 94

Jacobsen Van Den Berg have recently been appointed sole United Kingdom agents for Supercolori, of Milan, who manufacture anti-settling agents for paints. The Supercolori products "Sedapol" and "Bentonite" will be displayed on Jacobsen Van Den Berg's Stand at the OCCA Exhibition.



The new Mastermix twin head change can disperser will be on display at Stand 12

Sandoz Products Limited

Stand 66

The company is sorry to have to announce that it will not be showing the highly soluble, intense black *Savinyl Black RLS* at the Exhibition. However, other products in the *Savinyl* range will be on display, together with those ranges mentioned in the Official Guide.

Industria (Chemical Services) Ltd.
Stand 10

The company (United Kingdom agents for Veba-Chemie AG) has changed its address to: Marbaix House, Bessemer Road, Basingstoke, Hampshire RG21 3NT.

Reception for Exhibitors

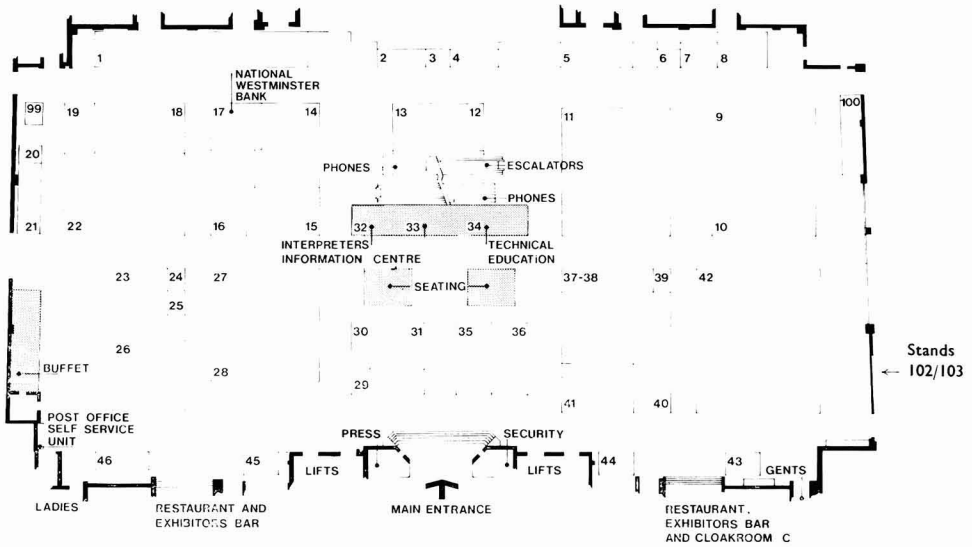
On the occasion of the Silver Jubilee Exhibition, the Exhibition Committee has decided to hold a reception for exhibitors, not only from this year's exhibition but also from some previous exhibitions, in order that they may meet members of the Exhibition Committee and the Director and Secretary to discuss the arrangements that have been made for future exhibitions.

It is felt that exhibitors will welcome this opportunity for exchanging views.

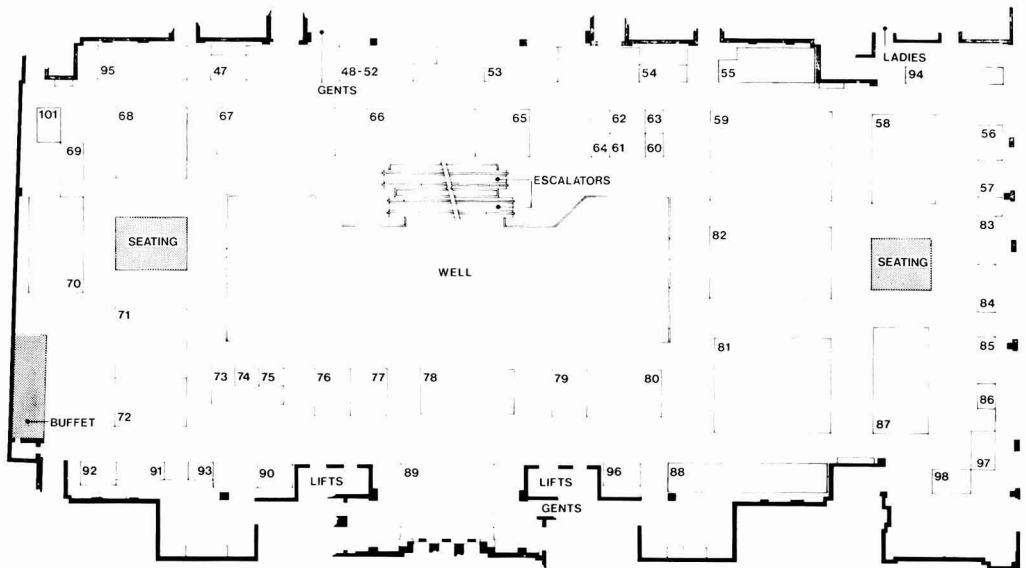
Invitation cards have been returned by exhibitors, and tickets have already been sent to those who have accepted the Committee's invitation.

Where exhibitors are not able to attend the reception, the Committee welcomes any views which should be submitted in writing to the Director and Secretary at the Association's offices.

Plan view of the Exhibition Hall at Olympia



GROUND FLOOR



FIRST FLOOR

Empire Hall,
Olympia, London,

Stand 42

Meet us at the OCCA to learn about the latest developments

21st - 24th May 1973

Synthetic Resins

Water-thinnable resins for air-, forced drying and stoving systems.

Water-emulsifiable two-component epoxy resin system for anti-corrosive paints.

New alkyd- and melamine resins for industrial finishes.

Oil-free polyester resins for Coil-Coating and ES-powder-coatings.

Unsaturated polyester resins for UV- and IR-curing.

Pigments

Organic pigments of the 70-series with improved flow and opacity for paints and printing inks.

® Hostatint multi-purpose shading pastes for aqueous and non-aqueous paints.

® Flexonyl-pigments for aqueous flexographic and gravure inks.

New Reflex Blue grades for Heat-Set inks.

® Hostaprint-pigments for gravure inks for printing plasticized PVC.

® Hostasol-fluorescent dyestuffs for mass dyeing of plastics.

Plastic Emulsions

Copolymer acrylic emulsions for exterior and interior application.

Styrene-acrylic emulsion for coloured plasters and emulsion paints.

® Hostaflex-copolymer from vinyltoluene/acrylic in solution for white spirit compatible primers.

Farbwerke Hoechst AG -
D-6230 Frankfurt (M) 80



Hoechst
keeps thinking
ahead

Oil & Colour Chemists' Association

PAINT TECHNOLOGY MANUALS

The second edition of
3 Convertible Coatings
is still available

Chapters on the latest
developments in the field have
been added to the volume

The price of the 2nd edition is £2.80 per
volume.

Still available in 1st edition is:

6 Pigments, Dyestuffs and
Lakes

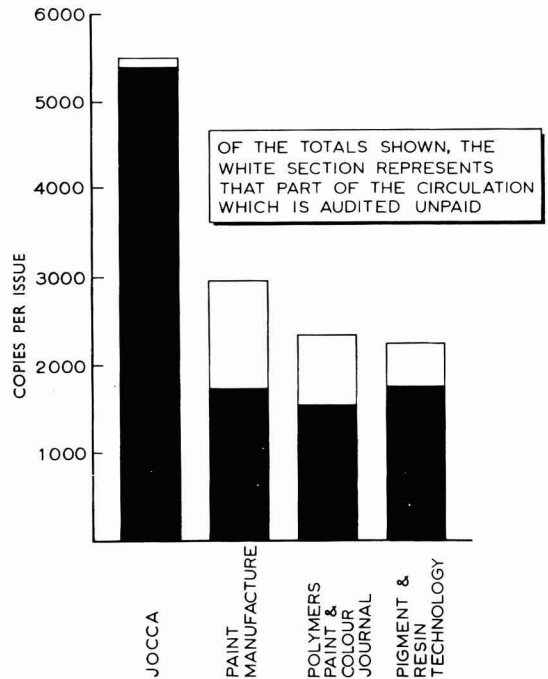
The price of this volume is £2.00

The following parts:

- 1 Non-convertible Coatings
 - 2 Solvents, Oils, Resins and Driers
 - 4 The Application of Surface Coatings
 - 5 The Testing of Paints
- are now in the course of reprinting.

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For full details of advertising in this, and other Association publications, contact **C. A. Tayler**, Assistant Editor

JOCCA
Journal of the Oil and Colour Chemists' Association

Priory House, 967 Harrow Road, Wembley, Middx.
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Telephone: 01-908 1086
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Plan of Olympia

1. For those travelling by road, there are limited car parking facilities available in the multi-storey car park, the entrance to which is from Maclise Road, and in the British Rail car park, access to which is from Russell Road.

2. Visitors arriving at the West London Air Terminal may board District Line trains to Earls Court, from which station a special Underground train is available at 10-15 minute intervals to Olympia.

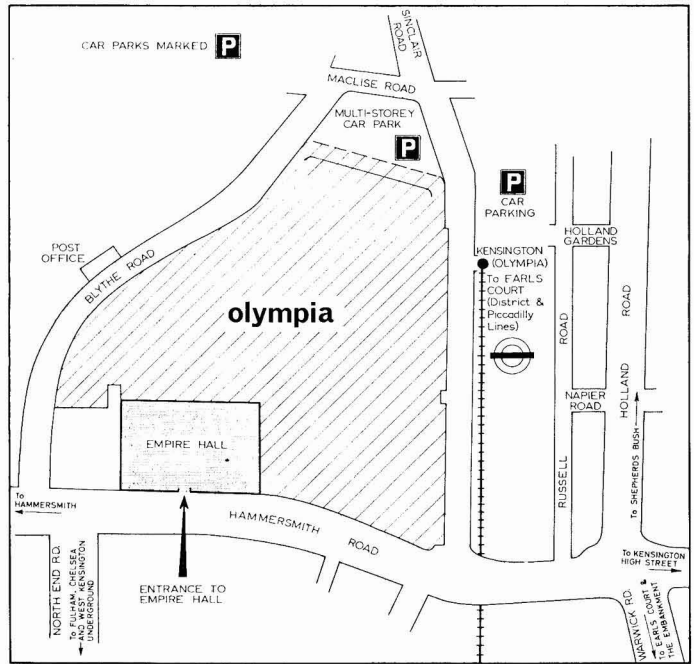
3. Olympia can be reached from main line stations by travelling on the Underground to Earls Court, which is on the District Line or Piccadilly Line, and changing to the special train.

4. There are also a number of bus routes which serve Olympia:

Bus Nos.: 9, 27, 28, 49, 91, 207A and 270.

Green Line Coaches Nos.: 701, 702, 704, 705, 714 and 716A.

5. There is a Motorail Terminal at Olympia and those wishing to transport their cars should contact British Rail.



Numerical list of Exhibitors—OCCA 25

For position of stand, please refer to plan view of the Exhibition Hall on page 228

Stand

Stand

- 1 D.H. Industries Ltd.
- 2 H. E. Messmer Ltd.
- 3 *Pigment & Resin Technology*
- 4 Torsion Balance Co. (GB) Ltd.
- 5 Silverson Machines Ltd.
- 6 Research Equipment (London) Ltd.
- 7 Millroom Accessories & Chemicals Ltd.
- 8 Willy A. Bachofen
- 9 Chemische Werke Huels AG
- 10 Veba-Chemie AG
- 11 Laporte Industries Ltd.
- 12 Mastermix Engineering Co. Ltd.
- 13 Buhler Brothers (England) Ltd.
- 14 Degussa
- 15 Rhone-Poulenc Group
- 16 Hercules Powder Company Limited
- 17 National Westminster Bank Ltd.
- 18 Durham Raw Materials Ltd.
- 19 Westerlins Maskinfabrik AB
- 20 Rank Precision Industries Ltd.
- 21 Wacker-Chemie
- 22 Bayer AG
- 23 Sachtleben Chemie GmbH
- 24 Society of Dyers and Colourists
- 25 Worsdall Chemical Co. Ltd.

- 26 Synres International NV
- 27 Tioxide International Ltd.
- 28 Titanium Intermediates Ltd.
- 29 Torrance & Sons Ltd.
- 30 Rudolph Meijer's Inc.
- 31 Croxton & Garry Ltd.
- 32 Interpreters
- 33 Information Centre OCCA
- 34 Technical Education
- 35 BIP Chemicals Ltd.
- 36 Anchor Chemical Co. Ltd.
- 37 Transportmaschinen Export/Import
- 38 Marchant Brothers Ltd.
- 39 Microscal Ltd.
- 40 Montedison
- 41 CdF Chimie
- 42 Farbwerke Hoechst AG
- 42 Cassella Farbwerke Mainkur AG
- 42 Harlow Chemical Co. Ltd.
- 42 Hoechst Cassella Dyestuffs Ltd.
- 42 Hoechst UK Ltd.
- 42 Reichhold-Albert-Chemie AG
- 42 Resinuous Chemicals
- 42 Vianova Kunstharz AG
- 43 William Boulton Ltd.

Stand

44	Winn & Coales (Denso) Ltd.	
45	G. J. Erlich Ltd.	
46	Silver, Peter, & Sons (Engineers) Ltd.	
47	International Colloids Ltd.	
48	} Croda Oleochemicals Group Ltd.	
49		
50		
51		
52		
53	Bowater Industrial Packaging Ltd.	
54	The Baker Castor Oil Company	
55	Rohm & Haas (UK) Ltd.	
56	Daniel Products Company	
57	RK Chemical Co. Ltd.	
58	Shell Chemicals UK Ltd.	
59	CIBA-GEIGY (UK) Ltd.	
60	Arco Chemical Co.	
61	Cornelius Chemical Co. Ltd.	
62	Roehm GmbH	
63	Industrial Colours Ltd.	
64	Kemira Oy	
65	Henkel & Cie GmbH	
66	Sandoz Ltd.	
67	Union Carbide Europe SA	
68	Eastman Chemical International AG	
69	Ferranti Ltd.	
70	Ugine Kuhlmann	
71	Akzo Chemie NV	
72	Synthese Kunststoffsabrik NV	
73	A/S Norwegian Talc	

Stand

74	Wentworth Instruments Ltd.
75	Buckman Laboratories SA
76	Victor Blagden & Co. Ltd.
77	Rex Campbell & Co. Ltd.
78	Amoco Chemicals Europe
79	Cabot Carbon Ltd.
80	Polyvinyl Chemie Holland NV
81	Imperial Chemical Industries Ltd.
82	BASF United Kingdom Ltd.
83	<i>Polymers, Paint & Colour Journal</i>
84	Sheen Instruments (Sales) Ltd.
85	Carl Zeiss (Oberkochen) Ltd.
86	Diffusion Systems Ltd.
87	Dynamit Nobel AG
88	Dyno Industrier AS
89	Schering AG
90	Kollmorgen Colour Systems
91	Spelthorne Metals Ltd.
92	Winter Osokeyhtio
93	Guest Industrials Ltd.
94	Jacobsen van den Berg & Co. (UK) Ltd.
95	Patent Office
96	Elcometer Instruments Ltd.
97	Instrumental Colour Systems Ltd.
98	AB Metall and Bergproduktur
99	Anderman & Co. Ltd.
100	Kingsley & Keith Ltd. (Olin)
101	Strazdins, A., Pty. Ltd.
102	Fischer Instrumentation (GB) Ltd.
103	Kingsley & Keith Ltd. (Sherwin Williams)

In addition to the exhibitors listed above, reference is also made in the *Official Guide* to the following:

<i>Stand</i>	<i>Company</i>	<i>Official Guide Page Number</i>	<i>Stand</i>	<i>Company</i>	<i>Official Guide Page Number</i>
94	Armoform	105	61	Mearl Corporation	74
1	Ateliers Sussmeyer	82	99, 31	Merck	53, 78
74	Atlas Electric Devices Company	157	45	Molteni Off. Mech.	91
67	Bakelite Xylonite Ltd.	153	18	Morehouse-Cowles International	86
88	Barter Trading Corporation Ltd.	88	94	Neulinger, Rudolph	105
27	British Titan	149	100	Olin Chemicals	107
14, 21	Bush, Beach & Segner Bayley Ltd.	81, 155	1	Oliver & Batlle	82
4	Cahn Company	152	45	O'Toole Ltd.	91
76	Cargill Chemical Corporation	62	61	Oulu Oy	74
96	Cattaro Scientific Control Company	91	70	Pechiney Ugine Kuhlmann Group	152
15	Chemietals Ltd.	129	94	Polychimie	105
97	Digico Ltd.	103	45	Pressindustria	91
56	Dussek Brothers Ltd.	81	45	Previero	91
68	Eastman Kodak Company	90	94	PVO International Incorporated	104
74	Gardner Laboratories Incorporated	157	16	Radiant	96
94	General Electric	105	74	Research Incorporated	157
8	Glen Creston	56	89	Schering Chemicals Ltd.	136
10	Industrial (Chemical Services) Ltd.	154	63	Sericol Group Ltd.	102
1	Jenag Equipment Ltd.	84	103	Sherwin Williams	152
93	Karntner Montanindustrie Gesellschaft	92	76	Societe de Produits Chimiques et Matieres Colorantes de Mulhouse (SPCM)	63
37	Kombinat Nagema VEB	110	2	Thwing-Albert Instrument Company	114
1	Kupper, Peter	84	1	Vollrath, Paul	82
2	Lorentzen & Wettres	114	1	Vree, J. De, & Co.	84
90	Macbeth Corporation	106	40	Weil, Joseph, & Son Ltd.	118
36	Marbon Chemical Company	53			
15	May & Baker Ltd.	129			

OCCA Biennial Conference

towards 2000

eastbourne 19-23 June 1973

Registrations

The closing date for registration at the Conference was given as 31 March 1973 primarily for the benefit of the hotel managements who wished to be in a position to let any accommodation not taken up by that date. Registrations have been received from delegates in the United Kingdom and eleven overseas countries.

Applications can still be accepted but to their remittances delegates must add Value Added Tax of 10 per cent. Copies of the Conference Brochure setting out the full programme of technical and social events and details of registration fees can be obtained from the Association's office (Telephone 01-908 1086. Telex 922670 OCCA Wembley).

Preprints

Preprints of the papers are now being bound and it is expected that these, together with details of accommodation, badges, programmes etc. will be sent to those who have registered at the end of this month. It is a feature of the Association's Conferences that preprints are sent well in advance of the function, in order to enable delegates to read them before the Conference at which the lecturers illustrate their topics, but do not read the papers in their entirety. This allows for a much longer discussion period than at many other conferences and has proved of immense value to those attending previous Association Conferences.

Dates and times of sessions

The Conference assembles on the evening of Tuesday 19 June when, in accordance with its usual tradition of hospitality, the Association will hold a reception for all those attending from Overseas, which will be followed by a meeting of the lecturers and the chairmen of sessions. The Conference sessions (which this year

comprise 16 technical papers) will be held as follows:

Wednesday 20 June (9.30 a.m.-12.30 p.m.)

Professor C. E. H. Bawn (University of Liverpool). "Polymers: Developments for the future."

Professor W. Funke and Dr Zorll (Forschungsinstitut für Pigmente und Lacke e.V., Stuttgart). "The influence of supermolecular structure on the properties of polymer films."

Dr E. Ladstädter and Dr H. D. Hanus (Vianova Kunstharz A. G., Graz). "The hardening of organic coatings with infra-red lasers."

Wednesday 20 June (2.30 p.m.-4.30 p.m.)

Mr F. Armitage (Sherwin Williams Co. Inc.). "The American Paint Industry—Present Trends and Future Possibilities."

Mr A. T. S. Rudram (Donald Macpherson & Co. Ltd.). "Relations with the developing countries."

Panel Discussion on "Britain and the EEC—Technico-commercial aspects."

Thursday 21 June (9.30 a.m.-12.30 p.m.)

Mr G. Isserlis (Polytechnic of the South Bank). "The challenge of metal finishing."

Drs R. P. M. Procter & V. Ashworth (UMIST). "The role of coatings in corrosion prevention—future trends."

Dr V. P. Simpson and Mr F. A. Simko Jr. (Hooker Research Center, Niagara Falls, New York). "Electrochemical activity of conductive extenders for zinc rich coatings."

Dr J. D. Murray (Materials Quality Assurance Directorate, Woolwich). "Chlo-

ride ion in epoxy polyamide films and the substrate effect."

Thursday 21 June (2.30 p.m.-4.30 p.m.)

Dr H. Gysin (Ciba-Geigy, Basle). "Environmental problems of the chemical industry."

Professor G. Scott (University of Aston-in-Birmingham). "Tomorrow's Packaging."

Mr K. McLaren (ICI Ltd.). "The future for colour measurement."

Friday 22 June (9.30 a.m.—12.30 p.m.)

Mr C. Meredith (British Standards Institution). "100 Years of Standards."

Mr R. L. J. Morris (Materials Quality Assurance Directorate, Woolwich). "The characterisation of mechanical properties of paint films."

Mr D. S. Newton (British Steel Corporation). "Finish first—Fabricate later. The continuing story of coil coating."

Mr S. T. Harris (Arthur Holden & Sons Ltd.). "A consideration of powder coating problems."

The Association's Annual General Meeting will take place at 2.15 p.m. on the afternoon of Friday 22 June and this will be followed by three Workshop Sessions, which have proved very popular in the past. The subjects this year will be: "Sales Forecasting," "The changing influence of the do-it-yourself market" and "The measurement of research output." The number attending each Workshop Session is strictly limited and places will be allocated in order of receipt. Where the total places for a session have been filled, later applicants will be informed and, if possible, offered an alternative session.

Receptions and Dinner

There will be an Informal Reception for all delegates at lunchtime on Wednesday and a Civic Reception will be held, at which delegates will be welcomed by the Mayor and Mayoress of Eastbourne, on the evening of the same day. The Association's Dinner and Dance will be the closing function of the Conference on the Friday evening. Other social activities, such as coach tours, are being arranged for the benefit of ladies attending the Conference.

Newcastle

Ladies Night

The Section held their Ladies Night at the Five Bridges Hotel, Gateshead, on Friday 23 February. About two hundred and thirty people attended, the Guests of Honour being the President of the Association, Mr A. A. Blenkinsop and his wife.

Despite the gas strike, which affected the hotel's cooking facilities, the evening was a tremendous success.



From left to right, Mr A. W. Blenkinsop, Mrs Duell, Mr A. Duell and Mrs Blenkinsop

News of Members

Mr R. Howe, an Ordinary Member attached to the London Section, has been appointed a director of Burrell and Co. Limited, the London-based chemical pigment colour manufacturer. His special responsibility will be the production of the colour pigments marketed by the group's sales company, SCC Colours Limited.

Reorganisation of Berger Paints' research and development laboratories has resulted in the following appointments.

Mr E. Farrow, an Ordinary Member attached to the London Section, has been appointed technical manager of the Berger Paints Industrial Laboratory.



Mr E. Farrow



Mr B. Giordan

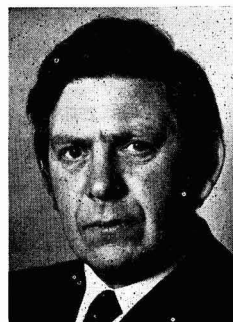
Mr B. Giordan, an Ordinary Member attached to the London Section, becomes technical manager of the new Projects Laboratory for long term development.



Mr A. Lock

Mr A. Lock, an Ordinary Member attached to the Bristol Section, has been appointed technical director.

Mr R. Woodbridge, an Ordinary Member attached to the Bristol Section and a Fellow in the Professional Grade, has been appointed technical manager of the Berger Decorative Laboratory.



Mr R. Woodbridge

Mr K. S. Burch, an Associate Member attached to the London Section, has retired from his positions as managing director of Rex Campbell and Company Limited and sales and commercial director of the Chemical Supply Company. Mr Burch has had forty-five years service with these two companies.

Mr R. J. Buckland, also an Associate Member attached to the London Section, has been appointed managing director of Rex Campbell and Company Limited.

Forthcoming Events

Details are given of meetings in the United Kingdom up to the end of the month following publication, and South Africa and the Commonwealth up to the end of the second month.

May

Irish Section: Treasure hunt and golf outing. Details to be announced.

Thursday 3 May

Thames Valley Section—Student Group: "Corrosion inhibitive pigments." Speaker to be arranged. To be held at the Main Lecture Theatre, Slough College, at 4.00 p.m.

Friday 4 May

West Riding Section: Luncheon lecture at the Astoria Ballroom Restaurant, Roundhay Road, Leeds, at 12.30 p.m. for 1 p.m. The Guest Speaker will be Mr D. J. T. Howe who will give a talk on "Problems of toxicity in the paint industry."

Monday-Thursday 21-24 May

OCCA-25. Twenty-fifth (Silver Jubilee) Technical Exhibition at Empire Hall, Olympia, London.



Monday 21 May

Exhibition Dinner at the Savoy Hotel, London WC2. Informal dress, 7.00 for 7.30 p.m.

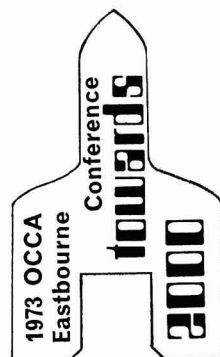
June

Tuesday-Saturday 19-23 June

OCCA Conference: *Towards 2000* at the Grand Hotel, Eastbourne, Sussex, England.

Friday 22 June

AGM of the Association at the Grand Hotel, Eastbourne, at 2.15 p.m.



Register of Members

The following elections to membership have been approved by Council. The Section to which new members are attached is given in italics.

Ordinary Members

BALFOUR, JOHN GRAY, BSc, 672 Chigwell Road, Woodford Bridge, Woodford Green, Essex. *(London)*

BINKS, GEOFFREY, 14 St. Andrews Place, Harrogate, Yorks. *(West Riding)*

CADMAN, PHILIP MICHAEL, BSc, 7 Cypress Avenue, Ellowes Hall Estate, Lower Gornal, Dudley, Worcs. DY3 2JF. *(Midlands)*

GARCIA FANDINO, NESTOR ANTONIO, Avda. Generalísimo, 61-Plta. 9a, Madrid 16, Spain. *(General Overseas)*

GAYNOR, HELEN MCDONALD (Mrs), BSc, 8 Maze Road, Glenwood, Durban, South Africa. *(South African)*

JEFFERY, PHILIP LESLIE, BSc, Pinchin Johnson Paints Ltd., North Woolwich Road, Silvertown, E16. *(London)*

LEE, YOKE SENG, D'Argon, Wexham Street, Stoke Poges, Bucks. *(Thames Valley)*

LLOYD, KEITH FREDERICK, 18 Church Road, Braunston, Nr. Rugby, Warwickshire. *(Midlands)*

MALHERBE, W. M. TERTIUS, BSc, 12 Third Avenue, Boston, Belleville, Cape Province, South Africa. *(South African)*

MILNER, ALISON MARY, PhD, 30 Highway Road, Amanzimtoti, Natal, South Africa. *(South African)*

PERCY, GORDON CHRISTOPHER, PhD, South African Paint Institute, PO Box 16, Gonsella, Natal, South Africa. *(South African)*

PRATT, ERNEST NOEL, Smith & Walton Ltd., Hadrian Works, Haltwhistle, Northumberland. *(Newcastle)*

RILEY, MICHAEL JOHN, 49 Beechwood Rise, Watford, Herts. *(London)*

SOWDEN, ROY HENRY, LRIC, AMBIM, 10 Manor Lane, Ettington, Stratford-on-Avon, Warwickshire. *(Midlands)*

VADAS, PAUL, Vadek (Pty) Ltd., 609 Voortrekker Road, Maitland, South Africa. *(South African)*

WILLIAMS, DAVID PETER, MSc, Ciba-Geigy Ltd., Gunners Circle, Epping, South Africa. *(South African)*

Associate Members

FONSATO, PETER, 37 Floralyn, St. Andrew Street, Durban, South Africa. *(South African)*

OLIVER, LAURENCE HALDANE, 24 Victoria Street, Lower Hutt, New Zealand. *(Wellington)*

TUCKERMAN, BERNARD JAMES, Dulux (NZ) Ltd., Crn. Gracefield Road and Hutt Park Road, Lower Hutt, New Zealand. *(Wellington)*

Registered Students

ACRES, JOHN, Courland Grove Hall, Courland Grove, London, SW8 2PX. *(London)*

CLARKE, DOMINIC, Crimpton, Cowark, Nr. Clitheroc, Lancs. *(Manchester)*

CRUQUENAIRE, JEAN PAUL, 74 Kenton, 90 West Street, Durban, South Africa. *(South African)*

GUESS, PHILIP ERNEST, 3 Brackley Road, Buckingham, Bucks. *(Thames Valley)*

HUNT, JOHN HENRY, Harrison Mayer Ltd., Meir, Stoke-on-Trent. *(Midlands)*

TREWHITT, MARTIN JOHN, Peach Tree Farm, Minskip, Yorks. *(West Riding)*

Optional Professional Grade

Members will be aware that the Certification fees charged to Ordinary Members of admission to the optional Professional Grade were raised by the Council, with effect from 1 January 1973, to £10.00 for Fellowship, £6.00 for Associateship and £3.00 for Licentiatehip.

The Association has been advised that Certification fees are subject to VAT of ten per cent and Ordinary Members who are sending in application forms should, therefore, add ten per cent to the relevant fee payable.

Temporary amendment to regulations

At its meeting on 11 April, Council received a report from the President's Advisory Committee on the wishes of some Associate Members of long standing. These Members had not transferred to Ordinary Membership upon obtaining the necessary qualifications, and thus found themselves unable to make application for admission to the optional Professional Grade for Ordinary Members because they had not fulfilled the requirement of being an Ordinary Member for the stipulated period.

Council wishes it to be known that for a **limited period** only the following amendment to the regulations will apply: *that the regulations regarding the qualifying periods of Ordinary*

Further copies of the new application form may be obtained from the Association's offices and Members are reminded that the regulations governing admission to the Professional Grade were last printed in the January 1973 issue of the *Journal*.

The full list of Members admitted to the Professional Grade by the end of 1972 appeared in the December 1972 issue and a full list will be published again in the December 1973 issue; in the meantime, further admissions will be published in the *Journal* from time to time.

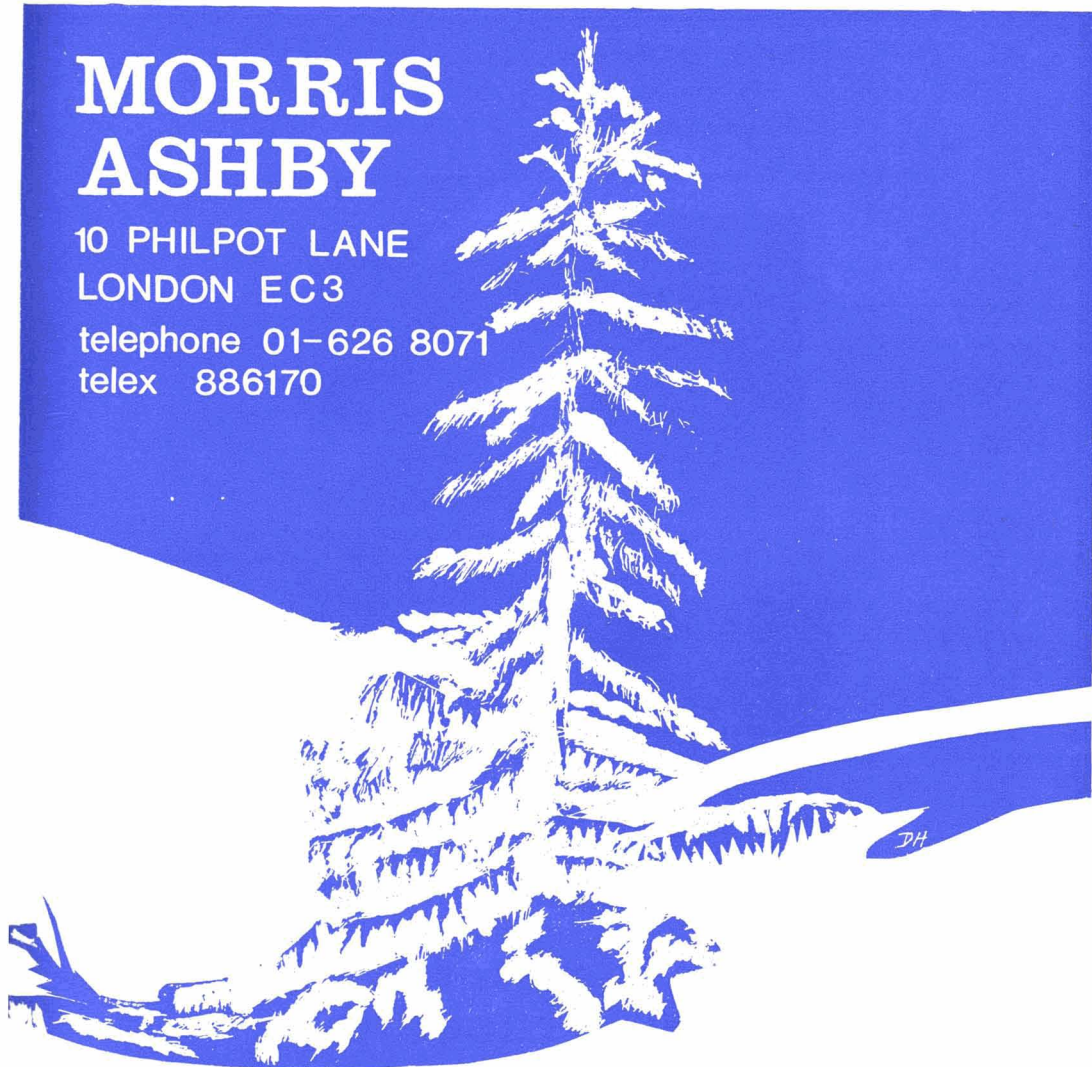
Membership for admission to the various Professional Grades be waived for those Associate Members of ten years' standing who are able to show that they had obtained the necessary examination qualification(s) to enable them to transfer to Ordinary Membership at an earlier stage and that, upon transferring to Ordinary Membership BEFORE 31 DECEMBER 1973, the date of such transfer may be backdated by the President's Advisory Committee to the same date as the date of the qualification(s) to a maximum of five years.

Any member wishing to avail himself of this provision should write immediately to the Director & Secretary at the Association's offices. It is stressed that **this amendment will cease to apply from 31 December 1973.**

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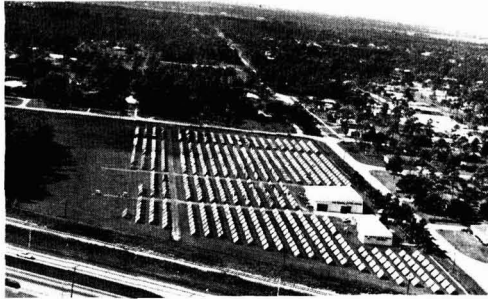
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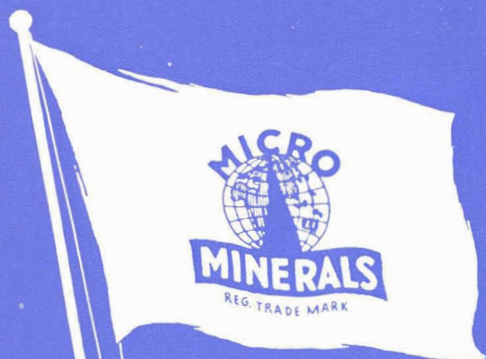
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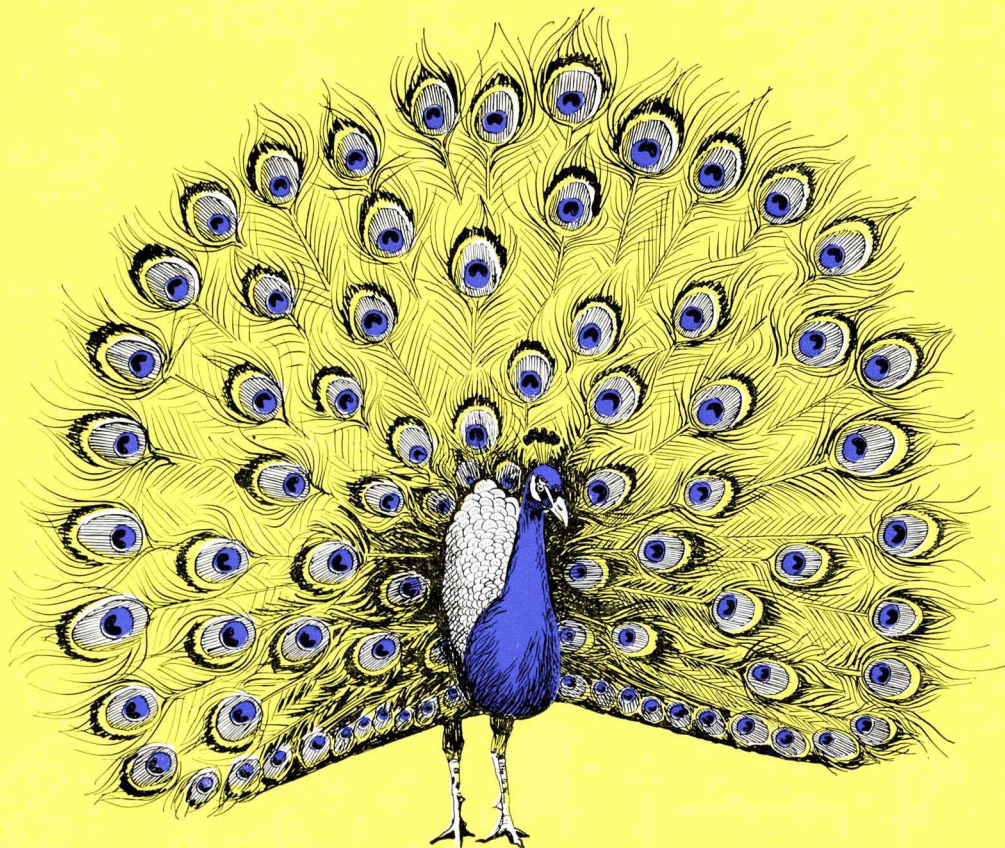
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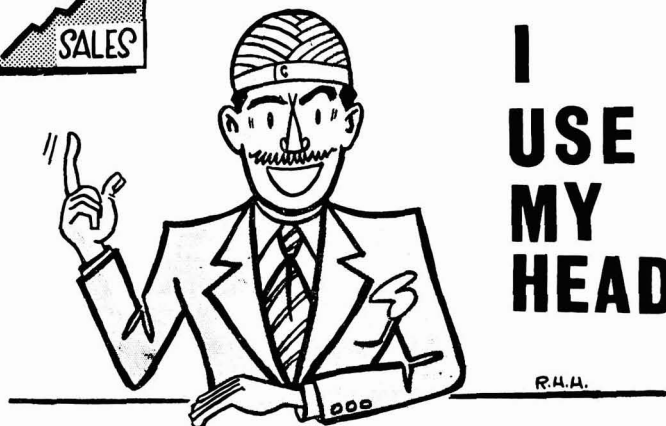
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Journal of the Oil & Colour Chemists' Association

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INDEX TO ADVERTISERS

A	
Anchor Chemical Co. Ltd.	Cover
Ashby, Morris, Ltd.	xxv
B	
Banner, Samuel, & Co. Ltd.	vii
BASF (UK) Ltd.	xi
BIP Ltd.	xxvii
Bowater Industrial Packaging	iv, v
Bray, E. P., & Co. Ltd.	xxix
C	
Chemische Werke Huls AG	xxxi
CIBA-GEIGY (UK) Ltd., Pigments Division	xix
CIBA-GEIGY (UK) Ltd., Resins and Plastics Division	i
Cory, Horacø, & Co. Ltd.	xvi
Cuprinol Ltd.	vii
D	
Dynamit Nobel Chemikalien	Insert
E	
English China Clays Sales Ltd.	iii
F	
Ferranti Ltd.	xxxvi
G	
Guest Industrials Ltd.	xxvi
H	
Hoechst, Farbwerke, AG	xxiii
I	
ICI Mond Division	xxii
K	
Kemira Oy	xviii
Kingsley & Keith (Chemicals) Ltd.	Cover
Kronos Titan GmbH	vii
M	
Metchim & Son Ltd.	xii
Mickle Laboratory Engineering Co. Ltd.	ix
N	
Norwegian Talc, AS	xxviii
S	
Sandoz Products Ltd.	x, xiii
SCC Colours Ltd.	xxxii
Schering AG	vi
Shell International Chemical Co. Ltd.	xvii
Shell (UK) Ltd.	xx
Sterling Chemical Co. Ltd.	Cover
Sub-Tropical Testing Services, Inc.	xxvi
Suter, A. F., & Co. Ltd.	xii
T	
Tioxide International Ltd.	xiv
V	
Veba-Chemie AG	xxi
Z	
Zeiss, Carl	ii

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