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JOURNAL OF THE OIL & COLOUR CHEMISTS' ASSOCIATION

Quantitative characterisation of paint surfaces using ray deflection mapping and schlieren techniques *D. M. Howell*

Recent developments in protective finishes for metal containers Part I: Recent developments in internal protective finishes *R. T. Read*

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Fluid polybutadiene in air-drying oil and alkyd varnishes *K. Gorke*

Priory House, 967 Harrow Road, Wembley, Middx, England HA0 2SF

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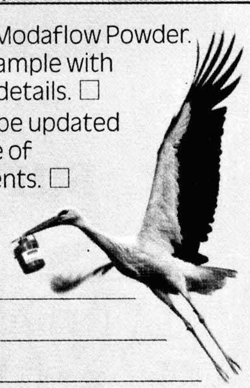

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Transactions and Communications

Quantitative characterisation of paint surfaces using ray deflection mapping and schlieren techniques*

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Summary

Ray deflection mapping and schlieren optics have been applied to the visualisation and measurement of surface defects and profiles, and the potentialities of these methods have been investigated.

Ray deflection mapping is particularly suited to the study of levelling. It has been used to measure surface profiles, but is found to be especially suitable for measurement of the slope and amplitude of residual peaks of a paint applied with a crenellated levelling blade. In this case the profile is shown to be approximately sinusoidal and consequently the peak amplitude may be easily and accurately measured. It is shown that the method may be used for measuring surface slopes as small as 0.1 milliradians, or for a sinusoidal profile amplitudes of 0.02μm, and of resolving distances of 10^{-1}cm.

The schlieren technique has been developed to visualise surface defects and for quantitative characterisation by measurement of surface slope. An apparatus has been built to measure slopes as small as 0.5 milliradians with a spatial resolution of 25μm. By using opaque and coloured transparent schlieren stops, different facets of surface structure can be revealed. The use of a photocell converts the technique to a simple instrumental method for quantitatively measuring levelling.

The techniques described have been demonstrated to be of high sensitivity and precision, and should be useful in the research and quality control laboratories.

Keywords

Processes and methods primarily associated with analysis measurement or testing

ray deflection mapping
schlieren optics

Properties characteristics and conditions primarily associated with:

coatings during application

flow levelling

dried or cured films

orange peel

La caractérisation quantitative des surfaces de peinture en traçant la déflexion des rayons qu'y tombent et au moyen des techniques schlieren.

Résumé

On a utilisé le traçage de la déflexion de rayons et aussi les techniques des optiques schlieren pour effectuer la "visualisation" et la mesure des défauts de surface, des profils, et d'ailleurs on a étudié les possibilités de ces méthodes.

Le traçage de la déflexion de rayons est particulièrement commode pour étudier les caractéristiques d'aplanissement. Egalement on l'a utilisé pour mesurer les profils des surfaces, cependant on l'a trouve exceptionnellement apte à mesurer la pente et l'amplitude des pics residuels d'une couche de peinture appliquée au moyen d'une lame crénelée. On démontre que le profil est d'une forme à peu près sinusoïdale et par conséquent on saurait mesurer l'amplitude des pics avec facilité et précision. On démontre que l'on pourrait se servir de la méthode pour effectuer la mesure des pentes de surface aussi minuscules que de 0.1 milliradians, où lorsqu'il s'agit d'un profil sinusoïdal, que des amplitudes de 0.02μm, et des distances résolubles de 10^{-1}cm.

On a perfectionné la technique schlieren afin de "visualiser" les défauts de surface et d'obtenir la caractérisation quantitative par la mesure de la pente de la surface. On a construit un appareil destiné à mesurer les pentes aussi minuscules que de 0.5 milliradians et avec une résolution spatiale de 25μm. En utilisant les diaphragmes schlieren opaque ou transparent et coloré, on peut réveler divers aspects de la structure des surfaces. L'emploi d'une cellule photo-électrique permet l'exploitation de la technique pour effectuer la mesure quantitative de l'aplanissement à l'aide d'une méthode instrumentale et facile.

Les techniques décrites dans cet article ont été démontrées d'être de haute précision et sensibilité, et elles doivent être utiles dans des laboratoires de recherche et de contrôle de qualité.

Quantitative Charakterisierung von Anstrichoberflächen durch Benutzung von Strahlen-krümmungs-Kartographie und Schlierentechnik

Zusammenfassung

Zur Sichtbarmachung und zum Messen von Oberflächenschäden und Profilen wurden Strahlenkrümmungs-Kartographie und Schlieren-optiken angewandt. Die Möglichkeiten dieser Methoden wurden untersucht.

Strahlenkrümmungs-Kartographie eignet sich besonders zum Studium des Verlaufs. Es wurde benutzt, um Oberflächenprofile zu messen, es wurde jedoch als besonders geeignet zur Messung der Einsenkung und Amplitude zurückgebleibener Spitzen eines Anstrichs, der im Interesse des Verlaufs mit einder gekerbten Klinge aufgetragen worden war, befunden. Es zeigt sich, dass in diesem Fall das Profil annähernd sinusförmig ist, und infolgedessen die Spitzenamplitude leicht und genau gemessen werden kann. Es wird gezeigt, dass diese Methode für die Messung von Oberflächengefällen bis hinunter zu 0.1 Milliradians oder für sinusförmige Profil Amplituden von 0.02μm und von Auflösungsabständen von 10^{-1}cm benutzt werden kann.

Die Schlierentechnik wurde zur Sichtbarmachung von Fehlern in Oberflächen und für quantitative Charakterisierung durch Messung

*Presented to a meeting of the London Section on 10 December 1974.

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von Einsenkungen in Oberflächen entwickelt. Eine Apparatur zur Messung dieser Neigungen bis hinunter zu 0.5 Milliradians mit einer Raumauflösung von 25μm wurde gebaut. Bei Benutzung opaker und farbig transparenter Schlieren-Stops können verschiedene Facetten der Oberflächenstruktur gezeigt werden. Die Anwendung von Photozellen wandelt die Technik in eine einfache instrumentale Methode zur quantitativen Messung des Verlaufs.

Es wurde gezeigt, dass die beschriebenen Techniken hochempfindlich und präzis sind, sie sollten daher bei Forschungsarbeiten und in Qualitätskontrollaboratorien von Nutzen sein.

Introduction

Refs. 1-3

A paint surface which is devoid of defects and has a substantially flat profile is desirable for reasons of both appearance and performance. For example, an irregular surface will give poor distinctness of image gloss, and faults such as orange peel, sagging and poor levelling are unsightly: nibs may cause premature failure of the coating, and ribbiness of coated sheet metal could result in fabrication problems.

The increasing requirement of many manufacturers for high quality surface finishes requires that surface coatings be capable of forming, like moulded plastics, plastic laminates, and glass, surfaces approaching that of optical perfection. There is, therefore, a need in the research laboratory for a convenient and accurate method for measurement of the flow-out and levelling properties of coatings, and for the purposes of quality control a device for suitably characterising the profile of a surface once it has formed.

It is shown here how the methods of ray deflection mapping and schlieren optics, which have been used for many years for quantifying defects in optical elements (Töpler[1]), and exploited as a research tool by Weinberg[2], may be usefully and simply applied to the measurement of the properties of paint surfaces. The techniques described are not, however, limited to paints and can be applied to any kind of glossy surface.

When applied to surface measurements, the principle of both deflection mapping and schlieren optics is the measurement of the change in angle of deflection of a reflected ray of light which is caused by a change in the surface slope. The two techniques differ in how this measurement is achieved.

Freier[3] has recently reported the application of the schlieren method to the visualisation of paint surface defects. It was not, however, put on a quantitative basis and it is shown here how this and related methods may be used to measure the amplitude, wavelength and slope of surface irregularities.

Ray deflection mapping

This technique is ideally suited to the quantitative study of levelling. For example, it may be used to measure the amplitude of ridges in an unlevelled surface, and for following the flow-out of freshly applied coatings.

Theory

Ref. 4.

The principle of the method is illustrated in Fig. 1. In this method, and in the following schlieren method, the change θ in the angle of deflection of a ray reflected off a surface, and the change φ in slope of the surface causing the deflection are related by the identity

$$\varphi = \theta/2 \quad \text{(1)}$$

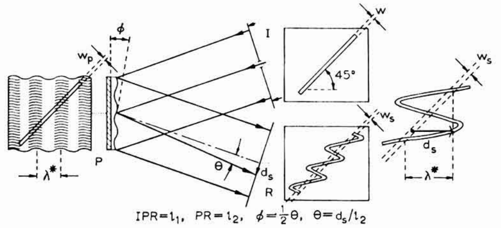

Fig. 1. Principle of ray deflection mapping method using an inclined slit. I inclined slit; P paint surface; R recording plane

The dashed reference line in Fig. 1 is a record of the shadow of the inclined slit when the test object *P* is replaced by a perfectly flat surface. The centre of this line is used as the origin for ray deflection measurements. In the basic ray deflection mapping system the angle of deviation θ is given by:

$$\theta = d_s/l_2 \quad \text{(2)}$$

where d_s is the displacement of the inclined slit record (the wavy line in Fig. 1) from its reference position, and l_2 is the distance from the test object to the recording plane.

To simplify interpretation of the record it is necessary to restrict test objects to those having a surface profile which changes in one direction only. An important example of such a surface is that produced by the Paint Research Association (PRA) levelling blade[4]. This blade spreads a film of paint with ridges of various widths superimposed on a film of uniform thickness. Several different films spread using this blade have been used as test objects to illustrate how ray deflection mapping techniques may be applied to the analysis of their profile.

Generalised profile

In general, the surface profile may be described by an equation of the form

$$y = y_m + F(x) \quad \text{(3)}$$

where *y* is the film thickness at a point *x*, and y_m is the mean film thickness (Fig. 2). The surface slope φ at any point *x* is then given by the differential of equation (3); that is, by

$$\varphi = dy/dx \quad \text{(4)}$$

It follows that if θ is known as a function of *x* (determined from the inclined slit record), the profile *y* can be found using the equation

$$y = 0.5 \int_0^x \theta dx + \text{constant} \quad \text{(5)}$$

Sinusoidal profile

When the surface has a sinusoidal profile

$$y = y_m + y_0 \sin (2\pi x/\lambda^*) \quad \text{(6)}$$

where y_0 and λ^* are respectively the amplitude and wavelength of the surface oscillations. It follows from equation (4) that

$$\varphi = (2\pi y_0/\lambda^*) \cos (2\pi x/\lambda^*) \quad \text{.........(7)}$$

The maximum slope, φ_{max}, is, therefore, given by

$$\varphi_{max} = 2\pi y_0/\lambda^* \quad \text{..................(8)}$$

The maximum slope and amplitude for a sinusoidal profile may be determined, therefore, from the inclined slit record using the expressions:

$$\varphi_{max} = d_{s,max}/2l_2 \quad \text{.................(9)}$$

$$y_0 = \lambda^* d_{s,max}/4\pi l_2 \quad \text{................ (10)}$$

where $d_{s,max}$ is the maximum ray displacement.

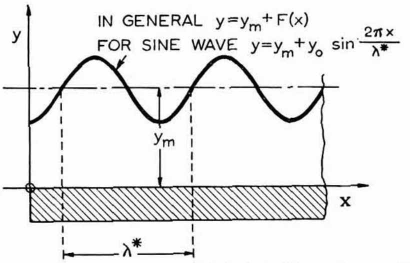

Fig. 2. Co-ordinate system used for describing surface profile

Optical system

The optical system is shown in Fig. 3. It consists of a mercury vapour lamp focused on to a pinhole placed at the focal point of a concave mirror, which acts as a collimator. This mirror forms a parallel beam of light incident on a slit which is inclined at 45 degrees to the horizontal. The beam of light which passes through the slit is reflected off the paint surface to form a distorted shadow of the slit on a screen or photographic film.

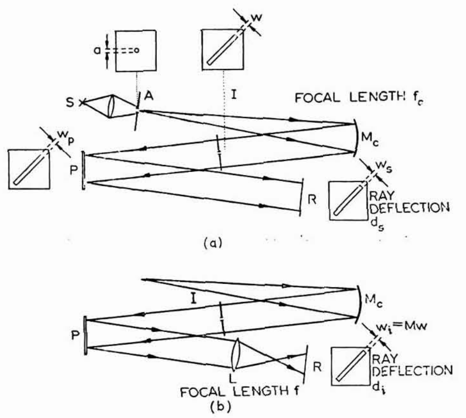

Fig. 3. Optical systems used for ray deflection mapping

(a) Basic system, (b) System incorporating an imaging lens.
S light source, 250 watt mercury vapour lamp;
A screen containing pin-hole; Mc collimating mirror;
I screen containing inclined slit; P test surface;
L lens imaging I on to recording plane; R recording plane.
$a = 1.10 \times 10^{-1}$cm; $f_c = 93.5$cm; $w = 4.1 \times 10^{-2}$cm; $f = 20.6$cm.
In (a) l_1=IPR=54.2cm; l_2=PR=27.1cm.
In (b) l_1=IPR=90.1cm; l_2=PR=63.0cm; h=LR=35.9cm.

Fig. 4a shows a record obtained using this arrangement. Measurements made of the maximum deflections, and wavelengths, on photographs similar to Fig. 4a were used to estimate (by assuming a sinusoidal profile) the peak amplitudes; these are given in Table 1. The errors quoted in the amplitudes were calculated from the width of the shadow of the slit at the image reference position. The validity of assuming a sinusoidal profile is discussed later.

Fig. 4a

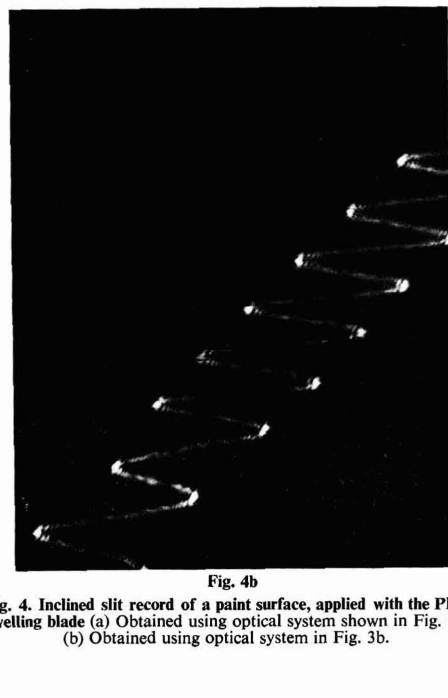

Fig. 4b

Fig. 4. Inclined slit record of a paint surface, applied with the PRA levelling blade (a) Obtained using optical system shown in Fig. 3a. (b) Obtained using optical system in Fig. 3b.

Table 1
Amplitude and wavelength of unlevelled paint surfaces measured by the different ray deflection mapping methods and compared with Talysurf measurements

Method	Wavelength λ^*(cm)	Amplitude y_0 (μm)	Wavelength λ^*(cm)	Amplitude y_0 (μm)
Wavelength of levelling blade crenellations	0.203±0.003	-	0.279±0.003	-
Ray deflection mapping:				
(i) No imaging lens	0.20	2.1±0.3	0.27	3.6±0.5
(ii) Imaging lens —integration	0.21	2.1±0.2	0.28	3.6±0.25
(iii) Imaging lens —sine wave approximation	0.21	2.0±0.1	0.28	3.5±0.15
Talysurf†	0.21	2.1± ?	0.28	3.4± ?

† Talysurf measurements were not made on same area as deflection mapping. Slight surface scratching by the stylus made it impossible to estimate the accuracy of these measurements. In the absence of any surface deformations the Talysurf has a claimed[9] precision of the order of 0.025μm.

Other systems have been built which use a collimating lens instead of a mirror. These had the advantage of being compact, but the mirror system was easier to adjust and allowed a larger field of view to be examined.

Effect of using an imaging lens

Whereas interpretation of the record in Fig. 4a is quite straightforward, the definition is far from good. This arises partly from minor defects on the surface of the paint film which scatter light out of the main beam. However, by far the most important effect is the spread of the beam caused by diffraction at the slit edges.

By placing a lens between the test object and recording plane, so that it forms an image of the slit at the recording plane, this problem of diffraction may be considerably reduced. It cannot, however, be totally eliminated as the irregularities on the paint film behave as localised elementary mirrors which throw the record out of sharp focus. The lack of definition produced by this effect is generally small and Fig. 4b shows that a considerable improvement can be achieved by using a lens in this way.

The magnification effect of the lens must be taken into account when interpreting the record. It can be shown that if d_i is the displacement of the distorted focused image of the inclined slit from the reference line, and h is the distance of the recording plane from the imaging lens of focal length f, then:

$$\theta = \frac{d_i}{l_2}\left[1 - \frac{h}{f} + \frac{h^2}{l_2 f}\right]^{-1} \quad \ldots\ldots\ldots\ldots (11)$$

$$\lambda_i^* = M\lambda^* \quad \ldots\ldots\ldots\ldots (12)$$

where

$$M = (1 - h/f) \quad \ldots\ldots\ldots\ldots (13)$$

Limitations

The spatial resolution of ray deflection measurements is limited by the width of shadow of the inclined slit reflected off the surface being studied. This width should be less than the wavelength of the surface irregularities being measured.

To a good approximation the width of a diffraction limited shadow at the test surface is given by

$$w_p = \lambda\,(l_1 - l_2)/w \quad \ldots\ldots\ldots\ldots (14)$$

where λ is the effective wavelength of light incident on the slit, and l_1 and l_2 are defined in Fig. 3. If λ^* is the minimum distance to be resolved, the slit width should be such that $w_p \ll \lambda^*$; that is

$$w \gg \frac{\lambda(l_1 - l_2)}{\lambda^*} \quad \ldots\ldots\ldots\ldots (15)$$

It is, of course, necessary on geometric grounds to ensure that

$$w \ll \lambda^* \quad \ldots\ldots\ldots\ldots (16)$$

Combining these last two inequalities gives

$$\frac{\lambda(l_1 - l_2)}{(\lambda^*)^2} \ll \frac{w}{\lambda^*} \ll 1 \quad \ldots\ldots\ldots\ldots (17)$$

For $\lambda = 5 \times 10^{-5}$cm, $w = 10^{-2}$cm and $(l_1 - l_2) = 10$ cm (reasonable practical values) it would would seem that distances as small as $\lambda^* = 10^{-1}$cm can conveniently be resolved using the ray deflection method.

The minimum detectable surface slope, in the absence of an imaging lens, is given by

$$\varphi_{min} = w_s/2l_2 \quad \ldots\ldots\ldots\ldots (18)$$

where w_s is the width of the shadow of the slit at the recording plane. Therefore

$$\varphi_{min} = \lambda l_1/2wl_2 \quad \ldots\ldots\ldots\ldots (19)$$

Thus, for $\lambda = 5 \times 10^{-5}$cm, $w = 10^{-2}$cm and $l_1 = 2l_2$, $\varphi_{min} = 5.0$ milliradians (1 mrad = 0.057°).

The minimum detectable surface slope using an imaging lens is given by

$$\varphi_{min} = \frac{Mw}{2l_2}\left[1 - \frac{h}{f} + \frac{h^2}{l_2 f}\right]^{-1} \quad \ldots\ldots (20)$$

For $M = -1$, and hence $h = 2f$, φ_{min} will depend only on the magnitude of l_2. Taking the case of $l_2 = 2f$ gives

$$\varphi_{min} = w/4f \quad \ldots\ldots\ldots\ldots (21)$$

For $w = 10^{-2}$cm and $f = 25$cm, $\varphi_{min} = 0.1$ mrad.

For the case of a sinusoidal profile the minimum detectable amplitude may be estimated using equation (8). Thus, assuming $\lambda^* = 10^{-1}$cm, in the case considered above in which no lens is used $y_{0,min} = 0.8$μm, and in the case when a lens is used $y_{0,min} = 0.02$μm.

Applications

Refs. 5, 6, 9

Deflection mapping may be used to show and measure any kind of unidirectional surface irregularity. For routine assessment of the levelling of a paint applied with the levelling blade it may be used to measure the maximum slope of the unlevelled surface. In circumstances where a sinusoidal profile may be assumed, the amplitude can also be calculated from this surface slope.

By direct application of equation (5) the detailed structure of a profile may be determined. To check the validity of the sine-wave approximation, measurements were made on the original negatives of photographs similar to the one in Fig. 4b. The negatives were placed in a photographic enlarger at a known magnification and the enlarged image drawn on millimeter-square graph paper. The curve was then integrated cycle by cycle by cumulatively summing the squares at one millimetre intervals along the X-axis, starting at a point of maximum deflection. The peak amplitude y_0 and wavelength λ^*, deduced from the photographs, are given in Table 1; also given are the amplitudes deduced using the sine-wave approximation, from Talysurf measurements, and from measurements on photographs obtained without the use of an imaging lens, such as shown in Fig. 4a. The error quoted in y_0 for the deflection mapping methods was calculated from the width of the shadow or image of the slit in the absence of a deflection. Fig. 5 compares the profile determined using the Talysurf and ray deflection mapping with a normalised sine-wave profile. The agreement is remarkably good.

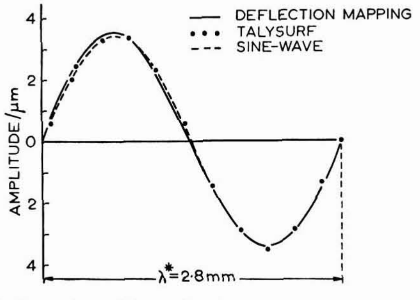

Fig. 5. Comparison of the profile of a paint surface, applied with the PRA levelling blade, measured by the ray deflection method and with a Talysurf. Also shown is a sine-wave profile

The agreement between the sine-wave approximation and the integration method of determining peak amplitude is within experimental error. The surfaces were prepared from paints of a thixotropic gel type, and under the action of the levelling blade were subjected to as little structural breakdown as possible. Thus it is likely that the profiles of most paint surfaces drawn down with a levelling blade are almost sinusoidal.

The advantages of the sine-wave approximation are the accuracy and ease of computation of the peak amplitude. It is more accurate than integration because no summation of errors is involved. In cases where the sine-wave approximation is not valid the maximum slope may still be calculated.

As lack of surface flatness is, generally, appreciated in practice by a distortion in the shape of a reflected image, it may in some circumstances be more useful to characterise irregularities in terms of surface slope rather than peak amplitude.

Fig. 6 shows an inclined slit record (using a lens) of a steep sag front. This was placed with the sag front horizontal instead of vertical as for the ridges of the unlevelled surfaces. The length of the spike is directly proportional to the steepness of the front.

Dynamic studies of levelling and sag development may also be made using the technique of ray deflection mapping. By taking successive photographs, or by incorporating a suitable photodetecting system, the rate of change of surface irregularity can be measured. If laser light is used to illuminate the inclined slit, the diffraction produced by the slit would be more pronounced and it should be possible to measure the movement of the surface using Doppler velocimetry[5, 6].

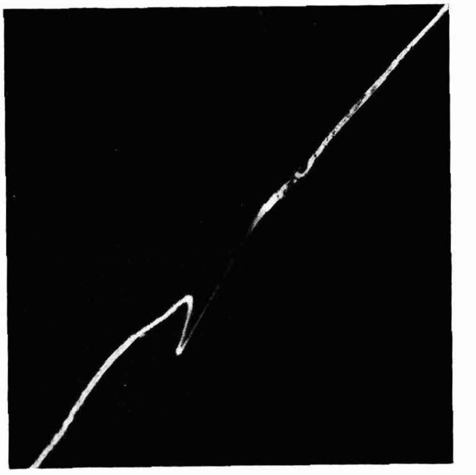

Fig. 6. Inclined slit record of a paint surface exhibiting sag; obtained using optical system shown in Fig. 3b

Schlieren method

Principle

The principle of the schlieren method is illustrated in Fig. 7. Parallel light incident on the surface is, in the absence of any surface irregularity, brought to a focus on the optical axis in the focal plane of the schlieren lens L_s. Light deflected through an angle θ by a surface facet (inclined at an angle φ to the mean surface plane) is also brought to a focus in the focal plane of the schlieren lens but at a distance θf_s from the optic axis, where f_s is the focal length of the schlieren lens. Directly behind the focal plane of the schlieren lens is a projection lens which images the test surface on to a viewing screen, photographic film, or photo-detector. If a schlieren stop, shown as a knife edge in Fig. 7, is positioned so that it cuts off light deflected through an angle θ, or greater, all areas on the test surface which have a slope greater than 0.5θ will appear as dark in the schlieren image, and areas with slopes less than 0.5θ will appear bright.

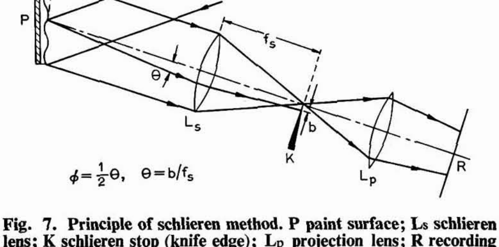

Fig. 7. Principle of schlieren method. P paint surface; L_s schlieren lens; K schlieren stop (knife edge); L_p projection lens; R recording plane

Optical system

A schlieren mirror can, of course, be used instead of a schlieren lens. This has the advantage of allowing larger fields of view to be studied. It also provides a convenient means for folding the optical system and, therefore, helps to save space. It eliminates chromatic aberration but introduces astigmatism. However, if an identical mirror is used to collimate the light and a symmetrical optical system is built as shown in Fig. 8, the effects of astigmatism are self cancelling. It is advisable to keep the angles between the two mirrors as small as possible.

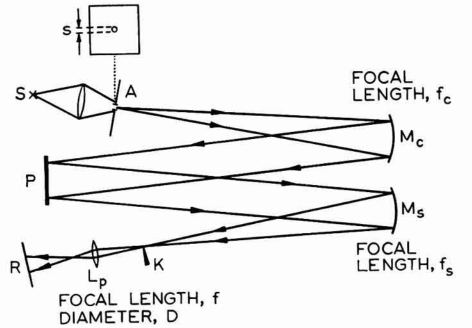

Fig. 8. Schlieren system used for the photographing and measurement of surface characteristics.

S light source (250 watt mercury lamp); A screen containing pin-hole; M_c collimating mirror; P test surface; M_s schlieren mirror; K schlieren stop (shown as knife edge); L_p lens imaging P on to recording plane; R recording plane. $s = 1.10 \times 10^{-1}$cm; f_c=93.5cm; f_s=93.5cm; diameter of collimating and schlieren mirrors=10.0cm; f=50cm or 100cm; D=5.0cm.

The schlieren stop need not necessarily be a knife edge, and circular stops, iris diaphragms, parallel slits, and coloured filters have all been used to advantage. The choice of schlieren stop depends on the nature of the object under test.

Limitations

The spatial resolution of the schlieren system illustrated is ultimately set by the numerical aperture of the imaging optics. If the diameter of the imaging lens is D, it can be shown that the system is incapable of resolving points in the object space less than $(2\lambda f_s)/D$ apart. For $\lambda = 5 \times 10^{-5}$cm, $f_s = 10^2$cm, and D=5cm the limiting distance is of the order of 20μm.

The minimum measurable slope can be estimated from a knowledge of the finite divergence of the collimated beam. This divergence arises from the finite size of the light source S or aperture A whichever is the smaller. The focal spot at the focus of the schlieren lens is, in fact, the image of the aperture A. If this spot size has a diameter s then a change in surface slope must be at least $s/2f_s$ before the region appears as completely dark in the image. For $s = 10^{-1}$cm and $f_s = 10^2$cm, this angle is 0.5mrad.

The maximum measurable change in surface slope is, for the optical system illustrated in Fig. 8, limited by the diameter of the imaging lens, and is equal to $D/(2f_s)$. For D=5cm and $f_s = 10^2$cm this angle is, therefore, 25mrad. All regions producing deflections greater than this will appear dark in the image even in the absence of a schlieren stop. By suitable choice of components, it is possible to design a schlieren system to have, within reason, any sensitivity required.

Applications

With the schlieren system illustrated in Fig. 8, a broad range of surface defects and structures may be made visible. By suitable design and positioning of the schlieren stop, any aspect of the surface structure may be measured. By replacing the photographic film with a photodetector it is possible, in some cases, to arrange for a certain aspect of surface structure to be measured directly on a meter.

Photography and measurement of surface slopes using opaque schlieren stops

Fig. 9 shows the presence of ribs in a lacquer coating applied to tinplate, made visible with a knife edge schlieren stop with its edge set parallel to the ribs. By adjusting the knife edge position relative to the optical axis, it is possible to alter the sensitivity of the system to reveal the presence of ribs having any defined slope. If the maximum acceptable slope (or amplitude if a sinusoidal slope can be assumed) were defined, the optical system could be set up for the purposes of coating quality control; in such an arrangement, the coating would be considered acceptable when no dark regions were visible on a viewing screen.

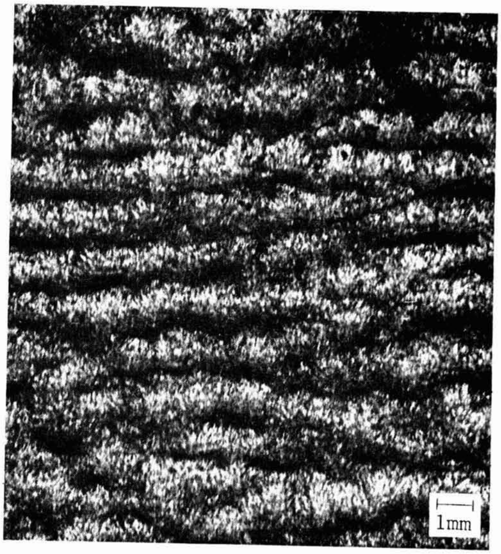

Fig. 9. Photograph showing ribbiness in a lacquer coating, using a knife edge schlieren stop with its edge set parallel to the ribs

An example where an iris diaphragm schlieren stop may be used to advantage is shown in Fig. 10. This is a schlieren image of a powder coating. The aperture of the diaphragm has been set to reveal regions (dark areas) having a surface slope exceeding approximately 3mrad.

Figs. 11a and 11b illustrate how different facets of the same surface may be brought out in the schlieren image by the appropriate choice of schlieren stop. In Fig. 11a the stop was a knife edge with its edge vertical and in Fig. 11b an opaque centre stop was used. The test surface was a paint film which contained a high concentration of nibs and was applied to a vertical surface. Note, the drain streaks apparent in Fig. 11a have been suppressed and are not visible in the schlieren photograph shown in Fig. 11b.

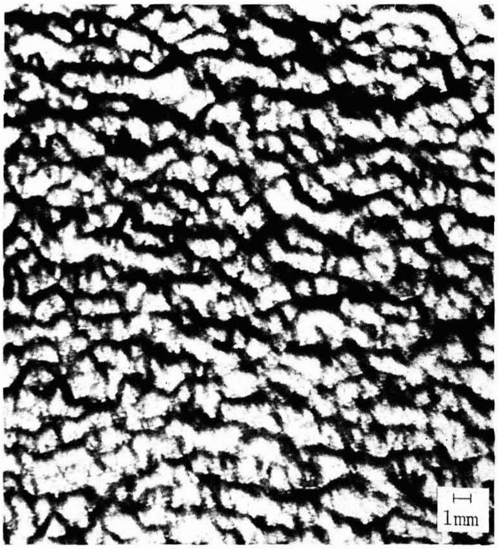

Fig. 10. Schlieren image of a powder coating obtained using an iris diaphragm as a schlieren stop. Dark regions correspond to areas having a slope greater than 3 mrad

Fig. 11a

Fig. 11b

Fig. 11. Schlieren image of surface defects in a paint film applied to a vertical surface.

(a) Showing the presence of nibs and vertical flow lines and (b) showing the presence of nibs only. In (a) a vertical knife edge schlieren stop was used, and in (b) an opaque centre stop.

Fig. 12 is a schlieren photograph of a brush-applied paint surface using a knife edge stop aligned parallel to the direction of brush out. The dark areas correspond to slopes greater than 3mrad.

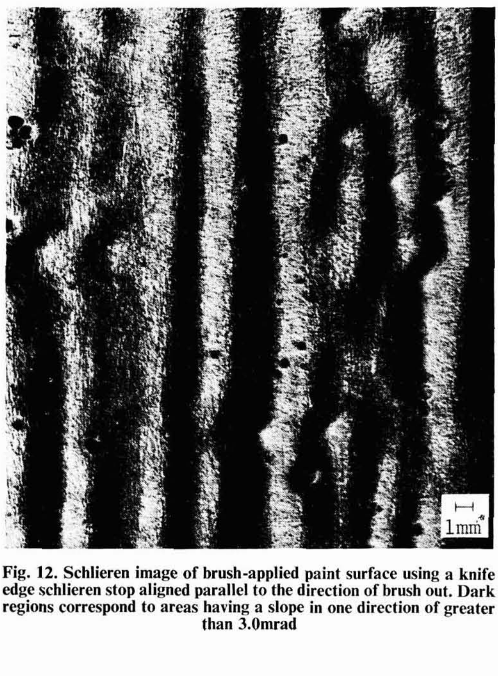

Fig. 12. Schlieren image of brush-applied paint surface using a knife edge schlieren stop aligned parallel to the direction of brush out. Dark regions correspond to areas having a slope in one direction of greater than 3.0mrad

Ridges of very low amplitude perpendicular to the direction of application are made visible in Fig. 13. The dark regions correspond to surface slopes of the order of 0.5mrad and greater. The surface slopes visualised as dark areas in Figs. 12 and 13 all occur in one direction.

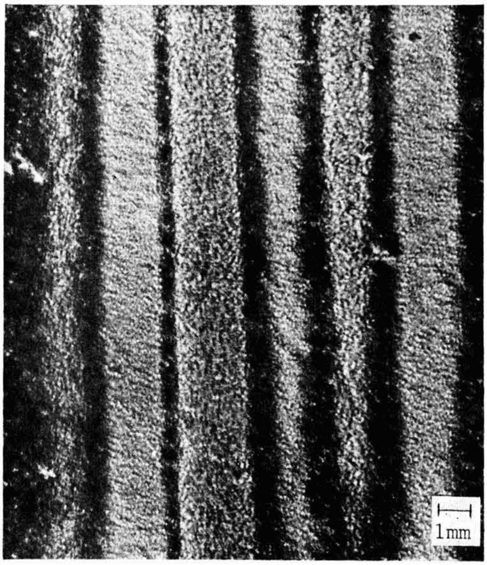

Fig. 13. Schlieren image of low amplitude ridges perpendicular to direction of application using a draw-down blade. Knife edge schlieren stop aligned parallel to ridges. Dark regions correspond to areas having a slope of the order of 0.5mrad and greater

A sag front is shown in Figs. 14a and 14b. In Fig. 14a, a knife edge schlieren stop was aligned parallel to the front so that the leading edge just became visible (dark area). The point at which this just occurred corresponded to a surface slope of 9mrad. A slit schlieren stop was used to produce the dark areas in Fig. 14b. In this case all the light deflected by more than 1mrad in both the upward and downward directions has been removed. The photograph illustrates the very poor flow properties of this particular paint both from the view of levelling and sag resistance. Note that in Fig. 14b there is no way of differentiating between upward and downward deflections.

Measurement of surface slopes using coloured transparent schlieren "stops"

The evaluation of surface structures in terms of ray deflections in a single direction may not, in many cases, be sufficient. In these circumstances it is necessary to use a slit schlieren stop. The ambiguity that arises from using such a slit—see Fig. 14b —may be overcome by replacing the schlieren slit with strips of coloured transparent film.

Fig. 15 illustrates how the direction of surface slope may be clearly defined by using coloured transparent strips as a schlieren stop. Regions of white or pale blue correspond to flat areas, whilst red and dark blue regions correspond to surface slopes producing ray deflections in the upward and downward directions respectively.

In Fig. 16 the relatively steep slope of the sag front is shown as blue, flat areas as yellow-green, and slopes opposite to that of the sag front as dark green.

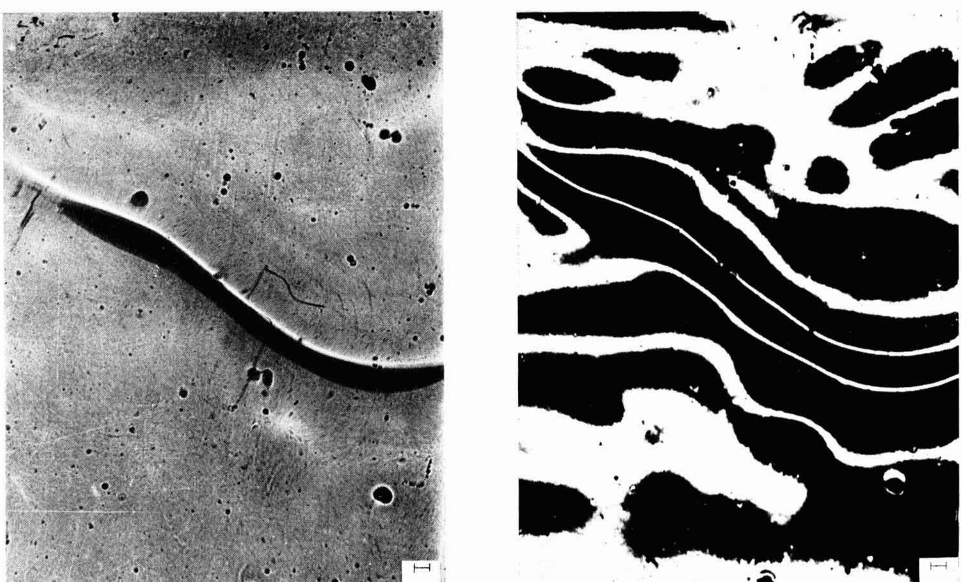

Fig. 14. Schlieren images of sagging paint film. (a) Knife edge schlieren stop aligned parallel to sag front so as to just cut off deflected light. (b) Slit schlieren stop aligned parallel to sag front so that light deflected in up and downward directions is cut off

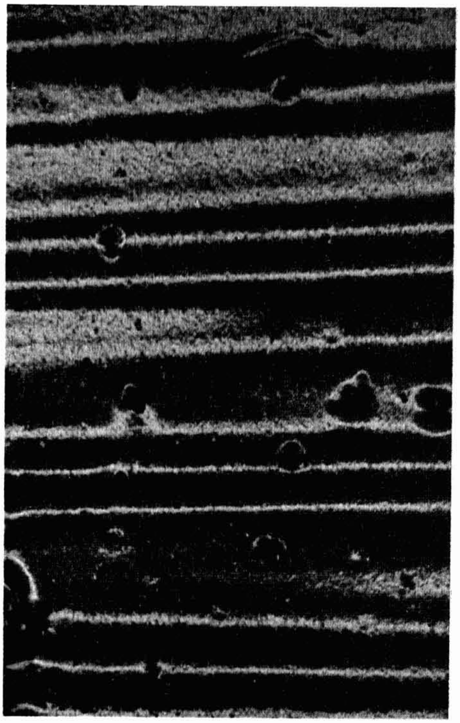

Fig. 15. Coloured schlieren image of surface (previously illustrated in Fig. 13) obtained using strips of coloured transparency as a schlieren stop.

Regions of white or pale blue correspond to flat areas; red and dark blue regions correspond to surface slopes producing ray deflections in opposite directions.

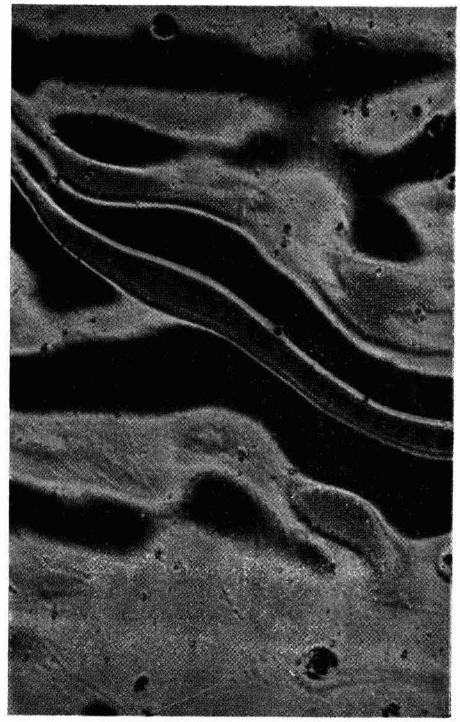

Fig. 16. Coloured schlieren image of surface (previously illustrated in Fig. 14b) obtained using strips of coloured transparency as a schlieren stop.

The steep slope of the sag front is shown as blue, flat areas as yellow-green, and slopes opposite to that of the sag front as dark green.

It is easy to see how this technique could be applied as a quick visual inspection tool for quality control purposes for surface finishes. The sensitivity of the device would be set by adjusting the position of the schlieren stop (that is, the boundary line between two coloured transparent strips) relative to the optical axis, and all the inspector would need to do would be to observe whether or not the schlieren image, projected on to a viewing screen, fell within the accepted colour limits. Whilst such a device has the great advantage of displaying the spatial distribution of surface defects, it relies on the eye to make an assessment on whether or not the field of view contains a significant colour change.

Photocell device for measurement of levelling.

The problem of deciding whether or not a significant area of surface under test is deflecting light through a given angle may be solved by replacing the eye with a photocell. This is particularly useful for making routine quantitative estimates of levelling.

Equations (6) to (8), derived for ray deflection mapping, are also applicable to the schlieren system. In this case θ is given by

$$\theta = b/f_s \quad \ldots\ldots (22)$$

where b is the distance of the schlieren stop (for example a knife edge) from the optical axis, and f_s is the focal length of the schlieren lens. The magnitude of the maximum surface slope, therefore, is given by

$$\varphi_{max} = b_{max}/2f_s \quad \ldots\ldots (23)$$

where b_{max} is the distance of the knife edge from the optical axis beyond which there is no detectable change in photocell reading. In this circumstance all the light reflected from the paint film falls on the photocell. If a sinusoidal profile can be assumed and the wavelength of the ridges on the levelling blade is known, the amplitude of the residual ridges on the unlevelled coating is given by:

$$y_0 = \lambda^* b_{max}/(4\pi f_s) \quad \ldots\ldots (24)$$

A compact schlieren system of low sensitivity was built using 25cm focal length collimating and schlieren lenses. Instead of forming an image of the test space on a screen or photographic film, the lens immediately behind the focal plane of the schlieren lens was used to project the light from the test object on to a calibrated photocell. The schlieren stop was an iris diaphragm. As the test object was a film of paint applied using the PRA levelling blade, deflections occurred in only one plane and so the iris diaphragm acted as a symmetrical schlieren slit centred on the optical axis. Fig. 17 shows how the photocurrent reading varied as a function of the iris diaphragm aperture setting. The diaphragm radius corresponding to the point where the photocell reading becomes independent of aperture size is a direct measure of the maximum slope of the ridges. The iris diaphragm can be calibrated directly in surface slope units (radians or degrees), or if a sinusoidal profile can be assumed in units of amplitude (e.g. microns). In the example cited $\varphi_{max} = 12.4$mrad and $y_0 = 5.1\mu$m.

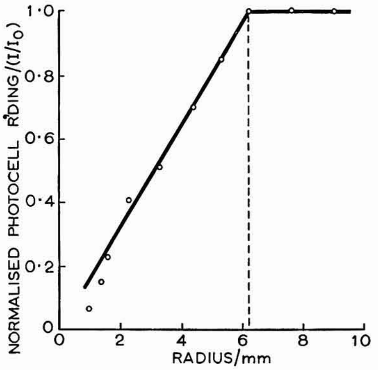

Fig. 17. Fractional change in photocurrent as a function of radius of iris diaphragm schlieren stop

Discussion and conclusions

Refs. 7, 8, 8, 4

The techniques described overcome a number of deficiencies inherent in some of the otherwise very useful devices frequently used for characterising surfaces. For example, the Talysurf[7] is capable of very accurate surface profile measurements but has only a limited travel and is, of course, unsuitable for following the dynamics of levelling and flow-out. Optical interference methods[8], whilst precise, are generally not so easy to use and if large fields of view are needed can be very expensive. Methods[8] of evaluating surface flatness, based on a visual observation of a reflected image distorted by surface irregularities, are not so amenable to precise interpretation as are ray deflection mapping and schlieren methods. The PRA levelling blade and viewer[4] has proved very useful for assessing the levelling properties of a paint. In the original method, levelling was rated by reference to a set of arbitrary standards. By using the ray deflection mapping procedures discussed in this paper, the use of the levelling blade can now be placed on a sound quantitative basis.

The ray deflection mapping and schlieren methods have been used to characterise quantitatively a variety of paint surfaces. They have been demonstrated to be of high sensitivity and precision and should prove useful in the research and quality control laboratories of maufacturers concerned with high quality surface finishes. In particular, because they can be used for monitoring the dynamics of flow-out and levelling, they should aid the technologist developing new coatings. The techniques described can easily be adapted for routine use in the quality control laboratory by unskilled personnel.

Acknowledgments

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Next month's issue

The Honorary Editor has accepted the following papers for publication, and they are expected to appear in the March issue of the *Journal:*

Blistering of varnish films on substrates induced by salts *by L. A. van der Meer-Lerk and P. M. Heertjes*

Plastics through atomic radiation *by T. A. Du Plessis and N. G. Schnautz*

The performance of low lead content wood primers *by P. Whiteley and G. W. Rothwell*

J. Oil Col. Chem. Assoc. 1975, 58, 51-56

Recent developments in protective finishes for metal containers. Part I: Internal organic coatings*

By R. T. Read

Metal Box Company Limited, Materials Development Division, Research and Development Department, Acton, London W3 0RR

Summary

The paper is divided in two parts and discusses the internal and external developments in protective finishes for three-piece and the more recently developed two-piece drawn and wall ironed (DWI) containers.

In this first part, the latest internal developments are discussed together with efforts to achieve greater flexibility with sulfur-resistant linings for open-top ends: modifications to both oleoresinous and phenolic systems are highlighted. Where possible the use of PVC organosol rather than vinyl solutions is justified and this section of the paper verifies the fact both economically and ecologically. Restrictions to the use of raw materials in formulations of internal linings are discussed and include the effects of the requirements of the Food and Drug Administration (of America) (FDA); ketonic solvents in epoxy and phenolic formulations; the 1972 fire regulations; and solvent recovery. The final section is an epitome of the developments involved with spraying internal linings to tinplate DWI beverage cans. The wall ironing process and the problems inherited with an ironed tinplate surface are explained. The effects of spray patterns on surface dimension are given as well as the variations of lacquer viscosity, temperature and pressure. The section on DWI internal spraying concludes with the results of an air purge experiment designed as a preventive against blister formation.

Keywords

Types and classes of coating and allied products

can coating
organosol coating
phenolic varnish
phenolic-epoxy varnish
spray finish

Développements récents dans le domaine de revêtements protecteurs pour les emballages métalliques: lère. Partie Revêtements organiques pour les surfaces intérieures.

Résumé

Cet article est en deux parties et il traite des développements dans le domaine des revêtements protecteurs pour les surfaces à la fois intérieures et extérieures des emballages à trois éléments et plus récemment pour les emballages étirés à deux éléments ainsi que les emballages DWI.

Dans cette première partie on discute les plus récents développements à l'égard de l'intérieure, de même que, dans le cas des emballages ouverts, les tentatives vers l'obtention d'une souplesse augmentée au moyen des revêtements résistant au soufre: on souligne les modifications effectuées aux systèmes formophénoliques ou aux vernis gras. Dans la mesure du possible on justifie l'emploi des organosols plutôt que des solutions de résines vinyliques, et dans cette partie on vérifie ce fait au points de vue économique et écologique. On discute les contraintes imposées sur l'emploi de certaines matières premières comme constituants des revêtements intérieurs y compris les effets des exigences de la Food and Drugs Administration de l'U.S. (F.D.A.); les solvants cétoniques en compositions époxyde ou formophénolique: les règlements sur la prévention de l'incendie de 1972; et la récuperation de solvants. La dernière section de cet article est un epitomé des développements dans le domaine des revêtements pour application par pistolage aux surfaces intérieures des boites à boisson en fer blanc (DWI). On explique le procédé d'aplanissement des parois des boites et les problèmes inhérents à la surface de fer blanc aplani. On mentionne l'influence qu'exerce le trajet du pistolet sur les dimensions superficielles, ainsi que des variations de la viscosité du revêtement, de la température et la pression. A la fin de la section consacrée au pistolage des surfaces intérieures des boites (DWI), on donne les résultats d'une expérience pour apprécier l'efficacité d'une purgation par air en tant que moyen de prévention de la formation de soufflures.

Neuere Entwicklungen von Schutzlacken für Metallbehälter: Teil I. Organische Beschichtungsmittel für das Innere

Zusammenfassung

Die Arbeit besteht aus zwei Teilen und bespricht die Entwicklungen von Schutzlacken für das Innere und Äussere von dreiteiligen und die unlängst entwickelten zweiteiligen, gezogenen und gut gedrosselten (DWI) Behälter.

In diesem ersten Teil werden die neuesten Entwicklungen betreffend den Innenschutz im Zusammenhang mit den Bemühungen grössere Biegefähigkeit schwefelbeständiger Auskleidungen für oben offenendende Modelle (open-top ends) besprochen: Modifikationen von Systemen auf Öl- und Phenolharzbasis werden besonders betont. Die Anwendung von vorzugsweise PVC Organosol anstelle von Vinyllösungen wird, wenn möglich, gerechtfertigt, und dieser Teil der Arbeit bestätigt dies sowohl vom wirtschaftlichen als auch ecologischen Standpunkt aus. Besprochen werden Beschränkungen hinsichtlich der Verwendung von Rohstoffen in Vorschriften für innere Auskleidungen, die Auswirkungen der von der amerikanischen Food and Drug Administration (FDA) gestellten Anforderungen eingeschlossen; Ketonlösungsmittel in Epoxy- und Phenolharzvorschriften; die Feuerschutzbestimmungen von 1972, und Lösungsmittelwiedergewinnung. Der Schlussteil ist ein Abriss der mit dem Spritzen von Innenauskleidungen von DWI Dosen für Getränke aus verzinntem Blech zusammenhängenden Entwicklungen. Das Drosslungsverfahren für die Wandungen und die mit einer aus gedrosseltem, verzinnten Blech bestehenden Oberfläche zusammenhängenden ererbten Probleme werden erklärt. Die Auswirkungen von Spritzmustern auf Oberflächendimensionen werden ebenso dargelegt, wie Variationen in der Lackviskostität, Temperatur und im Druck. Der sich mit DWI Spritzen des Inneren befassende Abschnitt schliesst mit der Wiedergabe der Resultate eines Luftreinigungsexperiments, das bestimmt war, Blasenbildung zu verhüten.

*Paper presented to a meeting of the London Section on 12 February 1974

The introduction of a phenolic-epoxy formulation

Two of the longest established internal protective linings have suffered as a result of trends to improve the sulfide staining resistance caused by processed foods. They are the phenolic and zinc oxide oleoresinous types (both with "open-top" end application).

During the processing of meat and vegetable packs, hydrogen sulfide is liberated and may give rise to underfilm staining (tin sulfide) and blackening (iron sulfide). The latter normally occurs at the headspace end and is the more commercially unacceptable of the two effects. The main factors affecting blackening are:

1. Protein degradation of the food
2. Processing temperature control
3. Air content of the headspace
4. Iron exposure in the headspace

The phenolics are highly cross-linked polymers and give excellent underfilm stain resistance; unfortunately, because they are so highly cross-linked, they only just reach the flexibility required to withstand open-top end stamping. By keeping the film weight low, however, every chance is given to attain maximum flexibility, although there has always been a danger in that the lacquer film is stretched to near its limit of flexibility during stamping of the ends, and it is sensitive to fracture. A break of this type is a site for the onset of iron sulfide blackening.

Another vulnerable property of phenolics is their lack of adhesion to prestoved tinplate. External decoration of the tinplate, therefore, must take place after application of the internal phenolic with a risk of mechanical damage during sheet stacking and the possibility of occasional overstoving of the internal lacquer. Overstoving increases the cross linking of the phenolics, thus decreasing the flexibility and increasing the risk of failure to fabricated open-top ends.

The internal lubrication of the phenolics improved their performance to some extent, but the so called "flexible" phenolics remained characteristically vulnerable to tooling.

A similar development has taken place in solving the problems of sulfur-resistant oleoresinous lining for ends of open-top, processed food cans. This type of material offers a more flexible lining than phenolics, but even at three times the basic film weight of the phenolics it does not possess the same excellent underfilm sulfide stain resistance. Acceptable sulfide resistance (SR) is achieved, however, by the addition of zinc oxide to the oleoresinous medium just before application. The sulfide attack of the metallic tin is prevented by reaction with the zinc oxide in the film thus alleviating the formation of tin and iron sulfides. Recently, however, occasional failure of the flexibility of the oleoresinous lacquer has been experienced, giving rise to blackening at the headspace end of open-top vegetable cans. This has occurred to such an extent that a new system has been developed.

So the problem of blackening exists on two fronts—meats (phenolic open top ends) and vegetables (oleoresinous SR open top ends).

It was decided to evaluate a range of phenolic epoxy formulations bearing in mind two factors:

(a) The flexibility should be increased compared to phenolics,

(b) The cost should be kept close to phenolics (bearing in mind the increase of film weight); see Table 1.

Obviously, these materials were formulated with relatively low concentrations of epoxy resin but with sufficient amounts of it to gain flexibility without losing too much underfilm stain resistance.

Although the phenolic-epoxy lacquer does not possess underfilm stain resistance equal to that of straight phenolics, it has increased resistance to breakdown during end stamping as shown by the blackening resistance in laboratory evaluations and monitored commercial operations.

The blackening of vegetable cans around the headspace end has been reduced also by incorporating a phenolic-epoxy lining. The phenolic-epoxy is used as the base coat and the oleoresinous sulfur-resistant lining as a top coat in a new two-coat system.

The use of organosol linings for metal containers

One of the many cost saving trends that has occurred over recent years in the internal lining of metal containers is the gradual use of organosols in place of vinyl solutions. With vinyl solutions it is difficult to achieve high solids content at the practical application viscosities, so that the necessary dry film weights are difficult to obtain in one pass through the coater. However, by dispersing higher molecular weight

Table 1
Relative costs of phenolic epoxy formulations

Type	Dry film weight (g m^{-2})	Relative cost per SI unit of tinplate area or SI (TA) defined as 100m^2
Phenolic-epoxy	2.79 3.86	1.38 1.92
Phenolic-epoxy	2.79 3.86	1.54 2.15
Epoxy-phenolic (Control 1)	3.72	2.23
Phenolic	2.79	1.77
Phenolic	2.33	1.30
Phenolic (Control 2)	1.86	1.00

polyvinyl chloride (pvc) polymers in organic diluent and plasticiser with a minimum of true solvent, it is possible to achieve increased solids at the usual application viscosities. Thus higher film weights can be obtained with one application (see Table 2). In addition, to the single pass high film weight organosols are:

(a) Cheaper on applied costs than vinyl solutions as shown by the lower cost per SIta (System International tinplate area, that is 100m^2) despite their higher cost per litre (Table 3).

(b) They present less of an ecological hazard (see Table 4).

Table 2

Dry film weight comparisons of solution, vinyls and pvc organosols

Type	Solids	One-pass dry film weight: (g m^{-2})
Solution vinyl	20%	6.96
Pvc organosol	60%	13.95

Table 3

Organosol linings: relative costs to vinyl solutions

Type	Solids (%)	Relative cost per litre	Dry film weight (g m^{-2})	Relative cost per SI (TA)
Organosol	52	1.96	8.51	1.42
Organosol	57	1.66	3.86	0.48
Vinyl solution	28	1.34	8.51	1.87
Vinyl solution	19	1.00	3.86	1.00

Table 4

Comparison of oven exhaust[4] organosol versus vinyl solution

Type	Solids (%)	Dry film weight (g m^{-2})	Rate of solvent removal kg hr^{-1}
Organosol	52	8.51	25.43
Organosol	66	8.51	14.10
Vinyl solution	28	8.51	70.84
Vinyl solution	23	8.51	92.17

Organosols are generally used as replacements for vinyl solutions as internal linings for metal containers. For example, organosols are used to protect the highly tooled aerosol valve cups from corrosion. Pvc organosols are used to protect the non-repair easy-open soft drink aluminium end. This end is particularly difficult to fabricate because of the need to maintain very low metal exposure, in order to prevent sacrificial attack of the aluminium coupled to the iron of the tinplate in acid medium. General line containers and tin-free steel open-top ends are also coated with pvc organosols.

One feature of pvc organosols is the need for plasticised formulations to withstand extraction tests. A high extraction rate can be encountered and care must be taken to ensure this falls within acceptable levels.

Another form of organosol is the non-aromatic dispersion in which polymers other than pvc are dispersed in an organic solvent at high solids. These dispersions are not used to any great extent, but a large potential exists, and will require investigation if only from the environmental standpoints.

Recent trends affecting the use of raw materials

Refs. 1-5

The last six years has seen the introduction of a number of modifications in the use of raw materials for internal linings for containers. These modifications have been brought about mainly by:

(a) The Food and Drugs Administration of America (FDA) requirements;

(b) Substitution for ketonic solvents in phenolic and epoxy phenolic formulations;

(c) The Highly Flammable Liquids and Liquified Petroleum Gases Regulations 1972; and

(d) Solvent recovery.

FDA requirements

There is a list of raw materials (White List) in specific and general terms to which the author's company insists all internal formulations must conform. As well as the White List there is also an extraction requirement which must not exceed (i) 0.5 mg of extractant per square inch of surface, and (ii) 50 ppm of the total volume of the container[1]. The extraction solvents are water-alcohol mixtures for beer and beverage, water alone for highly acid packs such as fruits, and heptane for fatty foods. The temperatures of the extractions vary and are related to the process temperature of the pack.

Substitution for ketonic solvents in phenolic and epoxy formulations

The use of ketonic solvents in lacquers for meat packs is avoided for the following reasons:

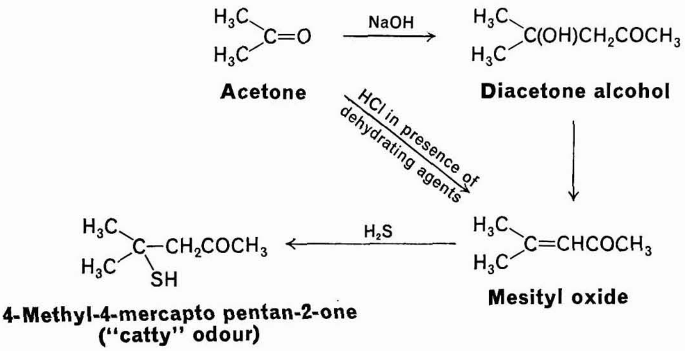

Fig. 1. Formation of a mercaptan from ketonic sources

It was shown by various workers[2,3] that mesityl oxide, which may be present in small amounts in diacetone alcohol could react with hydrogen sulfide to produce a mercaptan with a "catty" odour. The concentration of the mesityl oxide need only be 0.02 ppm for this "catty" odour to be detectable (see Fig. 1).

It was assumed that mercaptans might also be produced by the reaction of other ketones with hydrogen sulfide and it was decided, therefore, that ketones should be eliminated from epoxy-phenolic and phenolic lacquers used on meat cans on the grounds that extremely minute traces might be left in the film. It should be emphasised that it has never been proved that "catty" odours have been produced in this way nor is it accepted that even minute traces of solvent normally remain in the lacquer films after stoving. The elimination of ketones was taken as a precautionary measure.

Ketones have been replaced in internal lacquers chiefly by glycol ethers.

The Highly Flammable Liquids and Liquified Petroleum Gases Regulations 1972

This Regulation[4] extends the classification of highly inflammable liquids from a flash point of below 22.77°C to below 32.22°C. In some formulations whose flash points were above 22.77°C (the pre-1972 temperature limit) but below 32.22°C, it has been possible to modify these to give a flash point above the newer limit. This modification takes the materials outside the scope of the regulations and alleviates the need for strict storage conditions.

Solvent recovery

Solvent recovery may have to be extended and conservation has been brought about by two major factors:

1. The shortage and consequent price increase of solvents because of the oil crisis.

2. The introduction of the Deposit of Poisonous Waste Act[5]. This act has increased the price of solvent disposal and can rise to 50p per gallon depending on transport necessary.

Solvents obtained by regeneration save up to an estimated 10p per gallon, but there tends to be apprehension about the use of regenerated solvents as thinners and it is generally expected to limit the use of these solvents to wash-up purposes. Low boiling solvents are regenerated readily. Most recovery plants will accept up to 30% solids in the waste.

Spraying techniques for internal application to 12oz (0.34kg) DWI cans

One of the most revolutionary steps taken recently in the field of small metal packages is the development of a two-piece wall-ironed can. It was decided initially to market the can in tinplate form for packaging soft drinks using static internal spray techniques, thereby permitting greatly increased production speeds. In the static spray process, lacquer is taken from the source and pumped around a closed circuit in which the nozzle and lacquer heater are in series (Fig. 4). The pressure of the liquid is such that atomisation of the lacquer is achieved at the nozzle without the aid of compressed air. A detector signals an electronic timer which operates a solenoid and the compressed air released through the solenoid operates a small bellows valve on the nozzle head. Bearing in mind the packaging performance criteria of very low tin and iron pick up, the factors involved are as follows:

1. No side seam thus eliminating the most vulnerable section likely to give rise to perforation. In the few cases when perforations have occurred with three-piece cans packed with soft drinks, the most common cause has been failure within the side seam area.

2. Soft drinks in the main are iron anodic, and may perforate.

3. Static guns of the type required to spray two-piece cans require a new technology. Although they help to raise production speeds, their adjustments to obtain adequate metal coverage are more sensitive than reciprocating techniques.

4. The tin layer is disturbed during manufacture thereby exposing iron (Fig. 2).

It was decided to use a basic two coat specification for the can, since this would give an additional guarantee of performance.

The static gun spray time is controlled electronically, allowing about 90 milliseconds to spray an even coat on to the complete can. The best possible results are obtained with this technique by the use of nozzles designed to "beam" the lacquer at different rates according to the angle and distance

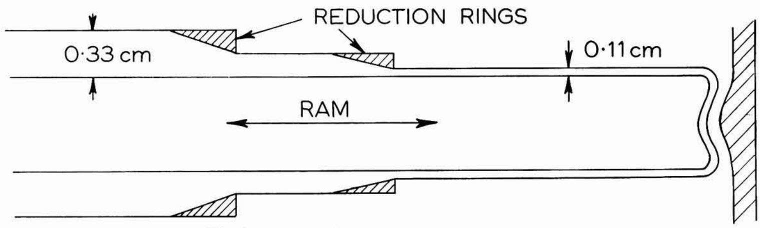

Fig. 2. Cross section of wall ironing process

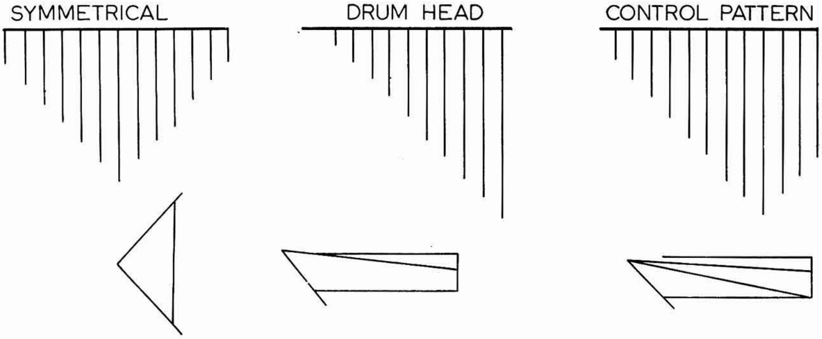

Fig. 3. Sprayhead nozzle patterns

from the can. The pattern is established by shooting liquid from the gun on to corrugated paper at a fixed distance and perpendicular to the nozzle (Fig. 3).

The spray pattern is controlled by the shape of the nozzle orifice. A symmetrical elliptical cut will deliver an asymmetrical pattern which, on a flat surface, results in a differential film thickness (Fig. 3). If the nozzle cut is made asymmetric the delivery is differential and it is possible to achieve a more even film thickness on a flat surface. A nozzle of this type is called a "drum head" nozzle and is shown in Fig. 3. An extension of the drum head design is a nozzle that is capable of covering evenly a two-dimensional flat surface, such as a two-piece can. Such a nozzle is called "control pattern" (Fig. 3). The controlled pattern nozzle effectively contains two drum head orifices, one controlling an even film weight to the body area and the other controlling an even film weight to the end area of a two-piece can. In order to achieve complete coverage over the body and end areas, the can is spun through at least three revolutions during lacquer application.

However, a lot of experimentation with varying viscosities, solvent balance, temperatures, pressures and spray times as well as nozzle type, was necessary before acceptable metal coverage and film weight were obtained. Each nozzle is hand cut, so that each one varies a little within the same basic design. It may be that at one setting of spray time, spray temperature, spray pressure and viscosity, a drum head nozzle gives a more equal film weight between base and wall than the expected control pattern. Sometimes turbulence plates are used to improve atomisation at the gun head so that the pump pressures can be reduced. The size of the turbulence plate, nozzle and filter correlate so that any

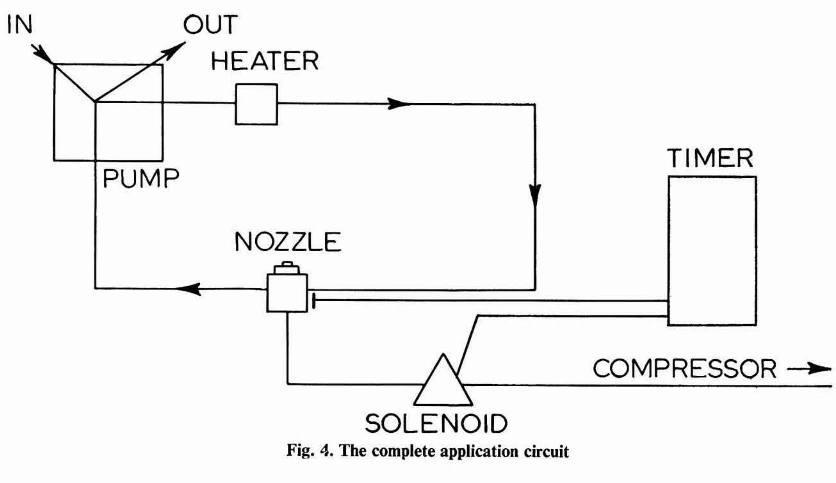

Fig. 4. The complete application circuit

particles which are larger than the nozzle and turbulence plate orifices are filtered out.

The position of the nozzle is extremely critical and precise mechanical control is essential (high gear screw mechanism) if consistently acceptable results are to be obtained. Fig. 4 shows the complete application circuit.

In order to achieve the necessary metal coverage both the base coat and top coat were given elaborate solvent modifications as well as numerous adjustments in temperature, pressure, and timing. For example, an increase in either pressure or time should result in an increase in film weight, but increasing pressure may be too sensitive within the working range, and the increased film weight may be too great and give rise to blistering. In another set of conditions, the reverse may be true and the spray time may be more critical in causing blistering.

As well as the physical adjustments, both coats were given a series of solvent modifications, which are briefly outlined in Table 5.

These conditions gave success at the sprayhead itself, but both spray processes still remained vulnerable to blistering and it was decided to evaluate a method of accelerating solvent evaporation between the sprayhead and the oven. A mechanical rig blowing air at various temperatures and velocities was set up at different stations between the sprayhead and the oven. Solvent extraction and degree of blistering was observed. oven. Both solvent extraction and degree of blistering were observed.

The conclusions drawn from these observations were:

(a) if air is to be blown into the can at an early stage then air velocities of less than 0.66m s^{-1} must be used to achieve satisfactory conditions.

(b) if the air velocity applied is greater than 0.66m s^{-1}, it becomes advisable to purge as far away from the nozzle head as possible to achieve satisfactory results. At least 80 seconds should elapse after spraying before puıging in this case.

Acknowledgments

The author would like to thank Mr W. H. Campbell and Mr P. H. Prince of Ault and Wiborg Limited for their help with this paper. Thanks are also due to the management of the Metal Box Company for permission to publish the paper.

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Table 5

Solvent modifications to base-and top coat formulations

Base coat					
Viscosity ($m^2 s^{-1}$)	8×10^{-5}	improved	4×10^{-5}		
Solids (%)	30	⟶	25		
Lacquer pressure (MPa)	5.171*	coverage	5.171		
Top coat					
Viscosity ($m^2 s^{-1}$)	8×10^{-5}	improved	4×10^{-5}	increased	1.1×10^{-6}
Solids (%)	30	⟶	17	⟶	22
Lacquer pressure (MPa)	5.171	coverage	5.171	film weight	7.584*

*5.171 MPa ≃ 750 psi; 7.584 MPa ≃ 1100 psi

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Recent developments in protective finishes for metal containers. Part II: External organic finishes*

By J. C. Holt

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Summary

This paper gives a resumé of the external organic finishes on metal containers and the methods of application. External finishes serve a decorative as well as a protective function and both these aspects must be considered when developing new materials and methods. Advances in the field of coatings, printing inks and varnishes are discussed, including their relationship to new customer and container manufacturing demands and to new developments in base metals, application techniques and equipment.

Keywords

Types and classes of coatings and allied products

can coating
metal decorating finish
printing ink
roller coating finish

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

lithography
overprinting
roller coating

drying or curing of coatings

ultraviolet curing

Développements récents dans le domaine de revêtements protecteurs pour les emballages métalliques: 2ème. Partie Revêtements organiques pour les surfaces extérieures.

Résumé

Cet exposé comprend une résumé des revêtements organiques pour les surfaces extérieures des emballages métalliques, ainsi que des méthodes d'application. Les finitions pour ces surfaces ont une fonction décorative autant que protectrice, et tous les deux aspects doivent être considérés lorsqu'on est en train de mettre au point des matériaux et des méthodes nouveaux. On discute le progrès dans les domaines de revêtements, d'encres d'imprimerie, et de vernis, y compris leur rapport aux demandes de nouveaux clients, et de nouveaux techniques de fabrication d'emballages, ainsi que de nouveaux développements à l'égard des métaux de base, des techniques d'application, et du matériel.

Neuere Entwicklungen von Schutzlacken für Metallbehälter: Teil 2 Organische Beschichtungsmittel für Aussen.

Zusammenfassung

Diese Abhandlung gibt ein Résumé der organischen Beschichtungsmittel für das Äussere von Metallbehältern. Aussenlacke haben die Funktionen sowohl zu schmücken als auch zu schützen, und beide Gesichtspunkte müssen bei der Entwicklung neuer Materialien und Methoden in Betracht gezogen werden. Fortschritte auf den Gebieten der Beschichtungsmittel, Druckfarben und Lacke werden besprochen, ebenfalls ihre Beziehung zu neuen Anforderungen seitens der Kunden und Behälterindustrie, sowie zu neuen Entwicklungen auf den Gebieten der Grundmetalle, Anwendungstechniken und Ausrüstung.

Introduction

Metal decorating is dealt with in this paper specifically in the context of the metal container industry.

The paper deals with the development of techniques of metal decorating, but does not deal in depth with the development of materials, which has often been required to keep abreast of the new techniques or which in some instances has initiated the new techniques. The Metal Box Company is a user of materials manufactured by a number of suppliers and although the formulation of conventional materials is often of common knowledge, the details of materials developed for new operations are not revealed or if for some reason, such as safety aspects, certain details are divulged this is done in confidence.

Developments are initiated by several factors, some of which are common throughout industry in general and not specific to metal decorating:

1. The need to cut operating costs to counter continuing increases in raw material and labour costs.

2. To expand the industry with minimum capital outlay.

3. To keep abreast of the changing demands of the packaging industry which is continually improving its own techniques.

4. The competition from other forms of packaging (for examples, plastics, paper, board and laminates).

5. Environmental demands—effluent disposal and solvent vapour control.

Many developments are not sensational and have taken place gradually over many years and are, therefore, not always appreciated. Reduction in the amount of material applied is not apparent from the appearance of the finished container, but improvements in resins and pigments for instance have made it possible to achieve an appearance as good, if not better, in colour and opacity with a film weighing 12.0g m^{-2} as was at one time obtainable only by applying a film weight in the region of 20g m^{-2}. This is a 40 per cent saving in material, but it has come about in small steps through the years. There are similar reductions in stoving schedules for conventional materials.

*Paper presented to a meeting of the London Section on 12 February 1974.

The decorative system

Conventional metal decorating in the container industry is by roller coater application of lacquers, coatings and varnishes (Fig. 1) and printing press application of the various inks (Fig. 2) to produce the design.

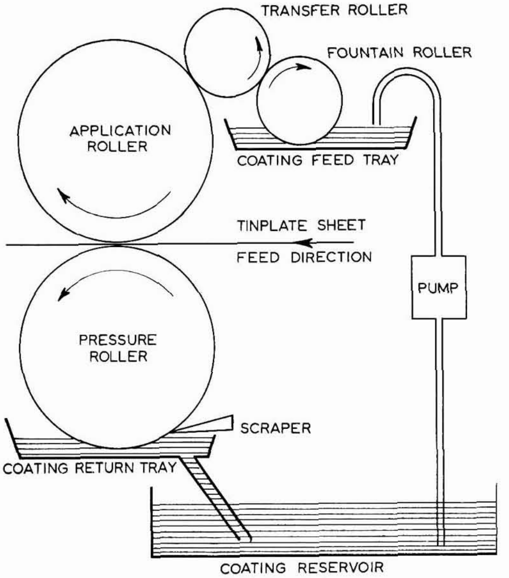


Fig. 1. Roller coater

It is usual to apply a white coating or a base white ink to receive the printed design. Over the printing inks an overprint varnish is applied to give gloss and hardness. If the decoration is to undergo severe tooling or to receive harsh treatment at some later stage, a size coat is applied before application of the white coating or white base ink, to improve the adhesion of the decorative materials.

In general, developments have been in the conventional field of decorating but in recent years some new concepts of container manufacture have been introduced which have required a reappraisal of decorating methods and materials.

The metal

The metal used in the container industry is for most part tinplate, although a percentage of aluminium is used for extruded containers and tooled components.

Developments are being made in this field, of which one result is the use of lighter gauge tinplate. This can and does give rise to problems, such as the sheets wrapping round rollers if the decorating materials are too viscous or tacky. This then requires control within closer limits of the rheological properties than with earlier materials. This is one initial restricting factor with any new development.

In recent years there have been developments in the use of tin-free steel for containers. Previously the corrosion hazard had restricted the wide use of non-tinned steel, but new surface treatment techniques have reduced this hazard. Tin-free steel does have the disadvantage of not being solderable and its use for built up containers is dependent on welding or organic bonding. It is, however, suitable for drawn containers and components. It has the advantage of good adhesion of the decorative materials, but being greyer in colour necessitates adjustment of the coating materials to obtain a final colour similar to that obtained with tinplate.

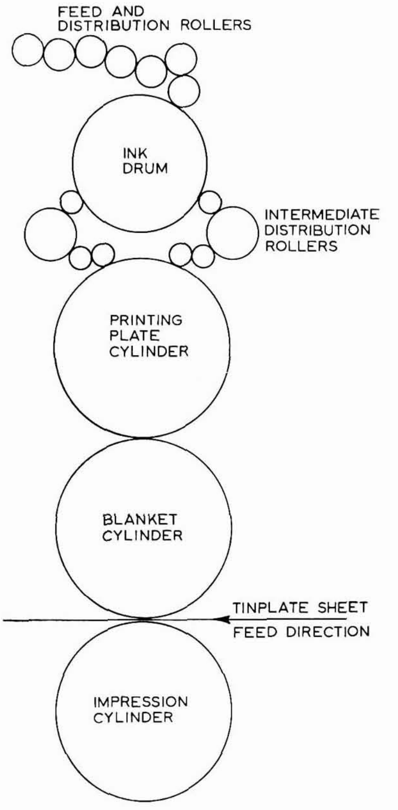


Fig. 2. Printing press

Size coats

This is a constituent of a number of decorative systems which the metal decorating industry would like completely eliminated. Only a thin film of size is applied, but it involves the cost of an additional application and stoving operation.

Sizes today are mainly of the epoxy or vinyl type, although alkyds are used to a limited extent. The mechanics of how they work is not completely understood despite many theories being put forward, but what is known is that they do improve significantly the adhesion of the decorative film when used with the appropriate coatings.

Coatings having good adhesion to the base metal have been conceived in recent years and in conjunction with other developments have resulted in a large percentage of work being unsized. Sizes are still required for work which involves severe deformation during stamping and tooling operations at high speeds, or where considerable abrasion of the decoration takes place. This latter problem frequently occurs not only in the container manufacturing operations, but also during subsequent packaging and distribution operations over which the metal decorator has no control.

Coatings

In the majority of cases the coatings used in the container industry are white, giving a background on to which the printer can apply his design. In some parts of the industry, however, such as the caps and closure field, solid coloured coatings are frequently used.

As mentioned previously, gradual improvements in reducing the quantity of coating necessary to give good opacity have taken place during recent years and improvements have been made which give brighter and cleaner whites. The development of polyester white coatings have contributed much in this area, since being completely synthetic, the manufacturer has greater control over their properties.

Coatings based on acrylic resins have marked heat stability and have given a wider scope to the metal decorator since any restoving schedules which might be necessary can be given a greater tolerance. Acrylic materials can have the disadvantage of an unpleasant odour in the wet state and have given rise to complaints from the shop floor. Some manufacturers, however, are managing to overcome this problem.

Both the above types of coatings are finding use in the processed food field where the food is given a high temperature steam process after packing in the can.

Application techniques have also improved and sheets of tinplate are now used with larger areas, giving a larger number of container impressions per sheet; higher coater speeds have necessitated coating modifications to eliminate "starving" of the rollers, and this advance has been assisted by the introduction of heaters on the roller coating machines which control the temperature of the coating and thereby control the application viscosity giving more consistent production.

Printing inks

This is the area where the more remarkable developments have taken place, which is not surprising since the printing operation is more complex than roller coating and, therefore, has more scope for development and simplification.

The conventional method of metal printing is by offset lithography. A bimetallic printing plate is used having an hydropholic metal area in the form of the design which is receptive to printing ink and a surrounding hydrophilic metal area receptive to water. This plate is fed by a system of inking rollers and a system of damping rollers. The ink is picked up on the design area but its pick-up is prevented by water in the non-image area. The printing plate transfers the ink, in the form of the design, to a rubber blanket which in turn transfers it to the sheet of tinplate or aluminium.

This process requires close control, since it is influenced by outside factors such as shop temperature, humidity and draughts. The inks can also become emulsified with the water present. This tendency varies with different inks and, therefore, is not a simple characteristic to control.

It can be seen that these problems are related to the presence of water and the elimination of water in the printing process would improve the printing efficiency.

Printing on to metal must be carried out by some offset process since the life of any printing plate printing directly on to metal would be extremely short.

Advances have been made in the paper printing industry by using a dry offset technique, whereby the non-image area is coated with a silicone-based material which, therefore, has a built-in rejection to printing ink. This technique has not been developed sufficiently for use in metal decorating but an alternative dry offset method is having considerable success. This last process involves a printing plate with the image area raised 0.05mm above the non-image area so that only the image area contacts the inking roller and picks up ink for transfer to the application blanket. The plates can be made of metal, but are frequently made of hard solvent-resistant plastic. Although this sounds a simple process it has, in fact, required considerable improvements in the printing inks to obtain satisfactory transfer and good quality reproduction at the high speeds currently used in the metal decorating industry.

The dry-offset plates are more expensive than conventional lithographic plates, but with the advent in recent years of much longer runs on one design, following similar trends in the packaging industry, the difference in price has become less significant.

The printing inks required considerable modification for dry-offset application, but whilst both processes are in use it is desirable to have inks suitable for both, to simplify stocks and to avoid the wrong inks being used, and this has been achieved to a great extent.

So far reference has been made solely to the printing of one colour, but a design usually consists of several colours. These colours can be applied and stoved independently, but it is desirable to reduce the number of stoving passes and where the different colours do not overlap these can be printed by having a number of single colour printing presses in sequence, the colours then being stoved at the same time. This operation requires very accurate registration of the print to avoid overlapping the colours and consequent blurring of the image edges. This can be overcome to some extent by using Y-type two colour printing presses (Fig. 3) but this is an expensive piece of equipment and has not been widely adopted, reliance generally being put on more precise engineering to improve the accuracy of register on follow-on printing lines.

The number of inks used for a design can often be reduced by overprinting one colour on another to produce a third colour. This would normally be carried out by stoving one colour before printing the second colour on top. It is possible, however, to print one wet ink on top of another wet ink providing the tack characteristics are adjusted to prevent the first ink being "picked-off" on to the application blanket applying the second ink. This technique, although in use, is not completely satisfactory for high speed work at present, since it depends on factors outside the control of the printer.

It would be a great advantage if it were possible to "set" the inks to be superimposed between the in-line single colour printing machines. Various methods have been investigated, flame treatment, high temperature air blasts and so forth, but the method showing the most promise to date is the setting of inks by ultraviolet radiation.

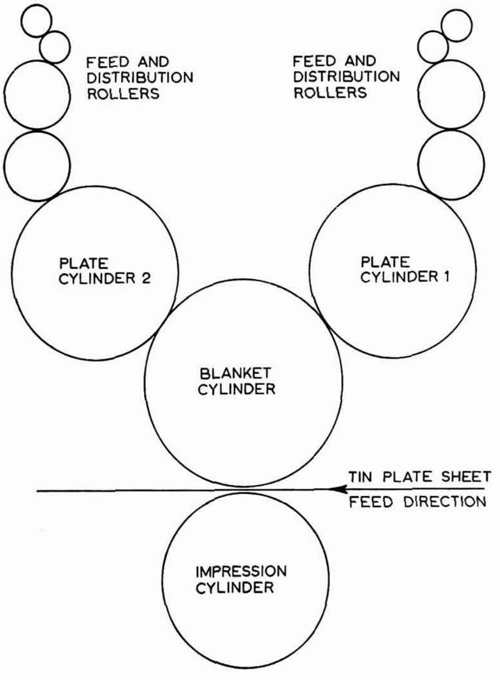


Fig. 3. Y-type printer

Setting or curing inks by ultraviolet (UV) radiation has required the investigation of a completely new field of ink formulation. Basically, it depends on the free radical polymerisation of unsaturated liquid materials to produce a solid. In the case of tin-printing inks, UV light is used to activate an initiator of the reaction.

The UV unit must be small in order to fit between the printing decks of a conventional line. At the present high speeds of these lines this means very short irradiation times, somewhere in the region of 0.02s. Fortunately inks are applied in very thin films and UV curing can be used successfully, but inks formulated for this type of work are at the moment limited in their physical flexibility after application and curing.

It is necessary that inks formulated for setting by UV radiation must have the usual properties for satisfactory printing, stability on the machine, good colour and colour retention, be non-toxic and have a good storage life.

Varnishes

Varnishes are applied over printing inks to give a good gloss and protection against abrasion. Today varnishes are applied directly over the last applications of wet ink by a roller coater in line with the printing presses. This has been achieved by using the correct balance of particular solvents to avoid washing out or "bleeding" of the inks.

Varnishes currently in use also contain lubricants to varying extents, depending on the final usage, to give good manufacturing line mobility, resistance to abrasion and to assist in stamping and tooling operations without the application of an external lubricant.

Non-varnish decoration

Attempts are being made, in some areas successfully, to use inks not requiring the application of an overvarnish. For this purpose, the inks themselves are required to have a satisfactory gloss, adhesion and abrasion resistance. Obtaining a good gloss is not too difficult, but in order to obtain good abrasion resistance it is necessary to incorporate a wax as lubricant and this unfortunately may affect the adhesion and final colour of the ink.

When using non-varnish inks there will be, in many designs, areas of unprinted white base coating. This coating will also be required to have good abrasion resistant which will necessitate the incorporation of a lubricant. This will then inhibit the adhesion of the ink.

The ultimate aim is, of course, a non-varnish UV-cured ink.

UV-cured varnishes

Another field being investigated is that of UV-cured varnishes. The demands made on a container varnish are more severe than on the other components of the decorative system, since it is the final film, exposed to external conditions. Depending on the type of product for which it is intended, it must have good chemical resistance, resistance to steam processing, a good colour and colour retention, good adhesion and resistance to abrasion. It is not expected that all these properties could be obtained initially with a UV-cured varnish, but should some of these properties be obtainable the varnish would be of use in certain fields.

Investigation is considered worthwhile, since even if only of limited use the combination of UV-cured printing inks and a UV-cured varnish would eliminate some of the large stoving ovens at present used with conventional decoration.

Water-based decorative materials

In keeping with the environmental demands being made today, the possibility of using water-based materials is being seriously studied. Initially, this is being looked at in relation to varnishes and promising results have been obtained in experimental application.

Problems which have been encountered are frothing on the roller coater, lower gloss than that obtained with solvent based varnishes and low viscosity which results in only relatively low film weights being obtainable.

Two-piece cans

A new technique of container manufacture introduced during recent years is that of drawing and wall ironing by which a one piece seamless container, the size of which is the same as a conventional built up and soldered container, requires only an end to be seamed on when the can is packed.

To be economical this method of can manufacture must operate at speeds similar to or greater than conventional can lines, that is in excess of 600 cans per minute. This is possible mechanically, but means that much higher decorating speeds than normally encountered are necessary. Owing to the heavy metal working it is not possible to pre-decorate the metal, therefore, each container must be decorated individually. Machines for decorating individual containers have been in use for some time for the decoration of extruded aluminium tubes, but these normally run at speeds of 80 to 100 containers per minute. On the other hand, when decorating sheets of plate for conventional built up cans, upward of 30 can body impressions are applied to each sheet in one pass. It can be seen, therefore, that very high speeds are required to decorate cans and maintain the same output as a conventional line.

Machines for this work are available, basically similar to the tube printing machines, but operating at much greater speeds (Fig. 4). To facilitate printing, a turret with eight application blankets is used and these blankets are inked by the dry-offset method from four inking stations. Demands on the inks are severe; transfer must be satisfactory at the high speeds used and the rheological properties and consistency of the inks must remain constant at the high roller speeds and varying temperatures which occur. The ink-fly characteristics must also be satisfactory at these speeds. The varnish is applied directly over the wet inks on the same machine and similar properties for use at high speeds are required of the varnish.

Since only four inking stations are available and each can is decorated in one pass, a maximum of four colours only can be applied, all four colours being applied to each application blanket. Designs are also limited since no over-printing of wet inks is possible, although it is hoped that future developments will overcome this restriction and widen the scope of the decoration.

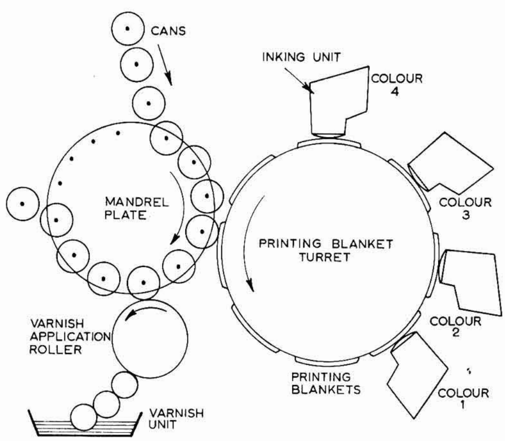


Fig. 4. Two-piece can decorator

[*Received 25 July 1974*

Review

New development in titrimetry

By J. Jordan, Editor

Marcel Dekker Inc., New York, 1974.
Pp. vii + 200. Price $19.75

Most chemists are aware that there are many other methods of establishing the end point of a titration than noting the change in colour of an indicator. This book, the second volume in a treatise on titrimetry, describes some of the less common methods. The first chapter deals with thermometric titrimetry, now becoming a fairly widely used technique, where the end point is indicated by an inflection point in the plot of the temperature of the system against the volume of added titrant. The second chapter is concerned with less well known methods, namely pressuremetric titrations, dependent on measurement of the pressure of an evolved gas; cryoscopic titrations, based on the change in freezing point of the system; phase titrations dependent on solubility relationships; and flame photometric titrations in which the titrant effects the emission intensity of an ion, for example, the depressing of calcium emission by phosphate. A book, therefore, for the shelves of the analytical research laboratory.

L. A. O'NEILL

J. Oil Col. Chem. Assoc. 1975, **58**, 62-67

Fluid polybutadiene in air-drying oil and alkyd varnishes*

By K. Gorke

Chemische Werke Hüls AG, 437 Marl, West Germany

Summary

It is demonstrated that the air-drying properties, especially of pigmented coatings, depend on the mean molecular weight of the polybutadiene used.

As a result of the growing shortage and the rising prices of natural oils with good drying properties, like linseed oil, soya bean oil, etc., the combination of polybutadiene oil with less expensive drying fatty acids, such as fish oil fatty acid, is gaining importance.

In admixture with naturally drying oils, the weather resistance is not affected provided the proportion of polybutadiene does not exceed 20 per cent.

Excellent weather resistance, as well as outstanding long-term elasticity, is obtained in combination with fish oil fatty acid.

Keywords

Types and classes of coatings and allied products
alkyd coating
oil base coating
red lead primer

Properties, characteristics and conditions primarily associated with dried or cured films
film durability
weather resistance

Raw materials:
Binders (oils)
drying oil

Binders (resins etc)
alkyd resin
polybutadiene

L'emploi de polybutadiène en tant que constituant des vernis gras aux alkydes séchant à l'air.

Résumé

On démontre, notamment où il s'agit des revêtements pigmentés, que l'aptitude à sécher à l'air se dépend du poids moléculaire moyen du polybutadiène que l'on a utilisé.

A cause de la pénurie croissante et les prix montants des huiles naturelles de haute siccativité, telles que l'huile de lin, de soja, etc., les mélanges d'huile de polybutadiène avec des acides gras siccatifs moins cher, tels que ceux d'huile de poisson devienent plus en plus important.

Dans le cas où la quantité de polybutadiène ne dépasse pas de 20 pour cent des mélanges avec des huiles siccatives naturelles, la résistance aux intempéries reste inaltérée.

En combinaison avec des acides gras d'huile de poisson, le polybutadiène rend une excéllente résistance aux intempéries, ainsi qu'une élasticité à long terme remarquable.

Flüssiges Polybutadien in lufttrockenden Öl- und Alkydlacken

Zusammenfassung

Es wird gezeigt, dass die lufttrockenden Eigenschaften insbesondere pigmentierter Anstrichmittel von dem durchschnittlichen Molekulargewicht des benutzten Polybutadiens abhängen.

Die Kombination von Polybutadienöl mit weniger kostspieligen, trocknenden Fettsäuren, wie Fischölfettsäure, gewinnt als Folge der immer grösser werdenden Verknappung und steigenden Preise für gute Trockeneigenschaften besitzende Naturöle, wie Leinöl, Sojabohnenöl etc. an Bedeutung.

Vorausgesetzt, dass in Mischungen mit trocknenden Naturölen der Polybutadiengehalt 20% nicht übersteigt, wird die Wetterbeständigkeit nicht beeinflusst.

In Kombination mit Fischölfettsäure wird ausgezeichnete Wetterbeständigkeit ebenso wie ungewöhnlich lang anhaltende Elastizität erhalten.

Liquid polybutadienes of low molecular weight have gained in significance during recent years for coatings and as cast resins. Distinction is made between the three configurations *1,4-cis*, *1,4-trans* and *1,2* or vinyl polymers. For air-drying surface coatings, only liquid *1,4-cis* polymer, which is marketed by Chemische Werke Hüls under the trade name "Polyoil† Hüls", has generally been accepted.

Because it is non-hydrolysable and is impermeable to moisture, Polyoil is mainly used in the electrophoretic field; however, this is not the subject of this paper. In connection with the shortage and rising prices of naturally drying oils, such as linseed oil, soya bean oil, etc., the object of the author's studies has been to examine the influence of polyoils on the drying properties and weather resistance of surface coatings.

At present, mainly two polyoils are being manufactured: Polyoil Hüls 110 and 130. The only difference lies in their mean molecular weights. At a mean molecular weight of 1 500 (measured by osmotic vapour pressure) Polyoil 110 has a viscosity of approximately 0.7kg m^{-1} s^{-1} at 20°C, whilst

†Strictly, "Polyöl", but given as "Polyoil" here to avoid any possible confusion with the common English abbreviation for a polyhydroxylated alcohol.

*Presented to a meeting of the West Riding Section on 12 February 1974.

Polyoil 130 has a viscosity of $3kg\ m^{-1}\ s^{-1}$ at 20°C and a mean molecular weight of 3 000.

In the tests described, both polyoils were mixed with varnish linseed oil and a drying agent and subsequently thoroughly tested with respect to drying properties. The touch-dry time was determined according to German standard method DIN 53 150, by applying standard sand; the through-drying time was determined according to DEF 1 053 method 8, at a load of 2.27kg, whereby the film to be tested is exposed to a rotating pressure pad and if no changes occur during the test, the film is considered through-dry. All drying tests were carried out under standard conditions of 23°C and 50 per cent relative humidity under constant exposure to an Osram daylight lamp.

Fig. 1 shows the results of tests carried out to determine the touch-dry and through-drying times of linseed oil/Polyoil clear varnishes. Drying time is plotted against composition. The No. 1 curves refer to the varnish containing Polyoil 110; No. 2 to varnish containing Polyoil 130. The touch-dry times are indicated by the dotted line, the through-drying times by the solid line. It appears that the touch-dry time as

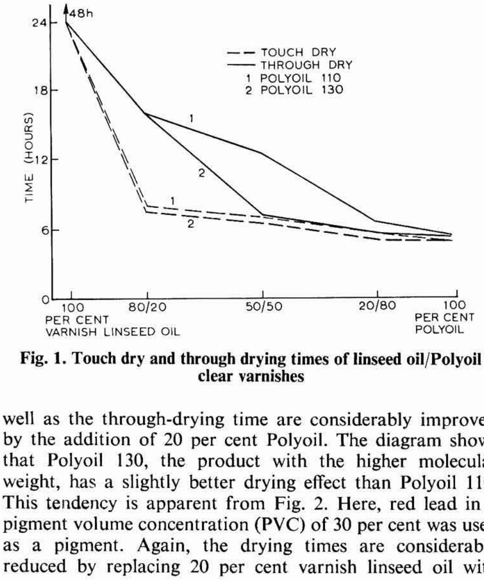


Fig. 1. Touch dry and through drying times of linseed oil/Polyoil clear varnishes

well as the through-drying time are considerably improved by the addition of 20 per cent Polyoil. The diagram shows that Polyoil 130, the product with the higher molecular weight, has a slightly better drying effect than Polyoil 110. This tendency is apparent from Fig. 2. Here, red lead in a pigment volume concentration (PVC) of 30 per cent was used as a pigment. Again, the drying times are considerably reduced by replacing 20 per cent varnish linseed oil with

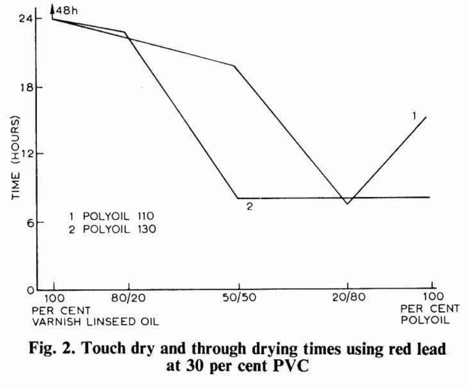


Fig. 2. Touch dry and through drying times using red lead at 30 per cent PVC

Polyoil; it appears that Polyoil 130 is more effective than Polyoil 110. The through-drying times are especially improved; the higher the PVC, the smaller the differences in touch-dry times. The same results are obtained if titanium dioxide is used as a pigment. To simplify matters, only the pure binding material has been plotted on the graph, namely 100 per cent varnish linseed oil and 100 per cent polyoil 110 or 130. When replacing 20 per cent varnish linseed oil by Polyoil, the drying properties almost correspond to those of long oil alkyd resins with the added advantage that the 100 per cent oil combination has a much lower viscosity. As a consequence, processibility and penetration are clearly improved. Moreover, this means a saving of solvent, which is most desirable from a financial point of view as well as for the sake of environmental protection. For ready-mixed paint, only approximately 10 per cent of white spirit will be necessary.

This has considerable consequences in the practical application of the paint coating. The following stringent tests have been carried out; a coat of red lead paint based upon 72 per cent linseed oil and 28 per cent Polyoil 130 was applied to sheets of degreased iron at a temperature of 3°C and after three days they were overcoated with various varnishes, as shown in Table 1.

Table 1

Varnishes used to overcoat red lead oil based primer

1. A resin varnish
2. An oil varnish
3. A two-component polyurethane varnish
4. A polyvinyl chloride and alkyd resin cyclised rubber varnish
5. An alkyd varnish
6. A pure chlorinated rubber varnish

(These reference numbers correspond to those used in Fig. 3)

In no case did lifting occur during these tests. A red lead primer based solely on varnish linseed oil must be allowed to dry for at least eight days at a temperature of 3°C or more before an alkyd resin coating varnish can be applied without causing lifting. After two years, the test samples exposed to out-door weathering in the industrial atmosphere of Hüls did not show any signs of corrosion (zero on the corrosion scale) (Fig. 3—numbers correspond with those given in Table 1); after

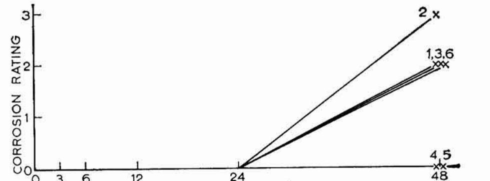


Fig. 3. Effects of weathering in an industrial atmosphere for two coats on degreased iron

four years, the PVC and cyclised rubber combinations were still unaffected by corrosion, the oil varnish had considerably corroded (3 on the corrosion scale); the other systems showed slightly better resistance to corrosion (2 on the scale). These values are based on the German corrosion scale. Even after four years of outdoor weathering in an industrial atmosphere, sand-blasted iron did not show any signs of corrosion.

Polyoil 110 can be used satisfactorily in air-drying systems, namely with air-drying alkyd resins; it can be incorporated easily into the alkyd resins, which are prepared as usual, although only 80 per cent of the fatty acids are used, with 20 per cent polyoil 110 containing approximately 15 per cent maleic anhydride added at the end of the cooking process. Care must be taken, however, to ensure that the temperature does not exceed 200°C when adding the Polyoil, otherwise the *cis*- double bonds will isomerise into *trans*- double bonds and will not produce the desired effect with respect to good drying properties.

A red lead paint was prepared on the basis of such an alkyd resin and compared with other alkyd resins. The results are shown in Fig. 4 in which the curves represent:

1. An alkyd resin/red lead primer, based upon 40 per cent fish oil fatty acids, 40 per cent tall oil fatty acids and 20 per cent Polyoil 110.

2. An alkyd resin/red lead primer based on a commercial alkyd resin containing 67 per cent fatty acids.

3. An alkyd resin/red lead primer based on a commercial alkyd resin containing 68 per cent fatty acids.

4. An alkyd resin/red lead primer based on a commercial alkyd resin.

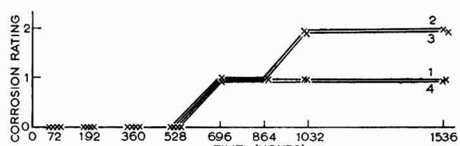


Fig. 4. Performance in ASTM salt spray test for two coats on degreased iron

The corrosion ratings after the salt-spray test (zero = no corrosion, 5 = highest degree of corrosion) are plotted against time. After an 864-hour salt-spray test accoıding to ASTM, the superiority of the red lead containing Polyoil becomes apparent in the same way as after the 384-hour Kesternich test, as demonstrated in Fig. 5. The Kesternich

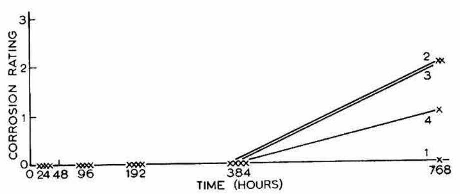


Fig. 5. Performance in Kesternich test (SO_2 atmosphere) for two coats on degreased iron; numbers correspond to those of Fig. 4

Corrosion ratings (corrosion by moisture and sulfur dioxide) are plotted against time. After exposure to outdoor weathering for more than four years in the industrial atmosphere at Hüls, none of the systems showed any signs of corrosion if the paint had been applied to degreased, clean, rust-free sheet metal. Fig. 6 shows the results of a test carried out under the same conditions, but with a paint applied on sheet iron from which the rust had been removed by hand. Again the superiority of the alkyd resin on a Polyoil basis is demonstrated.

The following diagrams show details of the weather resistance of white enamels based on alkyd resins. In every case, the PVC was 15 per cent titanium dioxide (KB grade of Titangesellschaft). The alkyd resins shown in Table 2 were used.

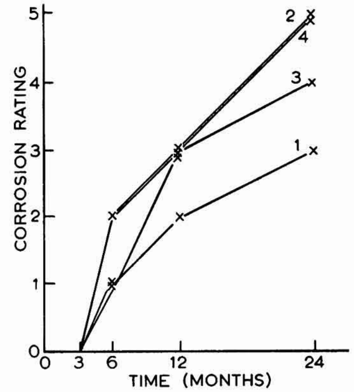


Fig. 6. Corrosion in an industrial atmosphere for sheet iron, rust removed by hand; numbers correspond to those in Fig. 4

Table 2

Alkyd resins used in preparation of white paints

Reference No.*	
1	An alkyd resin based upon 80% fish oil fatty acids, 20% polyoil 110-maleic anhydride adduct.
2	A commercial alkyd resin containing 65% soya bean oil fatty acids.
3	A commercial alkyd resin containing 67% fatty acids of unknown composition.
4	A commercial alkyd resin containing 68% fatty acids of unknown composition.
5	A commercial alkyd resin containing 63% linseed oil fatty acids.
6	A commercial alkyd resin containing 67% linseed oil fatty acids.
7	An alkyd resin based upon 40% fish oil fatty acids, 40% special olein and 20% polyoil 110-maleic anhydride adduct.
8	An alkyd resin based upon 40% fish oil fatty acids, 40% tall oil fatty acids and 20% polyoil 110-maleic anhydride adduct.

*These reference numbers correspond to those used in Figs. 7, 8 and 9.

The white enamels were subjected to very stringent tests: the paints were applied to one side of the parana pine panels leaving only the front ends and the reverse sides completely unprotected and allowing the rainwater to penetrate into the wood and make it swell, thus the various paints were severely tested for elasticity and adhesion. The paints were applied according to the 30/15/0 system, in other words, the primer was diluted with 30 per cent white spirit, the undercoat with 15 per cent white spirit, the finishing coat was applied undiluted. Accordingly, the panels were painted three times.

Figs. 7, 8 and 9 show the yellowing, chalking and gloss rating of these paints during exposure to the industrial atmosphere at Hüls. Fig. 7 indicates that the paints 1, 7 and 8, based on resins containing polyoil, have yellowed. After three months, the degree of yellowing ranged between G11 and G21, but remained constant during the next four years. All other alkyd resins remained a clear white. The yellowness (G11/21) is noticeable only if a clear white panel is placed beside it. From Figs. 8 and 9 it appears that as far as chalking and the degree of gloss are concerned, there is practically no difference between the various alkyd resins. The extent of

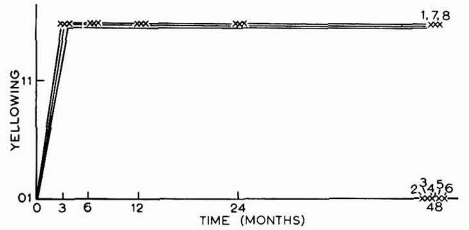


Fig. 7. Yellowing in an industrial atmosphere for 30/15/0 films on Panama pine substrate

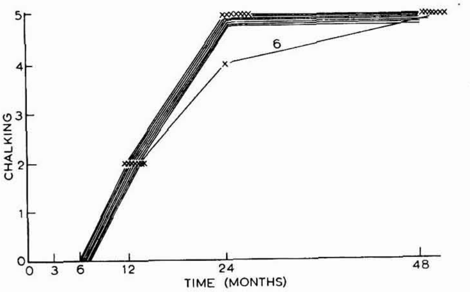


Fig. 8.

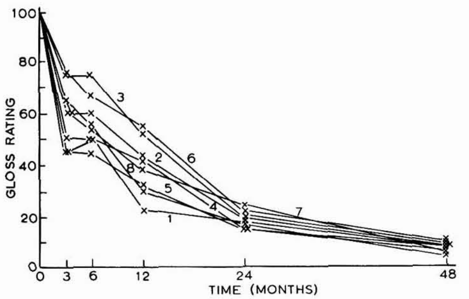


Fig. 9.

Figs. 8 and 9. Chalking and gloss ratings in an industrial atmosphere for 30/15/0 films on Panama pine substrate (reference numbers for lines correspond to those in Table 2)

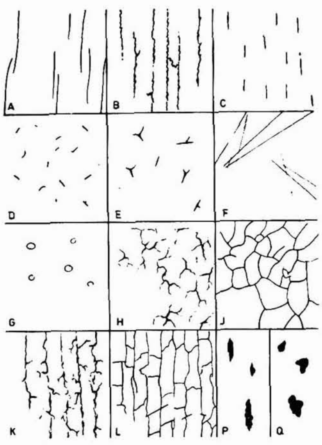


Fig. 10. Types of crack using the Dutch scale for the assessment of extent of cracking

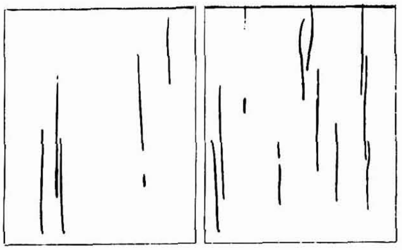


Fig. 11. Examples of crack formations A6 and 8

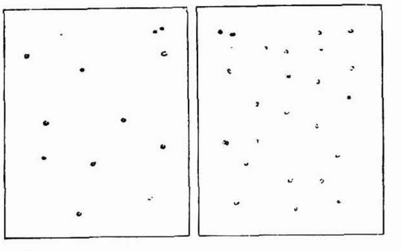


Fig. 12. Examples of crack formations G6 and 8

cracking can be used as a means of determining the long-term elasticity; the measurements are based on the Dutch scale, (Fig. 10) where the letters refer to the various types of cracks, and the numbers indicate the extent of cracking; A2 means a few cracks and A8 many longitudinal cracks. Fig. 11 illustrates crack formation A8, which was shown by the white enamel, based on 65 per cent soya bean fatty acid, after 48 months. Fig. 12 illustrates crack formation G6, which was shown by the commercial alkyd resin, containing 67 per cent fatty acid, after 48 months. After six months, the tester reported, "Considerable blistering along the lower edge," and after 24 months, "Complete flaking along the lower edge"—a well-known condition experienced with window ledges.

Fig. 13 illustrates crack formation G4, which was shown after 48 months by the commercial alkyd resin containing 68 per cent fatty acid. Fig. 14 illustrates crack formation D2, shown by the commercial alkyd resin containing 63 per cent linseed oil fatty acid after 48 months. The alkyd resin containing 67 per cent linseed oil fatty acid showed the same crack formation after 48 months, but flaking along the lower edge had already occurred after 48 months.

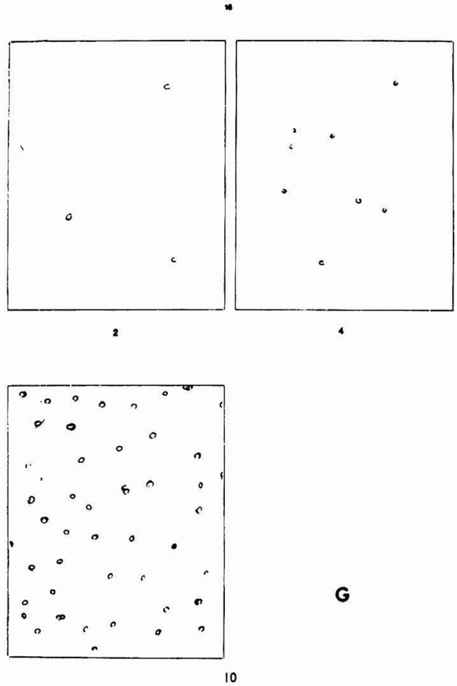


Fig. 13. Examples of crack formations G2, 4 and 10

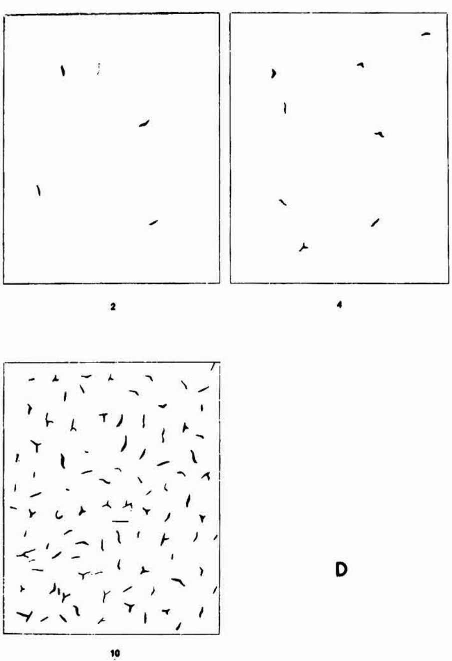


Fig. 14. Examples of crack formations D2, 4 and 10

Fig. 15 illustrates crack formation F6/F8, which the alkyd resins with a binder combinations consisting of 40 per cent fish oil fatty acid, 40 per cent special olefin and 20 per cent polyoil Hüls 110 maleic anhydride adduct and 40 per cent fish oil fatty acid, 40 per cent tall fatty acid and 20 per cent polyoil—maleic anhydride adduct, showed after 48 months. The only paint that after a period of four years did not show the slightest crack formation was alkyd resin 1 based on 80 per cent fish oil fatty acid/20 per cent polyoil adduct. Slight cracking—A2—did not occur until after 60 months, as illustrated in Fig. 16.

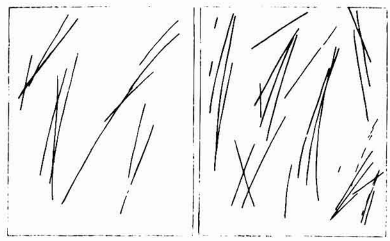


Fig. 15. Examples of crack formations F6 (left) and F8

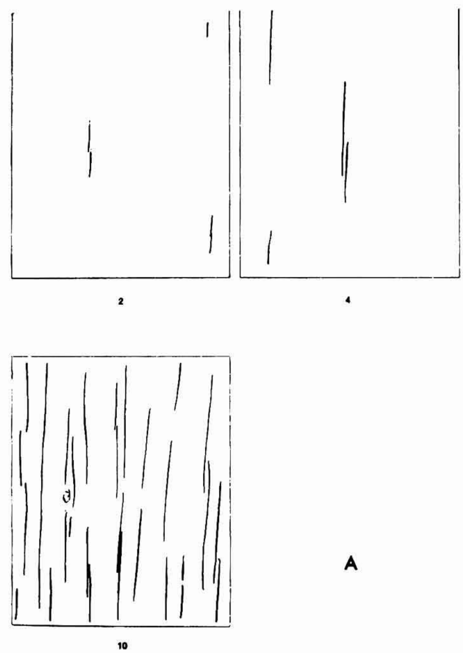


Fig. 16. Examples of crack formations A2, 4 and 10

The author's opinion is that from an economical point of view, it is more sensible to use a paint with good long-term elasticity than to attach too much importance to extreme whiteness.

As can be seen from Table 3, there is no appreciable difference between the drying times of the eight different white enamels; the best results were obtained with soya bean alkyd resin and the alkyd resin containing 67 per cent linseed oil fatty acid.

Table 3

Drying times of white alkyd paints applied with a 100µm film applicator

Alkyd resin		Touch dry time (hours)	Through dry time (hours)
Alkyd resin:	80% fish oil fatty acids	5.5	9.0
	20% polyoil 110-adduct		
Commercial alkyds:			
	65% soya bean oil fatty acids	3.5	5.0
	67% fatty acids (unknown)	6.0	12.0
	68% fatty acids (unknown)	6.0	8.0
	63% linseed oil fatty acids	5.5	12.0
	67% linseed oil fatty acids	3.0	4.5
Alkyd resin:	40% fish oil fatty acids	3.0	6.5
	40% special olefin		
	20% polyoil 110-adduct		
Alkyd resin:	40% fish oil fatty acids	5.0	6.5
	40% tall oil fatty acids		
	20% polyoil 110-adduct		

White enamels based upon oil only were prepared, having the following compositions:

1. 80% linseed stand oil, 20% polyoil 130 + 2% zinc oxide
2. 80% linseed stand oil, 20% polyoil 130
3. A commercial polyurethane oil

In all these paints the pigments used was titanium dioxide (KB grade) at a PVC of 15 per cent; in one instance an addition 2 per cent of zinc oxide was present.

The above reference numbers correspond to those used in Figs. 17—19 which show the results of weathering tests carried out in the industrial atmosphere at Hüls works. As expected, slight yellowing was observed after three months—G11—, however, after 24 months complete flaking of the enamel on the urethane oil basis occurred. The same results were obtained with respect to chalking and degree of gloss as shown in Figs. 18 and 19.

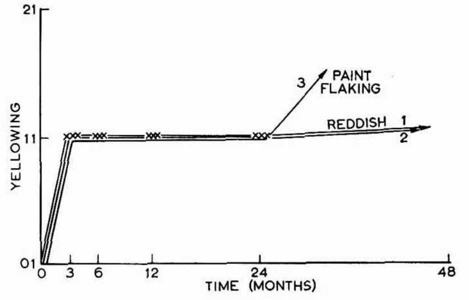


Fig. 17. Yellowing of 30/15/0 systems on Panama pine in an industrial atmosphere

Table 4 shows the drying properties of these enamels on a 100 per cent oil basis and it appears that the urethane oil dries considerably faster. According to Table 1, however, medium

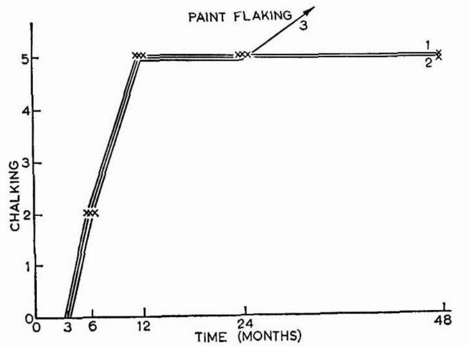


Fig. 18. Extent of chalking for 30/15/0 systems on Panama pine in an industrial atmosphere

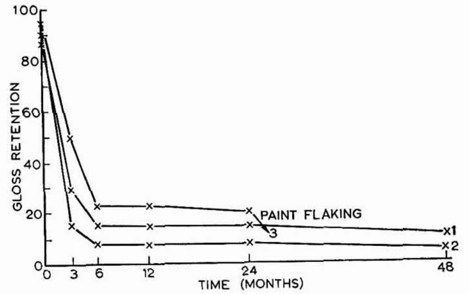


Fig. 19. Gloss ratings for 30/15/0 systems on Panama pine in an industrial atmosphere

oil alkyd resins with an oil content of approximately 65 per cent enamel, based on polyoil 130, is comparable to a long oil alkyd resin as far as drying properties are concerned. Of course, processibility and penetration of the enamels on a 100 per cent oil basis are undoubtedly superior to the results obtained with a long oil alkyd; the solvent content of the paint as supplied is lower—a factor which should have considerable bearing nowadays.

Table 4

Drying times of white enamels applied with a 100µm film applicator

Binder		Touch dry time (hours)	Through dry time (hours)
80% linseed standoil 20% polyoil 130	cold mixed	8.5	12.0
Commercial urethane oil		2.0	5.5

Acknowledgment

The author wishes to express his appreciation to Mr. Schoppen and his staff for their assistance in the laboratory.

[Received 15 July 1974

Correspondence

Dispersion of pigments

SIR—The paper by U. Kaluza (*JOCCA*, 1974, **57**, 368) on the dispersion of pigments and the rub-out effect was of considerable interest to us at the Paint Research Association, particularly because the reference to the significance of Bénard Cell formation recalls the earlier review of the subject by Dr S. H. Bell (Bell, S. H., *JOCCA*, 1952, **35**, 373).

We have recently been developing a gas discharge etching technique (see Kämpf, G., et al, *Farbe und Lack*, 1970, **76**, 25; 1105) for studying the dispersion of pigments in paint films. In this method, the organic medium is eroded away by charged molecules of a gas (oxygen or argon) bombarding the paint film surface and progressively exposing the pigment, whose distribution may then be established by a replication technique and transmission electron micrography.

The accompanying micrograph (Fig. 1) is of a shallow etch of an alkyd paint film pigmented to 40 per cent PVC with a mixture of TiO_2 and CI (Colour Index) Pigment Orange 5 (10:1 by weight) and illustrates very well, it seems to us, the pigment structure in a Bénard Cell in a way that we have not observed elsewhere.

The cell walls (pigment-free) are about 1.0 μm wide, on average, and the cells (somewhat elongated in one direction, but recognisably hexagons) have a longest dimension 30-40 μm. Such small cells are unusual. The borders are rather well defined by close-packed arrays of either single, or low number aggregated particles. The interior of a cell is not so densely populated and sometimes has quite large aggregates at the centre. Above the layer exposed and replicated are detached individual and aggregated particles. Many of the aggregates

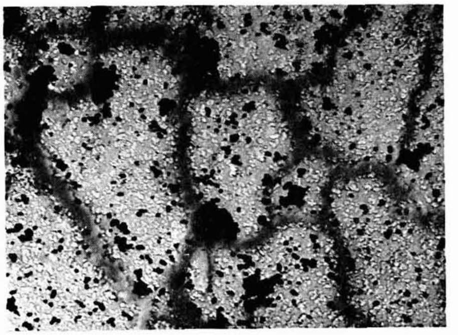


Fig. 1. Shallow etch of a 40 per cent PVC TiO_2/alkyd film—surface replica at × 5000 magnification

lie exactly on the boundary of a cell and no doubt are the de-wetted aggregates which Dr Bell referred to as being held in the film surface by surface tension forces which prevent their being driven down into the channels by circulating currents.

The micrograph appears to add significantly to the picture of the structure of a Bénard Cell outlined in Dr Bell's review.

Yours faithfully,

J. L. PROSSER

Materials Science Section,
Paint Research Association,
Waldegrave Road,
Teddington,
Middlesex TW11 8LD
9 December 1974.

Section Proceedings

Hull

Highly flammable, low flash solvents

The third ordinary meeting of the 1974/75 session was held at the George Hotel, Land of Green Ginger, Hull on Monday 2 December 1974. Mr E. Armstrong, the section chairman, introduced Mr J. B. Jolliffe of Liquid Handling Services Limited, who gave a lecture entitled "Bulk storage of highly flammable, low flash solvents".

Mr Jolliffe began by discussing the Statutory Regulations covering the bulk storage of highly flammable products, namely (a) The Highly Flammable Liquid and Liquified Petroleum Gases Act SI No. 917, (b) The Chemical Industries Association Codes of Practice and (c) The Petroleum Consolidated Act of 1928 and two model codes. The latter Act and its associated model codes applied to those solvents which were petroleum based and also to petroleum installations.

Design features of a bulk storage tank containing highly flammable/low flash products had to include properly sized vent pipes in the correct position. Internal and dip tank pipes had to be positioned below the take-off branch, thus providing a liquid seal within the tank. The entire installation should be adequately earthed to the required standard and/or eliminate any possibility of the development of static electrical charges. Any electrical equipment associated with the installation within the regulation distances had to comply with the Buxton Gas Certificate Group 2.

Safety requirements included road tanker earthing and limiting the rates of discharge and pumping of products having a high volume resistivity figure, where high static could be generated. Operators had to be aware that static could be built up when nylon clothing and non-conductive footwear were worn.

Mr Jolliffe's short talk prompted numerous questions and a lively discussion ensued. The meeting, which was attended by 15 members and 5 visitors, was concluded with a vote of thanks from Mr A. Pipes.

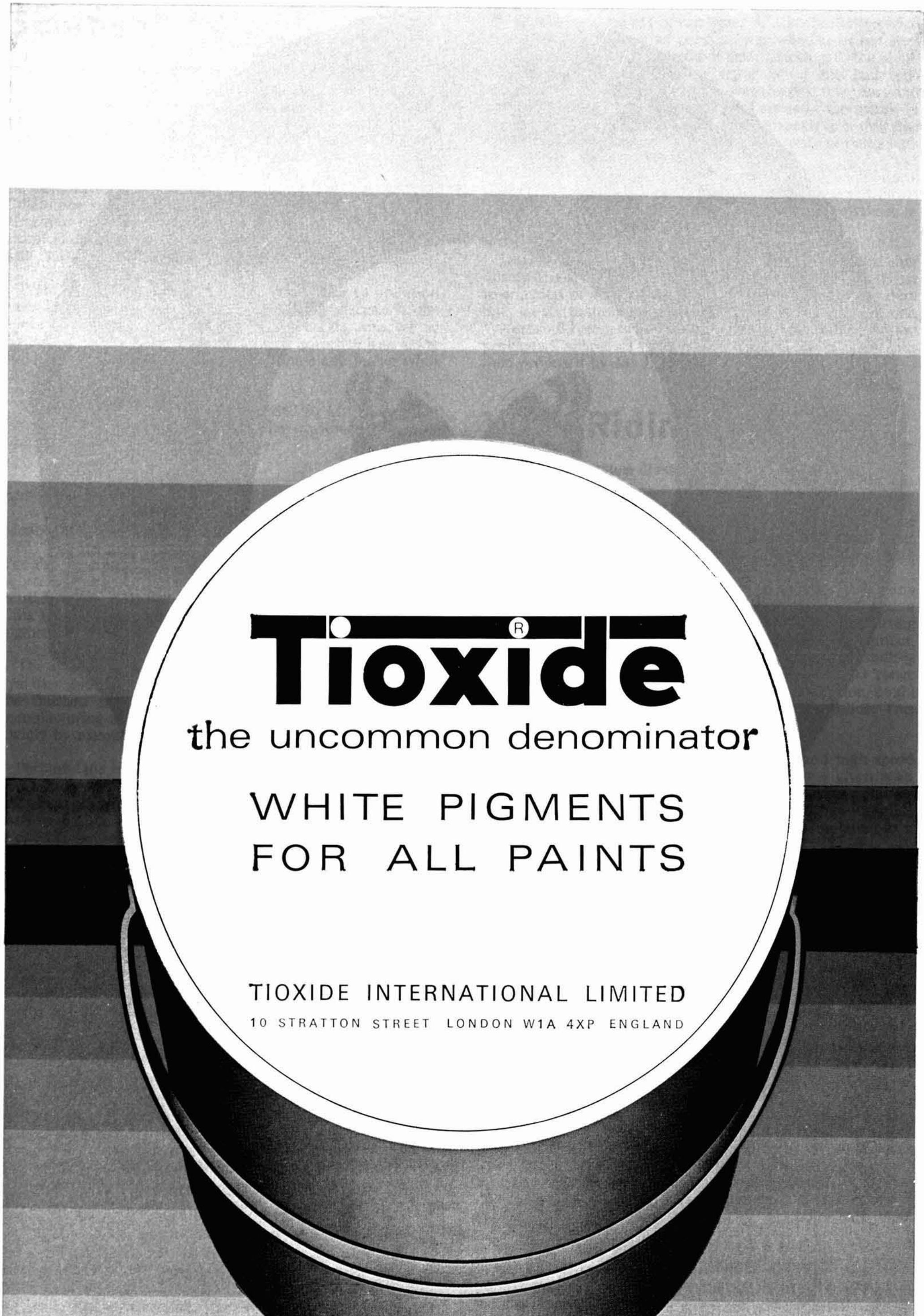
D.M.W.

London

Ray deflection mapping and schlieren techniques

A meeting was held on 10 December 1974 when Mr D. M. Howell gave a talk on work he had conducted at the Paint Research Station under the general title "Quantitive characterisation of paint surfaces using ray deflection mapping and schlieren techniques". The paper is published in full elsewhere in this issue.

B.A.C.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Scottish

Printing inks—developments to meet modern requirements

Mr G. H. Hutchinson (Croda Inks) gave a lecture on "Printing inks—developments to meet modern requirements" at the Beacons Hotel, Glasgow, on Thursday 14 November 1974.

The lecture was directed towards the topical problem of the effect of the raw material situation on developments. Mr Hutchinson pointed out how the new oil-related price structures and paper-recycling affected developments. As well as technical excellence, new inks had to be closely correlated with new substrates (cheaper paper) and rate of printing.

Water-based printing inks and their relevance to pollution were discussed in some detail. During a lively discussion, the relevance of pollution laws, designed for Los Angeles, to Scotland's situation was questioned. Photochemical smog build up was unlikely in the lower sunshine and higher wind levels.

A hearty vote of thanks was recorded to Mr Hutchinson for his excellent presentation and the obvious enthusiasm which he transmitted to his audience.

G.H.R.

Eastern Branch

Modern phthalocyanine pigments

The first meeting of the session was a joint meeting with the Scottish Student Group in the Lady Nairn Hotel, Edinburgh, at 10.30 a.m. on Saturday 5 October. Mr J. B. Blackburn of Ciba Geigy gave a lecture entitled "Modern phthalocyanine pigments".

The speaker began by outlining the chemistry of phthalocyanines and the effect of ring substitution on the shade of the finished pigments. The various synthetic routes and manufacturing techniques available were then described very lucidly by means of diagrams and drawings.

Perhaps the most important aspect of phthalocyanine production was the conditioning of the crude material to a pigmentary form. Several of the conditioning techniques used were discussed in detail and the difference in shade and properties between the alpha- and beta forms demonstrated. The application of the pigments in plastics, paints, and printing inks was outlined and several samples passed round, to exemplify phenomena such as flotation and flocculation.

After an interesting discussion period, Mr Nisbet expressed the thanks of all present to Mr Blackburn.

After lunch the company retired to the Skittles Alley where battle was once again carried out for the Newton Cup, the trophy going this year to the Student Group.

P.S.N.

Problems of a packaging chemist

After missing out a month (when there was a joint meeting with the BPBI as host), the second meeting of the session took place on Wednesday 18 December at the Carlton Hotel, Edinburgh, when Mr R. Logan of Van Meer (UK) Limited gave a talk on the above subject.

The packages referred to were mainly steel drums, though other materials were briefly mentioned. Most of the problems encountered by Mr Logan were connected with the protective coatings on the drums. Inside lacquering of tin cans had first been carried out about 70 years ago, and it had taken another 35 years for this process to graduate to metal drums. Much development was carried out during and after the last war and fairly sophisticated systems were now available. Several problems still existed, however, such as the vagaries of the weather. The pH of rainwater in Manchester has been measured at 3.5! Another problem was whether or not steel preparation should be carried out prior to testing of the paint. The attack of metal drums by acidic liquid inks had been encountered on several occasions over the past few years and had been found to be due to lines of stress in the metal. In some cases the drums had been eaten through in a thin line round the container, whilst all other areas were not attacked.

Polythene drums were mentioned as being economical only in the smaller sizes (5-25 litres) although it was noted that whilst the price of steel was rising, the price of polythene in Germany had levelled out.

During a lively discussion period, the speaker stated that during trials, a water-based acrylic lacquer had given rise to emission of more hydrocarbon in the oven flue gases than did a conventional hydrocarbon solvent-based lacquer. Water would seem to be not the complete answer to pollution problems! A vote of thanks for a very interesting talk was then proposed by Mr J. Patek.

P.S.N.

West Riding

Dispersion of titanium dioxide in modern paint making machinery

A meeting was held on Tuesday 8 October 1974 at the Griffin Hotel, Leeds. A lecture dealing with the above topic was presented by Mr D. Craig of Tioxide International Ltd.

In his lecture Mr Craig discussed the need for dispersion of titanium pigment in alkyd gloss paints and offered a method for devising satisfactory mill base formulations using the "flow-point" technique. Using one resin and one pigment, this method had been applied to high speed impeller milling and sand milling. For both machines, the PVC (f) range of the mill base over which satisfactory dispersion could be achieved was obtained for a range of resin solids. This was related to the flow-point curve.

It was shown that for both sand milling and high speed impeller milling, the range of PVC (f) with any given resin solids content at which optimum dispersion may be obtained was relatively small, but tended to increase as resin solids increases, thus allowing greater flexibility in formulating to a higher resin solids content.

The importance of the relationship between impeller diameter, vessel diameter, charge depth and impeller location when high speed impeller milling, was also demonstrated.

The lecture evoked many questions, and Mr Bartrum proposed the vote of thanks.

R.A.C.

Automation through instrumentation in the laboratory

A meeting was held on Tuesday 12 November 1974 at the Griffin Hotel, Leeds. A lecture dealing with the above topic was presented by Mr B. C. Burdett and Mr W. A. Straw of the University of Bradford.

Over the past decade there had been considerable changes in analytical techniques with a trend away from classical chemical methods towards physical techniques. In general, modern techniques led to increased speed of analysis, increased sensitivity and the ability to perform multiple analyses on complex samples, reduce operator costs and reduce the tedium and human error.

The various approaches were illustrated by use of typical examples. The uses and potentialities of ion selective electrodes, atomic absorption spectrophotometry and other techniques were discussed as well as the degree to which these and other methods could be automated. These were illustrated by slides of a number of semi- or fully automated systems which had been developed, particularly at the University of Bradford.

The lecture proved most interesting and drew a number of questions from an appreciative audience. A vote of thanks was proposed by Mr N. Cochrane.

R.A.C.

Salary versus job satisfaction

A meeting was held on Tuesday 10 December 1974 at the Griffin Hotel, Leeds. The lecture was presented by Mr I. Moll, who is an independent consultant.

The speaker posed two questions. Firstly, did money come before job satisfaction, or was the reverse true and secondly, what, in fact, was "being successful"? For example, in one's career, the attainment of position, or in business achieving a high profit, whilst in life happiness, social enjoyment and so forth could all be regarded as factors. The ultimate criteria of success should be related to life, and possibly with success in one's job coming second.

Mr Moll introduced concepts of Abraham Maslow in terms of human needs, postulating that a person had to satisfy his lower "needs" before progressing on to higher levels. At the lower level, for example, factors of survival, security and a sense of belonging needed to be fulfilled, before progressing to fulfilment of one's ego and attainment of self-realisation. These ideas were then related to work in an industrial society.

Fred Herzberg had looked at "motivators", dividing these into satisfiers (positive motivators) and dissatisfiers (negative motivators), and suggested the need to remove, or overcome, the dissatisfiers before one could be truly motivated. At this stage, Mr Moll involved the audience in arranging lists of typical situations in which examples of satisfiers and dissatisfiers were introduced. Herzberg had suggested typical motivators as achievement, recognition, and responsibility in one's work, whilst factors which could be regarded as dissatisfiers (negatives) would be disagreement with company policies, lack of responsibility, lack of achievement and recognition, and similar dissatisfiers.

The Tavistock Institute Survey had indicated a satisfying job to include, of necessity, factors such as being fairly demanding, providing continuous learning processes, permitting a degree of worthwhile decision making, offering the facility to support one's colleagues, and in general leading to a "better future".

These theoretical concepts were then related to individual industrial situations, suggesting for example that in British industry many people in managerial situations were really under-employed, and might perhaps really be regarded as redundant. Mr Moll outlined points that needed to be borne in mind by successful management. In general, these would appear to be related to the need to keep demotivating factors at a low level. He suggested that a successful manager needed to gauge the individual potentials of people under him; he had to find out their career aspirations, look ahead for career opportunities, and review options regularly for his staff. He should provide development training, and be prepared to help individuals to find more suitable situations if, in fact, he saw the need for this. Mr Moll followed by similarly outlining how individuals might attain greater job satisfaction by their own efforts.

After a very lively general discussion, which had to be terminated because of the time factor, the vote of thanks was proposed by Mrs K. Driver.

R.A.C.

Information Received

Change of name—Crown Decorative Products Ltd

The Walpamur Co. Ltd. has changed its name to Crown Decorative Products Ltd. and the company assures suppliers that this change of name will not affect in any way their trading relationships. Correspondence should now be addressed to Crown Decorative Products Ltd., PO Box No. 37, Crown House, Darwen, Lancashire BB3 0BG.

Change of name—T. R. Chemicals (Scotland) Limited

A. J. Gemmill & Co. Ltd. has changed its name to T. R. Chemicals (Scotland) Limited and its telex answer-back code to "TR Chem Paisley" in accordance with the policy of its parent company, T. R. International (Chemicals) Limited. This change will in no way affect present operations.

First VA-ethylene emulsion plant in UK

The first commercial plant in the UK to manufacture emulsion copolymers of vinyl acetate with ethylene and other gaseous monomers is now on stream at Vinyl Products' new factory at Warrington. The product range consists initially of pressure polymerised emulsions for adhesives manufacture, but will be extended before the end of the year to include grades for emulsion paints, textiles and paper coatings. Pressure polymer emulsions from Continental and North American sources are currently used in the manufacture of emulsion adhesives, and the output of the Warrington plant, which is considerably larger than the existing UK consumption of these products, will obviate the need for such imports.

This is the first phase of development at the company's Warrington factory; further capacity for pressure polymerised and more conventional emulsions is scheduled to become operational in 1975 and 1976, and the site will allow considerable subsequent expansion to meet the growing demand for both product types.

Further contracts for Simon Rosedowns Limited

Simon Rosedowns Ltd., a Simon Engineering Company based in Hull, has won two further contracts from Malaysia and Indonesia, firstly to supply a palm kernel oil extraction plant and secondly for an oil processing installation to refine, deodorise and polish crude cocount oil for C. V. Bumi Waras of Teluk Betung, Indonesia.

ICI to take licence from Japan

Negotiations have been successfully concluded between ICI and Nitto Chemical Industry Co. Ltd. of Japan. ICI will take a licence to erect a plant to manufacture dimethylformamide (DMF) at its amines complex at Billingham, Cleveland (formerly Teesside). The process to be used has been developed by Nitto and the design of the plant will be based upon Nitto's own operating unit.

The proposed new plant—part of ICI's continued development in the alkylamines derivatives area—will increased ICI's production capacity for DMF, which has a wide range of uses as an industrial solvent.

Thiocyanates from Akzo

Akzo Chemical UK Limited has assumed responsibility (from 1 January 1975) for sales within the United Kingdom, of the range of thiocyanates (Rhodanides) produced in Cologne, West Germany, by Rhodanid Chemie GmbH—in which Akzo Chemie has a majority interest.

Double export award to Silver Paint and Lacquer Company

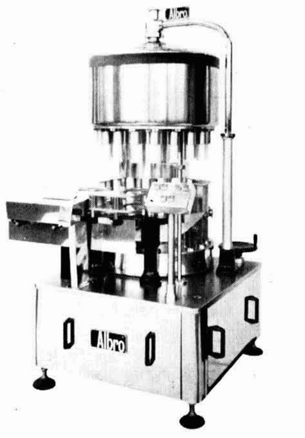
Silver Paint and Lacquer Company Limited, the largest privately owned paint manufacturing company in the UK, has been awarded a Double International Gold Medallion Award by the International Export Association for outstanding export achievements. The company is the first paint manufacturer to receive such an award.

Export figures rose from £323 000 in 1972 to £507 000 in 1973, and then rocketed to £1.25 million in 1974. It was for this reason that the Association granted an immediate double award to mark "a persistent development of export sales in some of the most highly competitive markets throughout the world".

Following this record increase in export sales, a major re-organisation of the SPL Group is taking place to enable a planned 15 per cent increase in production in 1975.

New products

Albro iso-vacuum filling system



Albro Fillers and Engineering Company has introduced a completely new addition to its range of bottling equipment—the "Iso-Vacuum" liquid-filling system. Based on a gravity-vacuum principle, the Iso-Vacuum machines have the advantage of being able to fill most free-flowing liquids into nearly all types of containers—including those made from low-density plastics, which cannot be handled on standard vacuum-operated fillers.

New Degussa acrylic resins for the production of lacquers

The Chemicals Division of Degussa, Frankfurt am Main, has enlarged its programme of "Degalan" lacquer materials and now offers—apart from the well-known thermoplastic methacrylate resins—a range of hydroxy-functional types which, after cold or hot curing with polyisocyanates, result in films whose properties are comparable with those of stoving enamels. The new resins bear the names "Degalan LS 50/100" and "Degalan LS 150/300." They are normally supplied as 60 per cent solutions in ethyl glycol acetate/xylene mixtures, but can also be supplied on request in other concentrations and with other hydrogen-inactive solvents.

New gold airless spray tips

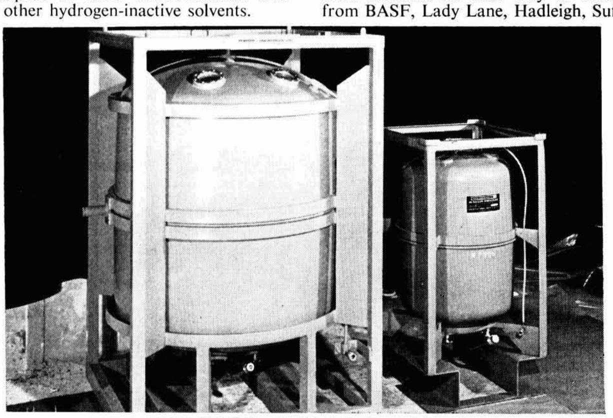
New gold "Turnaround" airless spray tips from Graco can cut lost time due to tip clogging. The tip is designed and sized so that it can be removed from the gun, reversed and mounted backwards. A squeeze on the trigger and the blockage is cleared. This simple, time saving feature is believed by Graco to be the only standard airless tip that can be safely reversed in this way.

Portatank

A unique demountable tank system for the bulk storage and distribution of liquids, paints and chemicals has been introduced by Porter Lancastrian Limited.

The company maintains that the "Portatank" system, represents a complete departure from all traditional methods and offers considerable labour and costs savings. Using "Portatanks" the final phase of production, followed by distribution and on-site application can be organised with production line efficiency.

The system utilises specially designed plastic disposable liners. These are quickly and easily inserted prior to filling, an automatic seal ensuring that the contents enjoy completely air-free conditions. The tanks are then ready for filling—either individually or on a production line.



Examples of the new Portatank containers

Waste gas incineration from Wellman

In association with Comprimo bv of Holland, Wellman Incandescent Ltd., a UK company specialising in the design of thermal and chemical engineering equipment, will manufacture and market a new range of thermal and catalytic incineration plants developed by Comprimo for the treatment of waste gases from industrial processes.

Th. Goldschmidt introduce two new silicone products

Th. Goldschmidt Ltd., Harrow, Middlesex, has introduced to the paint industry a new flow promoter "Tergopen" and an anti-flooding agent "Silicone Oil B1484".

Literature and films

BASF film catalogue

Copies of a catalogue listing the BASF films available for loan may be obtained from BASF, Lady Lane, Hadleigh, Suffolk or Guild Sound & Vision Limited, Woodston House, Oundle Road, Peterborough.

Inks for ultraviolet curing

A patent review and literature bibliography entitled "Inks for UV Curing" has been published by R. H. Chandler Ltd., price £5.00 per copy.

Readers are reminded that the Technical Education Stand at the 1975 OCCA Exhibition will have as its theme "Radiation curing" and the Newcastle Section is at present organising a two-day symposium on "Ultraviolet polymerisation and the coatings industry" to be held at Durham University from 10 to 11 April 1975.

Safe use of electricity

A new edition of the booklet "The safe use of electricity: A guide for industry and commerce" (price 53p) has been published by RoSPA (The Royal Society for the Prevention of Accidents) Royal Oak Centre, Brighton Road, Purley, Surrey. The purpose of the booklet is to provide a reliable guide to the safe use of electricity in industry and commerce.

Scandig 2

A new leaflet is available from Joyce-Loebl describing the new "Scandig 2," a high speed microdensitometer used to digitise photographs for subsequent computer processing. It has applications wherever photography is used to record scientific phenomena, and where fast automatic interpretation of these photographs is required.

Conferences, courses and symposia

Colour course in USA

A Spring/Summer programme of four courses in colour technology is once again being offered by the Rensselaer Colour Measurement Laboratories at the Rensselaer Polytechnic Institute, Troy, New York, USA (further details are also available from the Association's offices).

Colour and pigment choice

The Borough Surface Coatings Association plans to hold a one-day symposium with the title "Colour and pigment choice" on Tuesday 25 February at the Polytechnic of the South Bank, London. The theme will be paint as a decorative material.

Colour measurement

A one-day symposium with the title "Use of colour measuring instrument and prediction techniques in the non-textile colour industries," is being organised by the Northern Section of the Colour Group, to be held on 3 April at the Salford College of Technology.

Comminution and air classification

A three-day residential course, sponsored by the Institution of Chemical Engineers and with the title "Comminution and air classification," will be held at the University of Bradford from 25 to 27 March. Further information is available from the School of Powder Technology, University of Bradford.

OCCA—XXVII Exhibition

Olympia, London. 22-25 April 1975

The International Forum for Technical Display and Discussion in the Surface Coatings Industries

★ Belgium ★ Finland ★ France ★ Germany ★ ★ Holland ★ Hungary ★ Italy ★ Norway ★ ★ Poland ★ Rumania ★ Sweden ★ Switzerland ★ ★ UK ★ USA ★

General information

As already announced there has been one of the heaviest demands for stand space by exhibitors for OCCA-XXVII, the Association's annual international forum for technical display and discussion in the surface coatings industries, which will take place at Olympia, London, from 22 to 25 April 1975.

Directly represented now among exhibitors are organisations from the UK and the following thirteen overseas countries: Belgium, Finland, France, Germany, Holland, Hungary, Italy, Norway, Poland, Rumania, Sweden, Switzerland and the USA.

The "Official Guide" and season admission tickets

The "Official Guide" to the Exhibition is now being prepared for publication at the end of February.

Members of the Association will automatically be sent an individual copy of the Official Guide, together with a season admission ticket, when the booklet is published. It has been decided on this occasion, however, to make a small charge to non-members of £1.00 to cover both the Official Guide and the season admission ticket. Non-members wishing to receive tickets and copies of the "Official Guide" in advance should send to the Association's offices the relevant form together with the necessary remittance, as soon as possible.

Copies of the Official Guide and season admission tickets will also be available at the entrance to the Exhibition.

Venue

As in 1974, the exhibition will be of four days' duration and will open on the Tuesday morning at 09.30 and will close on the Friday at 16.00. The exhibition of raw materials, plant and equipment used in the paint, printing ink, colour, and allied industries will take place at the Empire Hall, Olympia, London.

Tuesday 22 April	..	09.30-17.30 hrs
Wednesday 23 April	..	09.30-17.30 hrs
Thursday 24 April	..	09.30-17.30 hrs
Friday 25 April ..	..	09.30-**16.00** hrs

Motif of Exhibition 1975

The motif for 1975, designed by Robert Hamblin, continues the theme of OCCA-26, when attention was drawn to the European Economic Community, by extending it to show the world-wide interest aroused by the association's annual exhibitions in London, which in recent years have attracted visitors from more than 50 overseas countries. The motif is printed in colour elsewhere in this issue, and these colours (two shades of blue and one of green) will be used throughout the publicity material for the exhibition. Two (cascade blue and leaf green) will be incorporated in the fascias of the stands, thus giving both an entity to the design and pleasing changes of colour to visitors as they move from corridor to corridor. A feature of OCCA exhibitions has always been the provision of special seating areas, where visitors can meet friends and discuss problems—and these areas continue the colour theme chosen for each particular exhibition.

Aim of the Exhibition

The aim of the Exhibition is the presentation of technical advances in those industries supplying the paint, printing ink, colour, linoleum and allied industries and the Exhibits may relate not only to new products but also to new knowledge on existing products and their uses and 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 essential that a technically or scientifically trained person, who has full knowledge of the products displayed, be available on the stand throughout the official hours of opening.

Special visits by overseas trade delegations

Following the great success of the delegation from Osaka, Japan, on the occasion of OCCA-26 when special arrangements were made for works visits etc, requests have already been received for similar facilities for a delegation from Czechoslovakia, Switzerland and for a further Japanese party.

Any company wishing to be placed on the list of those willing to accept such delegations should write to the Director & Secretary as soon as possible, setting out the countries in which they are interested and the scope of the activities which would be displayed.

The OCCA Exhibition and the raw material shortages

At the 1974 exhibition, when the acute shortage of raw materials was causing so many problems, the value of this annual technical display and the opportunity which it gives for the free interchange of ideas between suppliers and manufacturers in a relaxed atmosphere was especially evident, and new exhibitors at that exhibition were delighted with the response achieved and the goodwill built in a period of the most adverse of conditions in the industry. Indeed, the 1974 exhibition demonstrated the great strength of this unique and remarkable exhibition in weathering the frustrating problems and difficulties, such as the three-day working week in the United Kingdom at the beginning of the year, which severely handicapped so many other functions and caused the cancellation of others. The Council of the Association is convinced that the enthusiastic support which it received from exhibitors was reflected in the interest aroused by visitors and augurs well for the 1975 and future exhibitions.

Travel Agents

The Wayfarers Travel Agency Ltd., Cranfield House, 97/107 Southampton Row, London WC1B 4BQ, will be allocated a stand adjacent to the OCCA Information Centre at the Exhibition and will be prepared to advise on, and arrange, hotel accommodation and travel facilities to the Exhibition. They will also be able to make theatre ticket reservations for the evenings of the Exhibition.

Please address all enquiries to The Wayfarers Travel Agency AT THE ADDRESS SHOWN ABOVE, and not to the Association.

Scarborough Conference 1975

The titles of the seventeen papers to be presented at the Association's Conference which will take place at the Grand Hotel, Scarborough, Yorkshire, England from 17 to 21 June 1975, were given in the January issue of the *Journal* together with summaries of sixteen of these papers and biographies of the lecturers. The summary for the paper to be presented by Mr S. L. Davidson (NL Industries Inc) on "A new versatile lead-free pigment" is given below, together with a short biography of the author.

The papers are drawn from sources in the United Kingdom, Germany, Holland, Sweden and the USA, and they will be presented in five sessions. Two of these will be held on Wednesday 18 June, a further two on Thursday 19 June and the final session on the morning of Friday 20 June. Following the Association's Annual General Meeting in the afternoon of Friday 20 June, three workshop sessions will be held; the titles of the workshop sessions were given in the January issue. The arrangement of the five sessions is, provisionally, as follows:

Session 1 (Wednesday morning)

Chairman: A. R. H. Tawn (Hon. Research and Development Officer)

1. "Quality control of painting in the construction industry—making reality match the theory" by Mr F. G. Dunkley (BIE Anti-Corrosion Ltd).
2. "Testing of surface coatings by the customer" by Mr D. A. Bayliss (Central Electricity Generating Board).
3. "Flocculation—its measurement and effect on opacity in systems containing titanium pigments" by Mr J. G. Balfour and Mr M. J. Hird (Tioxide International Ltd).
4. "Prediction of the corrosion protective properties of paint films by permeability data" by Dr H. Haagen (Forschungsinstitut für Pigmente und Lack EV). Paper presented on behalf of FATIPEC.

Session 2 (Wednesday afternoon)

Chairman: G. H. Hutchinson (formerly Chairman of the Eastern Branch of the Scottish Section)

1. "Why did it fail?" by Mr A. F. Sherwood and Mr A. N. McKelvie (Paint Research Association).
2. "Problems encountered in testing paint films" by Mr M. B. Kilcullen (British Steel Corporation).
3. "Prediction of the performance of surface coatings by accelerated testing under normal conditions" by Dr K. M. Oesterle (formerly Maderlack AG).

Session 3 (Thursday morning)

Chairman: G. de W. Anderson (Director of the Paint Research Association)

1. "Implications of the paint film contraction theory for comparison of accelerated and natural weathering" by Mr T. W. Wilkinson and Mr J. Colling (Laporte Industries Ltd).
2. "Theories—laboratory investigations —practical performance" by Mr B. Lindberg (Scandinavian Paint and Printing Ink Research Institute).
3. "The theory and practice of film formation by co-ordination reactions involving aluminium compounds" by Mr J. H. W. Turner, Mr W. K. H. Lakin and Mr P. Womersley (Manchem Ltd).
4. "Practice makes perfect" by Mr A. E. Claxton (Inmont Ltd).

Session 4 (Thursday afternoon)

Chairman: A. G. Holt (Vice-President)

1. "Ecological coatings: the theory and the reality" by Mr A. G. North, Mr R. Little and Mr J. L. Orpwood (Cray Valley Products Ltd).
2. "Paints for buildings—the potential and the performance" by Mr P. Whiteley and Mr G. W. Rothwell (Building Research Establishment).
3. "The flow of epoxy powder coating films in relation to reactivity, rheology and wetting" by Mr S. Gabriel (Shell Delft).

Session 5 (Friday morning)

Chairman: A. T. S. Rudram (President Designate)

1. "A new versatile lead free pigment" by Mr S. L. Davidson (NL Industries Inc).
2. "Protection: from hypothesis to principle" by Mr P. J. Gay (formerly Storry Smithson & Co Ltd).
3. "Opportunities and constraints for the chemical industry" by Mr G. S. Galer (Shell Chemicals UK Ltd).

The registration fees for the Conference will be £30.00 (plus VAT) for members, £50.00 (plus VAT) for non-members and £10.00 (plus VAT) for wives. A full social programme, including tournaments, coach tours, a Civic Reception and the Association's Dinner and Dance, has been arranged.

The majority of delegates will be accommodated in the Grand and St Nicholas Hotels, which are situated opposite each other on St Nicholas Cliff. Forms of registration were circulated with the January issue of the *Journal* and further copies can be obtained from the Association's offices (Telex 922670). The closing date for registrations will be 1 April 1975.

A new versatile lead free pigment

By S. L. Davidson

With the development of latex paints for use on exterior wood substrates, it was found necessary to control the staining caused by coloured bodies in certain types of wood. Lead pigments were found to give the required performance, so that when subsequent coats of paint were applied the discoloration was contained.

Recent legislation in the United States, however, stipulates the use of lead-free materials in this connection. Compounds with metallic ions other than lead were studied and found to be useful for this purpose. Further studies indicated that other properties, such as corrosion resistance, were imparted by one of the products developed.

Detailed studies were made to establish the composition of the new product. Continuing studies have demonstrated that the pigment developed for one end use is much more versatile particularly in the field of corrosion resistance. Uses for the product as an anticorrosive pigment in metal primers, both oleoresinous and water reducible, have been found as well as finishes to be applied by electrodeposition. Correlation of actual performance and

A view of Scarborough castle

theoretical composition is demonstrated, which illustrates that sometimes performance is better than theory.

S. L. Davidson

Mr Davidson graduated from the University of California at Los Angeles in 1939. He joined N. L. Industries (then known as National Lead Company) in 1943 as a paint chemist and has been engaged in formulating paints since that time. At the present time he is Manager, Coatings Applications Department of the Industrial Chemicals Division.

He is a past president (1971) of the Federation of Societies for Coatings Technology, the Golden Gate Paint and Varnish Club (1950) and the New York Society for Paint Technology (1968). He is still active in both the Federation and the New York Society serving as chairman of various committees of both organisations. He has presented lectures and courses on colour technology in the USA, Canada, Great Britain and the Scandinavian countries.

He received the Armin J. Bruning Award for his contributions to the science of colour in the coatings industry in 1969. He is a member of the American Chemical Society, the American Society for Testing and Materials and the Federation of Societies for Coatings Technology, the Optical Society of America and a member of the Board of Directors of the Colour and Appearance Division of the Society of Plastic Engineers and Treasurer and a member of the Board of Directors of the Inter-Society Colour Council.

Corrigendum

Mr F. G. Dunkley has asked us to point out that, whilst the biographical note in the January issue correctly shows him as joining BIE Anti-Corrosion Limited after his service with British Railways Research Department, he is still functioning as a director of this company, although the Conference brochure inadvertently described him as "formerly BIE Anti-Corrosion Ltd." We apologise to Mr Dunkley for any inconvenience caused.

Irish Section

Cheese and Wine party

The second meeting of the session was held on Friday 18 October at the Clarence Hotel, Dublin, and this took the form of a Cheese and Wine party.

It had been decided that this would be a Ladies' Night and at short notice Dr F. Stoyle agreed to act as speaker for the evening, choosing as his title "Further reminiscences." In his inimitable way, which all who know Dr Stoyle have come to expect, he gave some most interesting facts and observations upon the reconstruction of old buildings into attractive houses, something with which Dr Stoyle has had considerable personal experience.

He also gave some views upon colour and its use, reminding the audience of the tremendous strides which have been made in printing with the introduction of bright fast-to-light colours.

The talk was illustrated with photographs and colour slides and it was generally agreed that the evening had been most enjoyable.

R.C.S.

Mrs Silver, Mr Silver, Mrs Power and Mr D. Power (Section Chairman) at the Irish Wine and Cheese Party.

Auckland and Wellington Sections

New Zealand Convention 1975

Low pollution coatings and the energy crisis

The New Zealand Sections' 1975 Convention, which is being organised by the Auckland Section, will be held from 1 to 3 August at the Warakai Hotel, which is near Taupo, a tourist resort on the North Island. The emphasis in the technical papers will be on low pollution coatings and the energy crisis. Because of the increasing attendance by general management in recent years, there will also be papers dealing with less technical subjects, such as marketing.

Among the speakers will be a representative from Dulux NZ Limited who will speak about powder coatings, a senior lecturer from Auckland University, Physics Department to talk on the energy crisis, a senior technical man from Rohm and Haas USA to talk on water reducible and high solids coatings and the Marketing Manager of Byk-Mallinckrodt USA who will present a paper on the use of additives in water reducible paints.

Further information can be obtained from the Hon. Secretary of the Auckland Section, PO Box 5192, Auckland, New Zealand.

News of Members

Mr J. N. Bailey, an Ordinary Member attached to the Newcastle Section, has been appointed managing director of Berger Chemicals of Newcastle, succeeding Mr V. C. Thompson (see below). Mr Bailey joined British Paints—now Berger Chemicals—in 1950. In 1969, he was appointed managing director of British Paints (Ireland) Limited, general manager of the Protection Division of Berger Chemicals, and subsequently the Resinous Chemicals Division.

Mr J. D. W. Davidson, an Ordinary Member attached to the Scottish Section and currently its Vice-Chairman, has been appointed Deputy Chairman of Federated Paints Ltd. with special responsibility for the technical side.

Mr L. Hopwood was presented with a travelling case on the occasion of the fortieth Anniversary Dinner of the Scottish Section, to mark his departure from that Section. He is a past treasurer of the Section and was elected vice-chairman for the present session; he now relinquishes this post.

Mr Hopwood, who is employed by ICI, is moving from Glasgow to Bristol.

Mr V. C. Thompson, an Ordinary Member attached to the Newcastle Section and a past chairman of the Bristol Section and past Vice-President of the Association, has been appointed supervising director of all Berger group activities in the UK. Mr Thompson was appointed managing director of British Paints and Chemicals (later Berger Chemicals) in 1971, and he also became a director of Berger Jenson and Nicholson Limited. In 1972, he was appointed chairman of Cuprinol Limited, Macgregor Wallcoverings Limited, Berger Traffic Markings Limited and Spelthorne Metals Limited—all companies in the Berger Group.

Scottish Section

Fortieth anniversary

A dinner was held in the Beacons Hotel, Glasgow on 8 November 1974 to mark the 40th Anniversary of the founding of the Scottish Section. The special guests were the President, Mr Silver and Dr F. M. Smith, Chairman of the Manchester Section. The dinner was also attended by eight of the eleven surviving past Chairmen of the Scottish Section; the remaining three tendered their apologies.

In his address, Mr Silver recounted the state of the paint industry in 1934—no titanium dioxide, no alkyds and £1.00 per week pay for a graduate.

Dr Smith (Technical Director, Ciba Geigy UK Limited Pigments Division) presented the Section with a complete set of inscribed name bars of past Chairmen, to be attached to the Chairman's chain of office. These inscribed bars were donated by Ciba Geigy Pigments Division in honour of past Section chairmen from the company.

Mr C. D. Smith, introduced as the oldest surviving past Chairman, talked of his memories of the inaugural meetings and personalities of the early days of the Section.

A strong link between the past and present was given by Mr J. Davidson, Joint Managing Director of Federated Paints. Mr Davidson was present at the founding meetings and is the newly elected Vice-Chairman for the coming two years. This period of service to the Scottish Section is matched by his record of having attended all the Association's biennial conferences since their inception.

Mr A. McLean, Chairman of the Section, thanked the speakers for their interesting reminiscences. He also thanked Ciba-Geigy Pigments Division for its generosity in donating the new chain of office.

G.H.R.

Wine and Cheese party

The social round in the Section turned yet another circle when the Wine and Cheese party was held at the Beacons Hotel on Friday 29 November. A selection of very moderately priced French, German and Italian wines proved to be most acceptable —especially if the rate at which bottles emptied was any indication—and these were accompannied by a wide selection of continental and domestic cheeses.

Many of the company, of more than sixty, spent the evening talking and renewing old acquaintances, whilst the more active remainder took to the floor after a preliminary fuelling operation and, if they did not actually dance the night away, at least disposed of a good part of it.

Music for the evening was provided by Messrs J. Davidson (drums) and C. Crombie (accordion).

A.McL.

West Riding Section

Annual Dinner and Dance

The Section held its sixteenth annual Dinner and Dance at the Crown Hotel, Harrogate on 29 November 1974. It was, as usual, a very successful evening, and attended by nearly 250 members and guests. The festivities ended all too soon at the designated time of 1.00 a.m., although unofficially they lingered on a good deal longer.

Host Chairman, David Morris shared the centre spot on the top table with Mr G. C. Moore, MA, LL.B, Chief Executive, Bradford Metropolitan District as Guest of Honour, flanked by the President and the following Section Chairmen: D. E. Hopper—Midlands; H. G. Clayton—Manchester; E. Armstrong—Hull; and C. N. Finlay—Newcastle, with Mr F. Cooper, the Association Hon. Treasurer, keeping a watchful eye on the expenses.

Although the names may have been provided by the gentlemen, in practice, the VIPs were the ladies, who brought colour, glamour and conversation to the proceedings.

Mr Moore was both eloquent and amusing in proposing the toast to the West Riding Section; Mr David Morris replied, and proposed the toast to the ladies and guests. Mrs Anita Silver added a feminine touch in replying on behalf of the ladies and guests.

N.C.

Group including Top Table guests at West Riding Section Dinner Dance

Admissions to the Professional Grade

At its meeting on 11 December 1974, the Professional Grade Committee authorised the inclusion of the names of the following Ordinary Members of the Association on the Register:

As Fellows

William Carr (*Manchester Section*)

James Graham Gillan (*Manchester Section*)

As Associates

Kenneth Raymond Geddes (*Manchester Section*)

John William Arthur Hirst (*Auckland Section*)

Jack Everand Judah (*Hull Section*)

Yousif Diran Kirakoz (*General Overseas Section—Iraq*)

Dennis Neil Rampley (*London Section*)

Peter Graham Staples (*General Overseas Section—Australia*)

As Licentiates

Peter Elliott (*London Section*)

Larry Raphael Francis Joseph Fernandes (*London Section*)

Full details of the regulations were given in the July 1974 issue of the *Journal* and the list of Ordinary members admitted to the Professional Grade was last given in the December 1974 issue. Council asks senior members of the Association to draw the attention of younger members to the Licentiate grade and it is particularly pleased to learn of the interest being taken at technical colleges in helping students to prepare their dissertations. It is felt that it will be of interest to other members considering applying for admission to the Licentiate grade to know that the dissertations on which the two successful candidates have been examined were:

Mr Peter Elliott "To examine the permeability related properties of amorphous poly (vinyl chloride) coatings laid down from different solvent media."

Mr Larry R. F. J. Fernandes, BSc, "An analytical study of epoxy-phenolic coating mixtures".

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.

February

Monday 3 February

Hull Section: "Science and crime" by Mr G. Devonport, North Eastern Forensic Science Laboratories, Harrogate, to be held at The George Hotel, Land of Green Ginger, Hull, at 6.30 pm.

Thursday 6 February

Thames Valley Section—Student Group: "Additives" by Mr Lakin, Hardman & Holden Ltd., to be held at Slough College in the main lecture theatre at 4.00 pm.

Newcastle Section: "Adhesives and sealants" by Mr N. Macdonald, Evode Ltd., to be held at the Royal Turks Head Hotel, Grey Street, Newcastle upon Tyne, at 6.30 pm.

Friday 7 February

Scottish Section—Eastern Branch: Burns Supper in the Lady Nairn Hotel, Edinburgh.

Thames Valley Section: Buffet Dance, Great Fosters Hotel.

Monday 10 February

London Section: "The painting of metal bridges—historical and current trends" by Mr P. Ferguson, Materials Quality Assurance Directorate, at East Ham College of Technology, High Street South, London E6, at 7.00 pm.

Tuesday 11 February

West Riding Section: "Paint packaging" by C. I. Mellor, Metal Box Co. Ltd., to be held at the Griffin Hotel, Leeds, at 7.30 pm.

Thursday 13 February

Scottish Section: "Paint pollution and possibilities" by Mr R. H. E. Munn of Cary Valley Products Ltd., to be held at Beacons Hotel, 7 Park Terrace, Glasgow G3, at 6.00 pm.

Midlands Section—Trent Valley Branch: Open forum on "Polution" to be held at the British Rail School of Transport, London Road, Derby, at 7.00 pm.

Friday 14 February

Manchester Section: "Some forward views on the energy situation and raw material supplies" by Dr J. K. Hambling of BP Chemicals Ltd., to be held at the Woodcourt Hotel, Brooklands Road, Sale, Manchester, at 6.30 pm.

Saturday 15 February

Scottish Section — Student Group: "Chrome pigments and their usage" by Mr A. C. D. Cowley of ICI Ltd., to be held at Three Pigeons, 573 Sauchiehall Street, Glasgow, at 10.15 am.

Wednesday 19 February

Scottish Section—Eastern Branch: "Photography" by Mr D. Rosie of Craig & Rose Ltd., to be held at the Carlton Hotel, North Bridge, Edinburgh, at 7.30 pm.

Irish Section: "Ireland—agricultural or industrial?" by Mr L. Sheedy, to be held at the Clarence Hotel, Dublin, at 7.45 pm.

Friday 21 February

Midlands Section: "Chemicals from coal —the impact of the energy crisis" by Mr P. Joy, British Steel Corporation, Chemical Division, to be held at the Birmingham Chamber of Commerce and Industry, 75 Harborne Road, Birmingham B15 3DH, at 6.30 pm.

Newcastle Section: Ladies' Night at Five Bridges Hotel, Gateshead.

Wednesday 26 February

Manchester Section—Student Group: "The prevention of bacterial corrosion of mild steel with paint films" by Mr A. V. Robinson of Camrex (Holdings) Ltd., to be held at the Manchester Literary and Philosophical Society, Manchester, at 4.30 pm.

Thursday 27 February

Thames Valley Section: "Protection of off-shore oil rigs" by Mr F. G. Dunkley, to be held at the Beech Tree Hotel, Maxwell Road, Beaconsfield, Bucks, at 7.00 pm.

Friday 27 February

Bristol Section: Technical film show.

March

Monday 3 March

Hull Section: Ladies' Evening "Cosmetics" by Mr D. S. Morris of Helena Rubenstein Laboratories to be held at the George Hotel, Land of Green Ginger, Hull at 6.30 p.m.

Thursday 6 March

Newcastle Section: Papers by members of the Section to be held at the Royal Turks Head Hotel, Grey Street, Newcastle upon Tyne at 6.30 p.m.

Thames Valley Section—Student Group: Works visit. Details to be announced.

Tuesday 11 March

West Riding Section: "Advances in condensation polymers" by Prof. I. Goodman to be held at the Griffin Hotel, Leeds at 7.30 p.m.

London Section: "European Lecture—interfacial phenomena of inks" by Mr W. Hansen, Scandinavian Institute for Paint and Printing Ink to be held at the Polytechnic of the South Bank, Borough Road, London SE1 at 7.00 pm.

Thursday 13 March

Scottish Section: "Golf" Film and talk by Mr S. L. McKinlay of the Glasgow Herald to be held at Beacons Hotel, 7 Park Terrace, Glasgow G.3 at 6.00 pm.

Midlands Section—Trent Valley Branch: "Newer emulsions for decorative systems" by Mr D. A. Wallace of Vinyl Products Ltd. to be held at the British Rail School of Transport, London Road, Derby at 7.00 pm.

Friday 14 March

Manchester Section: "The pigmentation of ultraviolet curable systems" by Dr B. E. Hulme, Tioxide International Central Labs, Stockton-on-Tees, to be held at the Manchester Literary and Philosophical Society, 36 George Street, Manchester at 6.30 pm.

Saturday 15 March

Scottish Section—Student Group: "Recent developments in wall-coverings" by a lecturer from the Walpamur Co. Ltd. to be held at Three Pigeons, 573 Sauchiehall Street, Glasgow at 10.15 am.

Wednesday 19 March

Irish Section: "Science and the detection of crime" by Mr R. Simon of the Institute for Industrial Research and Standards, and Detective Supt. D. Murphy of the Garda Siochana Technical Bureau to be held at the Clarence Hotel, Dublin at 7.45 pm.

Scottish Section—Eastern Branch: AGM followed by a film show. This meeting will start at 7.00 pm and be held at the Carlton Hotel, North Bridge, Edinburgh.

Thursday 20 March

Thames Valley Section: "Artists' colours" by Mr A. Brown, Winsor & Newton Ltd. to be held at the Beech Tree Hotel, Maxwell Road, Beaconsfield, Bucks at 7.00 pm.

Friday 21 March

Midlands Section: J. Newton Friend lecture at 7.30 pm "Interior design" by Mr J. Simkins, Alexander Fine Arts to be held at the Birmingham Chamber of Commerce and Industry, 75 Harborne Road, Birmingham B15 3DH.

Bristol Section: "High performance pigments for printing inks and paints" by Mr A. E. Honiball and Mr B. H. With m of Ciba-Geigy (UK) Ltd. to be held at the Royal Hotel, Bristol at 7.15 pm.

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

BELL, KEVIN ALEXANDER, 2 Cordir Mansions, 300 Stamford Hill Road, 4001 Durban, South Africa. (*South African*)

DIRKSEN, WESSEL, PO Box 2068, Durban, South Africa. (*South African*)

DOVE, CHARLES EDWARD, 11 Faircroft Avenue, Sandiacre, Notts. (*Midlands—Trent Valley Branch*)

GILMOUR, JOHN ALAN, 26 Waitmata Road, Takapuna, Auckland 9, New Zealand. (*Auckland*)

HARALAMBOF, VLADIMIR, Savas Sok 12, Ferikoy, Istanbul, Turkey. (*General Overseas*)

HOLLAND, PETER JOHN, BSc, Ciba-Geigy (UK) Ltd., Pigments Division, Roundthorn Estate, Wythenshawe, Manchester M23 9ND. (*Manchester*)

HUG, HANSRUEDI, Ciba-Geigy (UK) Ltd., Pigments Division, Roundthorn Estate, Wythenshawe, Manchester M23 9ND. (*Manchester*)

PAINTING, WILLIAM BRUCE, 34 Duck End, Wollaston, Wellingborough, Northants NN9 7SH. (*Thames Valley*)

PATEL, ARVIND MANIRHAI, MSc, 198 Walworth Road, London SE17. (*London*)

PRICE, DEREK STEVEN, BSc, 8 Lowton Road, Sale, Cheshire. (*Manchester*)

RAJAN, KOLANKARAI SHIVA, BSc, Seegutstrasse 8, CH 8804 AU, Switzerland. (*General Overseas*)

READ, ROBIN THOMAS, LRIC, 8 Hobbs Green, London N2. (*London*)

SMRCKA, JAROSLAVA, 35 Sunrise Street, Hazelwood, Pretoria 0002, South Africa. (*South African*)

SPAARGAREN, ALBERT AREND, PO Box 1452, East London, South Africa. (*South African*)

STAPLES, PETER GRAHAM, 8 Margaret Street, Kogarth, NSW 2217, Australia. (*General Overseas*)

WATTON, DENIS NEDEN, 20 Kaallaagte Street, Waverley Ext., Pretoria 0002, South Africa. (*South Africa*)

Associate Member

DAVIES, DEREK, PO Box 12-267, Penrose, Auckland, New Zealand. (*Auckland*)

Registered Students

HANCOCK, BRYAN COLIN, 2 Small Acre, Hemel Hempstead, Herts HP1 2LP. (*London*)

THUITA, PAUL RUCHUHI, YMCA, Rush Green Road, Romford RM7 0PH, Essex. (*London*)

Corrigendum

The address for Warner Maurice Saville published in the October 1974 issue should read: Mobil Oil New Zealand Limited, PO Box 38-073, Petone, New Zealand. We apologise to Mr Saville for any inconvenience caused.

On standardisation and the use of SI units

Uniformity of terminology, tense and units is desirable. A few years ago the Publications Committee decided that, as from 1 January 1975, all papers published in the *Journal* would be required to contain units specified in the Systeme International (SI) developed jointly by the International Organisation for Standardisation (ISO), the International Union of Pure and Applied Chemistry, and the International Union of Pure and Applied Physics. A description of SI units, listing those likely to be applicable to papers published in the *Journal*, appeared in its April 1971 issue; fuller treatments may be found in *Pure and Applied Chemistry*, 1970, **21,** 2, and in BS 3763 (1970).

In a practical situation the use of the base SI unit or the SI derived unit may not be convenient. In such an instance it is permissible to employ one of the units referred to as "Decimal fractions and multiples of SI units having special names". For example, the derived unit of volume is the cubic metre, but where this seems inappropriate volume may be expressed as litres or, preferably, as dm^3. (*JOCCA*, 1971, **54,** 376).

It is appreciated that some difficulties may be caused to authors who have already completed papers using cgs or other units and, in the transitional period, it may be possible in some cases for assistance to be given in converting to SI. However, where this is not possible any paper containing units other than SI will be returned to the author for amendment.

The standard nomenclature for organic and inorganic compounds, as recommended by IUPAC, should be used. Authors requiring further information should consult "IUPAC rules on the nomenclature of organic chemistry", 1972, London: Butterworths.

Authors are particularly urged to adhere to the standardised forms for references and abbreviations. This often saves library time wasted by taking down hastily a reference given in an unusual form. References should be made in the form of the following examples:

1. Scott, J. A., *JOCCA*, 1969, **52,** 593.
2. Wright, W. D., "The measurement of colour", 4th Edition, 1969, London: Adam Hilger, p. 31.

The use of the first person should be avoided, the writer being referred to as "the author".

There is no objection to the use of trade names where the material cannot be adequately described by a chemical or trivial name. However, these shall not be used in any way which could be construed as advertising. Also, it should be remembered that trade names may not be familiar outside their country of origin. Therefore, where first mentioned, the material should be characterised fully, followed by the trade name and manufacturer in parenthesis. Later references to the material can be by the trade name alone, thus

> ". . . were based on a 45 per cent oil length linseed/glycerol alkyd, of viscosity 5.0kg m^{-1} s^{-1} (25°; 50 per cent in xylol) (Joccalkyd H69, from Prioryhouse Ltd.) . . . In the adhesion tests, formulations based on Joccalkyd H69 showed . . ."

The Hon. Editor reserves the right to delete trade names where these are felt to be superfluous.

A leaflet "Notes for authors, lecturers, reporters and reviewers" has been prepared by the Association and describes the recommended method for preparation of text, illustrations and diagrams intended for publication in the *Journal*. Copies of the leaflet are obtainable by sending a stamped, self-addressed envelope marked "Notes to authors" in the top left-hand corner to the Association's offices at the address on the contents page of this issue.

Oil and Colour Chemists' Association

President: L. H. SILVER

General

The Oil and Colour Chemists' Association was formed in 1918, to cover paint, printing inks, pigments, varnishes, drying and essential oils, resins, lacquers, soaps, linoleum and treated fabrics, and the plant, apparatus and raw materials useful in their manufacture. In 1924 it absorbed the Paint and Varnish Society. The stated purpose of the Association is to promote by discussion and scientific investigation the technology of the industries concerned with the above-mentioned products, and to afford Members opportunity for the interchange of ideas. This is achieved by the regular holding of ordinary meetings at which papers are presented, and the organisation of annual technical exhibitions, biennial conferences, educational activities and practical co-operative experimental work. Details of these activities are given in the *Journal of the Oil and Colour Chemists' Association*, which is published monthly, and whose pages are open to receive communications and other pronouncements on scientific and technical matters affecting the Members of the Association and the industries concerned. The Association's meetings also afford opportunities for Members to meet informally and socially.

Sections

There are Sections of OCCA in Auckland, Bristol, Hull, Ireland, London, Manchester, the Midlands (with a Trent Valley Branch), Newcastle upon Tyne, Scotland (with an Eastern Branch), South Africa (with Branches in the Cape, Transvaal and Natal), Thames Valley, Wellington, and the West Riding, and these are responsible for the conduct of their own local affairs. There is also a General Overseas Section. There is also a close alliance between the Association, the Federation of Societies for Paint Technology in the United States, and the Fédération d'Associations des Techniciens de l'Industrie des Peintures, Vernis, Emaux et Encres d'Imprimerie de l'Europe Continentale (FATIPEC). The Association also maintains cordial relations with the Scandinavian Federation of Paint and Varnish Technicians (SLF).

The five Sections previously maintained by the Association in Australia formed (1.1.68) the Oil and Colour Chemists' Association Australia, having the same aims and activities as, and working in close liaison with, the parent body.

Membership

Ordinary Membership is granted to scientifically trained persons, and Associate Membership to others interested in the industries covered. An optional Professional Grade, conferring designatory letters, is open to Ordinary Members. Student membership is open without restriction to persons under the age of 21 and to those up to 25 who are following a course of technical study. An entrance fee of £1 (plus VAT) is payable by Registered Students and £5 (plus VAT) by Ordinary and Associate Members. Applications for membership are invited from suitably qualified persons who are engaged or otherwise interested in the industries noted above. Applications, which should be supported by two Members of the Association (one of whom must be an Ordinary Member), should be forwarded to the Director & Secretary at the address given below. Application forms and full details of membership may be obtained from the offices of the Association.

Professional Grade

The Association recently introduced (1971) an *optional* professional grade for its Ordinary Members, giving the designatory letters FTSC (Fellow in the Technology of Surface Coatings), ATSC (Associate in the Technology of Surface Coatings), and LTSC (Licentiate in the Technology of Surface Coatings). Full details are available upon request from the Association. Where Membership has lapsed, previous periods of Ordinary Membership count towards the total required under the regulations, as set out in the July 1974 issue of *JOCCA*.

Exhibitions

A technical exhibition is held annually at Olympia; Members are sent copies of the *Official Guide* several weeks in advance, in order to plan their itineraries. A charge is made to non-members for admission and for copies of the "Official Guides." Non-members should apply, in writing, to the Director and Secretary for copies of the *Official Guide* and admission ticket.

Conferences and Symposia

The Association organises large, biennial technical conferences, the papers for which (together with discussions) are published in this *Journal*. Sections of the Association in the UK and abroad hold symposia and these, too, are reported in *JOCCA*.

Publications

Journal of the Oil and Colour Chemists' Association (*JOCCA*) is published monthly and includes a yearly index in the December issue. The subscription rate to non-members is £20.00 p.a. ($50) post free; payable in advance. Single copies may be purchased for £2.00.

Introduction to Paint Technology (Second Edition with additional chapter). With illustrations, 187 pages and index £2.00 (including postage).

Paint Technology Manuals (Parts 1, 2, 4, 5 and 6 at present out of print).

Part 1 "Non-convertible Coatings"

Part 2 "Solvents, Oils, Resins and Driers"

Part 3 "Convertible Coatings," Second Edition, pp. 350, £2.80

Part 4 "The Application of Surface Coatings"

Part 5 "The Testing of Paints"

Part 6 "Pigments, Dyestuffs and Lakes"

Part 7 "Works Practice," pp. 218, £3.00

Director & Secretary: R. H. Hamblin, MA, FCIS,
Priory House, 967 Harrow Road, Wembley, Middlesex,
England HA0 2SF.

Tel. 01-908 1086; Telex 922670 (OCCA WEMBLEY)

ASSOCIATION TIES

Council has authorised the production of an alternative Association Tie, which has a single gold coloured motif on a maroon background, and this tie is now available from the Association offices, price £1.85 (including VAT).

The original tie, with a dark blue background, is still available at £1.65 (including VAT).

CLASSIFIED ADVERTISEMENTS

Classified Advertisements are charged at the rate of 75p per line. Advertisements for Situations Wanted are charged at 20p per line. A box number is charged at 20p. They should be sent to the Director & Secretary, Oil & Colour Chemists' Association, Priory House, 967 Harrow Road, Wembley, Middlesex HA0 2SF

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FORTHCOMING OCCA SYMPOSIA

"Gloss and its assessment" (Tuesday 25 March).

Enquiries to: C. L. Hill Esq., Thames Valley Section Honorary Secretary, 76 Keep Hill Drive, High Wycombe, Bucks.

"Ultraviolet polymerisation and the surface coatings industry" (Thursday 10 and Friday II April).

Enquiries to: H. Fuller Esq., Newcastle Section Honorary Social Secretary, Tioxide International Limited, Carlton Weathering Station, Yarm Back Lane, Stockton-on-Tees, Cleveland TS21 1AX.

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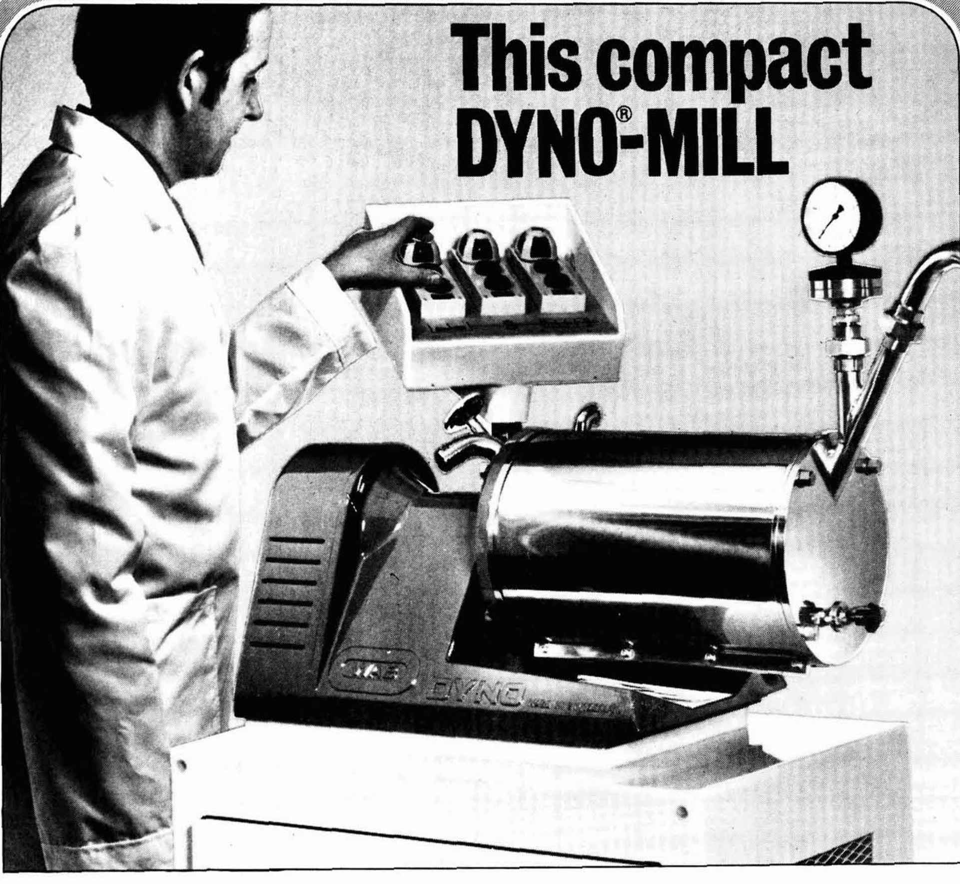

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