Vol. 59 No. 12 JOCCAB 59(12) 427-472 (1976) December 1976

OCCA-29 First list of Exhibitors

See pages 457 and 458 for details

The UK and fourteen overseas countries to be represented

OCCA-29 • March 1977
Alexandra Palace London N22

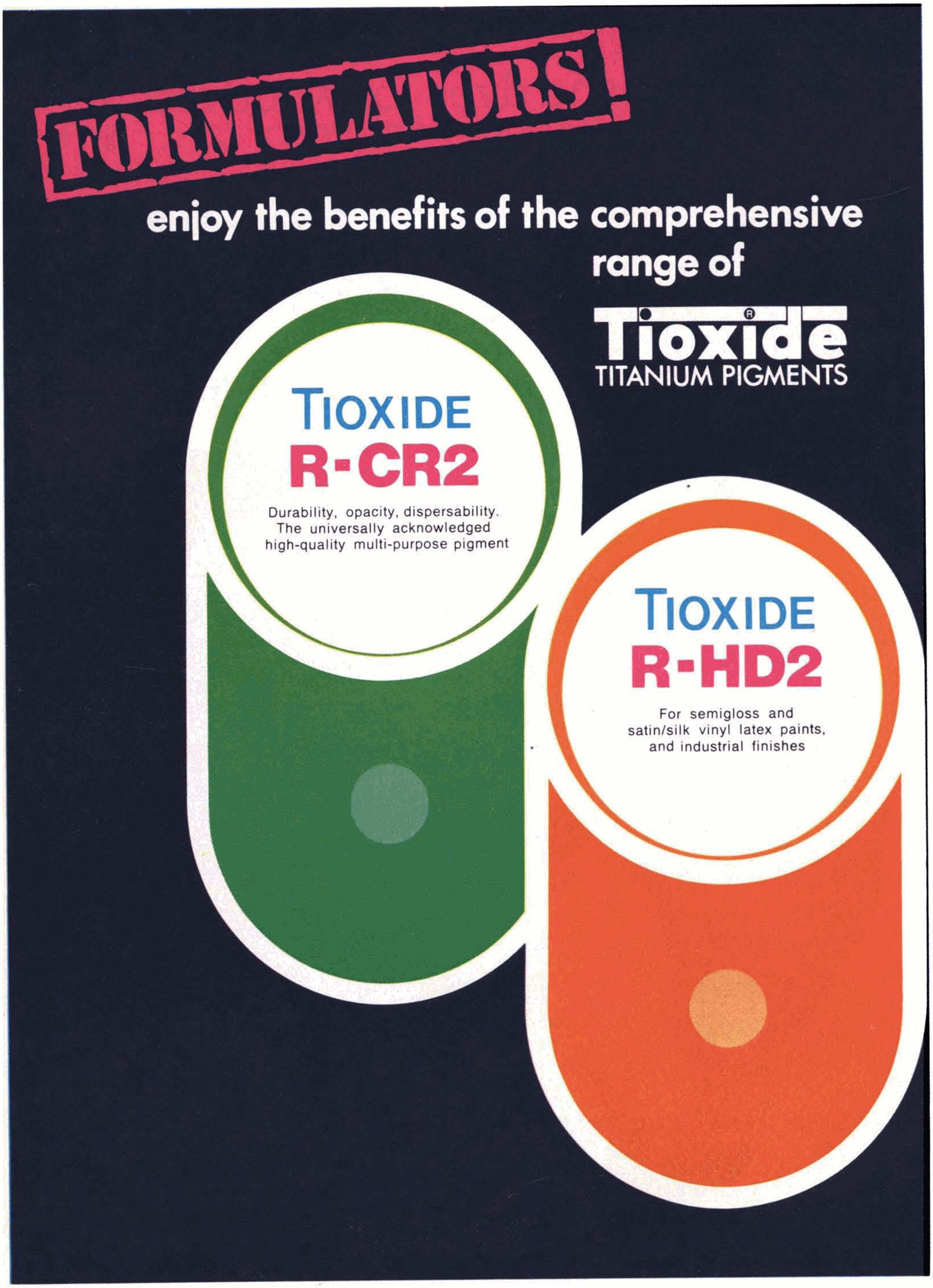
THE INTERNATIONAL FORUM FOR DISPLAY AND DISCUSSION IN THE SURFACE COATINGS INDUSTRIES

OCCA 29

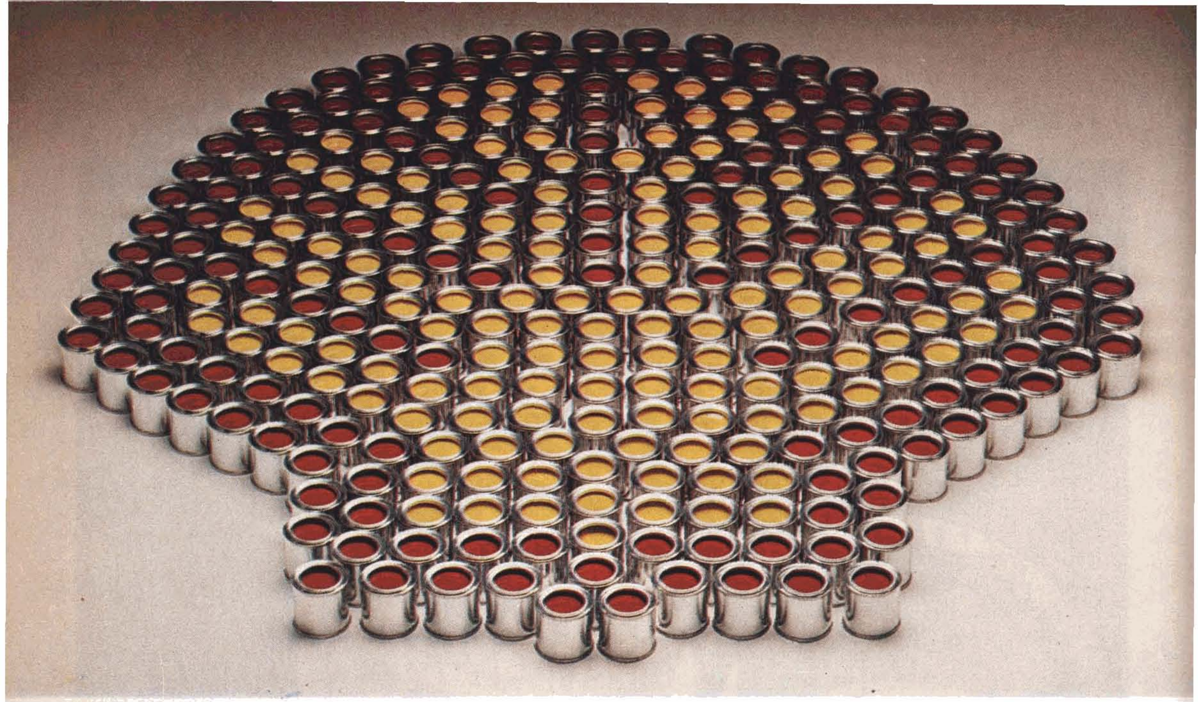
JOURNAL OF THE OIL & COLOUR CHEMISTS' ASSOCIATION

TEN-YEAR CONSOLIDATED INDEX
of Transactions and Communications
1966-1975, Volumes 49-58
NOW AVAILABLE from the Association's offices at the address below
Price (prepayment only): £5.00 to non-Members; £2.00 to Members

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




TIOXIDE
R-XL
For opacity, economy, dispersability and stability in matt and low-sheen latex paints
TIOXIDE
R-TC4
Multi-purpose by design. The chloride-process pigment of unsurpassed colour and brightness
TIOXIDE
R-XG
Specially developed for glossy latex paints
KARO



OCCA-29 Exhibition

The Association's twenty-ninth Technical Exhibition will be held at Alexandra Palace, London N22, from 22 to 25 March 1977. Further details regarding the arrangements for OCCA-29 and the many facilities offered at Alexandra Palace appear on page 457 and 458 of this issue of the *Journal*.

The Exhibition Committee emphasises on this occasion the quality of the OCCA Exhibitions in providing a *focus* for all those connected (either as suppliers of raw materials and equipment, or as buyers or in some other capacity) with the many and varied coatings markets throughout the world. The Exhibition has long been known as the annual international forum for display and discussion in the surface coatings industries, and the motif for 1977 draws attention to the concept of the annual "focal point" for the industries (see advertisement on the back outside cover of this issue).

Any organisation which has not previously exhibited and wishes to obtain an Invitation to Exhibit should contact the Association's offices immediately. The address is given on the Contents page of this issue.

"Official Guide"

The Exhibition Committee offers advertising space in the "Official Guide" to the Exhibition, which has proved to be a very popular advertising medium, not only for exhibitors but also for companies who were not showing at a particular Exhibition.

This unique publication will be circulated to all members of the Association, both at home and overseas, and as far as possible to all consuming companies in Great Britain. Copies will also be sent to those applying as a result of the Association's wide-spread publicity. The advantages of an advertisement in the *Official Guide* need hardly be stressed, since it will contain details of each Exhibitor's stand and thus constitute a summary of those recent technical developments which will be shown; consequently, it will be read widely and kept for reference.

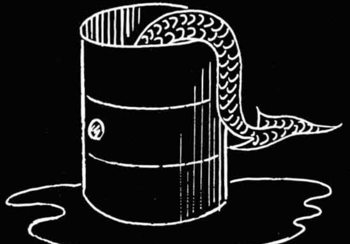
For details of advertising in this and other Association publications, write to the Assistant Editor at the address on the Contents page of this issue.

Optional Professional Grade for Ordinary Members

LTSC *Licentiate* in the Technology of Surface Coatings
ATSC *Associate* in the Technology of Surface Coatings
FTSC *Fellow* in the Technology of Surface Coatings

The optional Professional Grade for Ordinary Members of OCCA was instituted by Council in 1971. Since that time, over 400 candidates have been successful in their applications to join the Professional Grade and a full list is published on page 459 of this issue of the *Journal*. The various routes to the three Grades (see above) in diagrammatic form and the full regulations for admission are published in the July 1976 issue.

A reprint of the full regulations for admission to the Professional Grade and application form may be obtained by sending a stamped, self-addressed envelope, marked "Professional Grade leaflet" in the top left-hand corner, to the Association's offices at the address on the Contents page of this issue. **It is felt that some overseas Members, in particular, might encounter difficulties contacting the required number of sponsors and any applicant who finds himself in this position is advised to write to the Director & Secretary of the Association in the first instance.**



So you've got solvents problems !

Small quantities?
Large quantities?
Urgent delivery wanted?
Special mixtures?

3 strategically placed depots will take good care of you

Supplies are no problem, when you're a Samuel Banner customer. Just write or phone for fast and friendly service.

Latest comprehensive product list with full specifications on request.

Samuel Banner

LIVERPOOL 59/61 Sandhills Lane L5 9XL
Telephone 051-922 7871 Telex 627025
LONDON 24 Marshgate Lane, Stratford E15 2NH
Telephone 01-534 4321 Telex 897766
GLASGOW 289 Castle Street G4 0ST Tel. 041-552 0723

Inside some of the world's best known paint cans there are Hardman varnishes

It's true! Hardmans manufacture oleo-resinous varnishes for leading paint companies in the U.K. and overseas.
Close compliance with specification requirements is ensured by the use of modern plant and technology.
Hardmans do not manufacture paints in competition with their customers, varnish production is their speciality. They know the problems and the answers and will gladly quote against your specifications (treated in confidence) or to their own formulations.

HARDMANS

E. Hardman, Son & Co. Ltd.
Bedford Street, HULL HU8 8AX. Telephone: (0482) 23902
Varnish makers to the Paint Industry.

JOURNAL of the
OIL AND COLOUR CHEMISTS' ASSOCIATION

Hon. Editor: S. R. Finn, B.Sc, FRIC, FTSC

Editorial correspondence should be addressed to the Hon. Editor, *JOCCA*, 49 Elms Drive, Kirk Ella, Hull HU10 7QH.

General correspondence should be addressed to:
R. H. Hamblin, MA, FCIS,
Director & Secretary,
Oil & Colour Chemists' Association,
at the address below.

Tel: 01-908 1086
Telex 922670 (OCCA Wembley)
Telegrams: OCCA Wembley Telex

Assistant Editor: C. A. Tayler, BSc

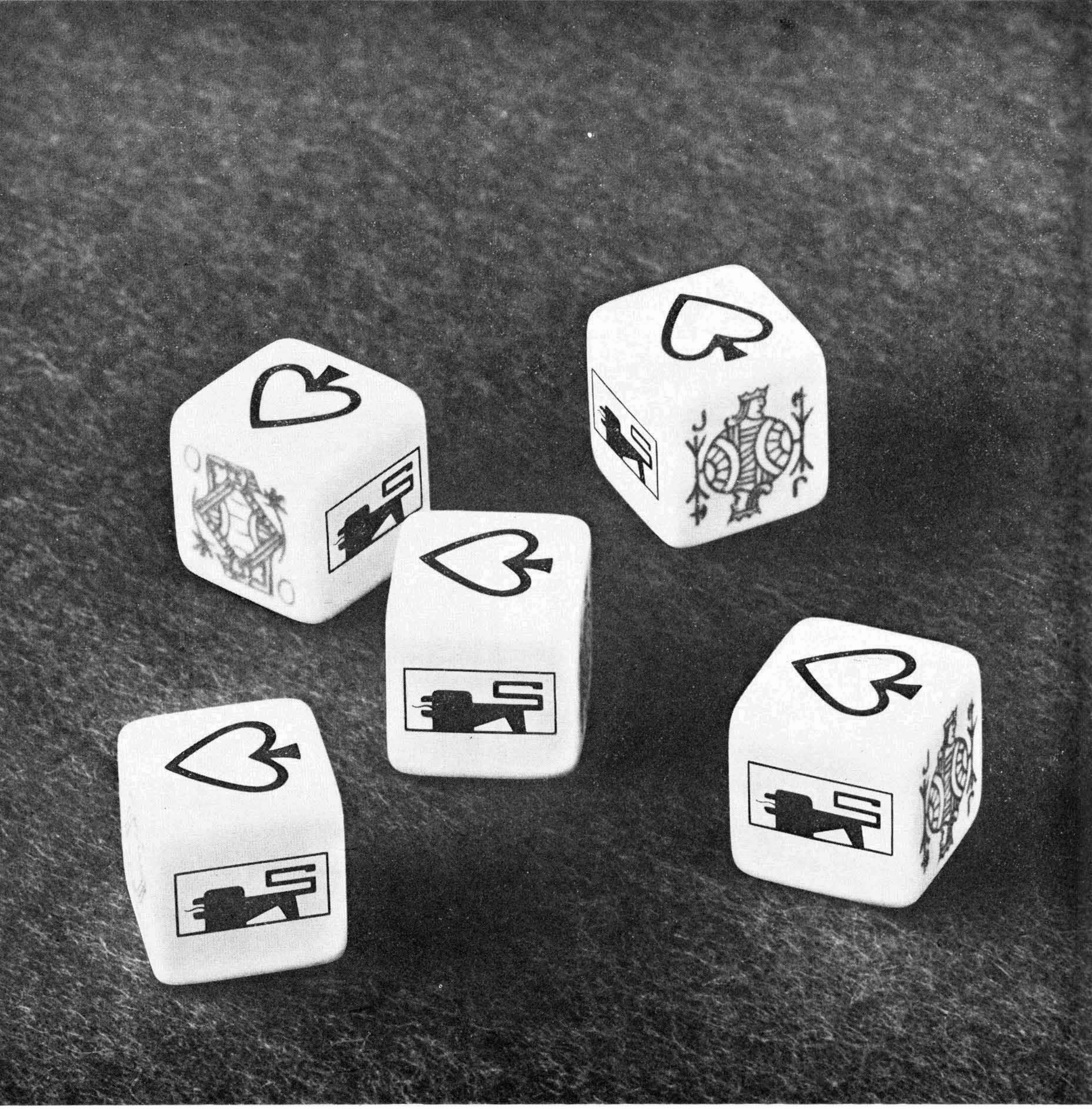
Annual subscription to non-members: £20 ($50), post free by surface mail, payable in advance.

Single copies £2 ($5), post free by surface mail, payable in advance.

Contents **Vol. 59 No. 12** **December 1976**

Transactions and Communications

Published by
OIL AND COLOUR CHEMISTS' ASSOCIATION
Priory House, 967 Harrow Road, Wembley, Middlesex, HA0 2SF England



J. Oil Col. Chem. Assoc. 1976, 59, 427-432

Transactions and Communications

Usefulness of the measurement of internal stresses in paint films*

By A. Saarnak, E. Nilsson and L. O. Kornum

Scandanavian Paint and Printing Ink Research Institute, Odensegade 14, 2100 Copenhagen, Denmark

Summary

Internal stresses develop in a paint film when a volume contraction is restrained due to adherence of the film to a rigid substrate. These stresses are unwanted phenomena, because they can impair the performance of the coating. Internal stresses are particularly harmful in paint films on substrates of low cohesive strength or on dimensionally unstable substrates, such as wood.

An accurate method for the measurement of internal stresses is described. The formation of stresses in films of several acid-cured furniture lacquers and the influences of concentration of hardener and atmospheric conditions are discussed. It is shown that internal stresses depend greatly on the water content of the film, and that water absorption in paint films can be studied through measurement of changes in the internal stresses.

The internal stresses in paint films are very sensitive to many factors and their determination might, therefore, be a valuable supplement to other physical methods for the investigation of paint film properties.

Keywords

Processes and methods primarily associated with:

analysis, measurement or testing
stress-strain testing

drying or curing of coatings
drying

service or utility
ageing

Properties, characteristics and conditions primarily associated with:

materials in general
modulus of elasticity

the environment
humidity
temperature

L'utilité de la mesure des tensions internes des films de peintures

Résumé

Les tensions internes se mettent en évidence au sein d'un film de peinture quand la contraction du volume est bornée en raison de l'adhérence du film au subjectile rigide. Ces tensions sont des phénomènes indésirables, parcequ'elles peuvent altérer le rendement du revêtement. Les tensions internes sont particulièrement nuisibles dans le cas de peintres sur les subjectiles de faible force cohésive, ou sur les subjectiles comme le bois qui manquent de stabilité dimensionnelle.

On décrit une méthode pour mesurer les tensions internes. On discute la formation des tensions au sein des films de plusieurs peintures pour meubles, durcies par acide et également on discute l'influence de la concentration de l'agent de durcissement et des conditions atmosphèriques. On démontre que les tensions internes dépendent en grande partie de la teneur en eau du film, et que l'absorption d'eau par le film de peinture peut être étudiée au moyen de la mesure des changements des tensions internes.

Les tensions internes au sein des films de peintures sont très susceptibles à plusieurs facteurs, et ainsi la mesure de leur force pourrait être un supplément de valeur aux autres méthodes physiques pour l'investigation des caractéristiques des films de peintures.

Nützlichkeit der Messung interner Spannungen in Lackfilmen

Zusammenfassung:

In einem Lackfilm entstehen innere Spannungen, wenn eine Volumenschrumpfung als Folge der Haftung des Films auf einem starren Substrat behindert wird. Diese Spannungen sind unerwünschte Phänomene, weil sie die Leistungsfähigkeit der Beschichtung behindern können. Interne Spannungen in Lackfilmen sind besonders nachteilig auf Substraten von niedriger Kohäsionskraft oder auf dimensionell unstabilen Substraten, wie z.B. Holz.

Es wird eine akkurate Methode zur Messung interner Spannungen beschrieben. Die Bildung von Spannungen in Filmen aus verschiedenen säuregehärteten Möbellacken und die Einflüsse der Konzentration von Härtern, sowie atmosphärischer Bedingungen werden besprochen. Es wird aufgezeigt, dass interne Spannungen wesentlich vom Wassergehalt des Filmes abhängen, und dass Wasserabsorption in Lackfilmen durch Messungen von Veränderungen in den inneren Spannugnen beobachtet werden können.

Die internen Spannungen in Lackfilmen sind sehr empfindlich gegen viele Faktoren, und ihre Bestimmung könnte deshalb eine wertvolle Ergänzung anderer physikalischer Methoden für die Untersuchung der Eigenschaften von Lackfilmen sein.

Introduction

Internal stresses influence the performance of a paint film. If the internal stress exceeds the tensile strength of the film, cracks are formed with failure occurring at sites of inhomogeneity in the film. The internal stress also decreases the adhesion of the paint film, so cracking and flaking often appear at the same time (Fig. 1). Failures of the same kind can appear if the film is on a substrate of low tensile strength, such as poor quality plaster. Here the internal stress in the paint film can be large enough to cause cohesive failure in the substrate. Internal stresses develop in a paint film when a volume change is restrained due to adhesion of the film to the substrate. If the film is rigid, the hindered shrinkage or

---

*Presented at a symposium of the Manchester Section held on 6 and 7 April 1976 at the University of Manchester Institute of Science and Technology.

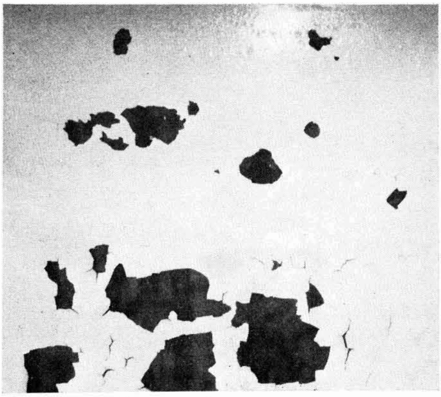


Fig. 1. Cracking and flaking caused by internal stresses

expansion leads to stresses according to Hook's law:

$$\sigma = E.\varepsilon \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where σ = the stress in the paint film,

E = the modulus of elasticity of the paint film, and

ε = the hindered dimensional change.

Shrinkage causes internal tensile stress; expansion causes internal compressive stress.

Internal stresses are especially dangerous in paint films on dimensionally unstable substrates, such as wood and wood products. Stresses caused by dimensional changes of the substrate may be added to the stresses which are formed during the drying and ageing of the paint film and cracking can take place.

A paint film which is continuously in a stressed state probably has a lower resistance to most external influences than has an unstressed film.

Factors affecting the internal stresses

Ref. 1

As previously mentioned, internal stresses are due to constrained dimensional changes according to Hook's law. The magnitude of the internal stresses depends both on the restrained dimensional change and on the modulus of elasticity of the paint film. All factors which cause dimensional changes or effect the modulus of elasticity cause changes in the internal stresses. The most important factors are briefly described below.

Drying and ageing

Evaporation of volatile components (solvents, plasticisers, degradation products) from the paint film will cause a volume decrease. The loss of these film softening elements also causes an increase in Young's modulus for the film.

Chemical reactions usually involve volume changes. For example, the polymerisation or curing of two-pack systems causes a decrease in volume and a gives higher film modulus. Depolymerisation (for example, due to ultraviolet radiation) can lead to a volume increase and a lowered modulus of elasticity.

Temperature

The modulus of elasticity is highly dependent on temperature. A low temperature causes increased internal stress. When the temperature rises, the internal stresses are decreased.

The internal stresses can also be affected by differences in the volume expansion coefficients of the substrate and the paint film. The greatest differences occur on inorganic substrates (metals, concrete) which usually have considerably lower thermal expansion coefficients than organic polymers.

The effects of the temperature are normally reversible, provided that chemical reactions do not take place.

Humidity

The humidity is of great importance, since every paint film contains a certain amount of water. When the relative humidity decreases, the paint film loses water. The volume decreases and Young's modulus for the film increases. An increase in relative humidity has the opposite effect.

Composition of the paint film

Internal stresses are mainly determined by the physical properties of the binder. Other components may also have an influence: the modulus of elasticity is decreased by adding low molecular substances (such as plasticisers and surface active agents), whilst pigments and fillers increase the modulus due to their reinforcing action.

At the Scandinavian Paint and Printing Ink Research Institute, internal stresses in paint films have been studied with the following aims:

(i) to develop a simple and exact method for measuring internal stresses in paint films;

(ii) to determine the internal stresses which develop in paint films of different compositions during drying and ageing; and

(iii) to study the effects of external influences on the internal stresses in paint films.

Experimental

Refs. 2-5

Internal stresses were determined by a beam deflection method[2-5]. The principle is as follows. The paint is applied on the one side of a thin homogeneous steel strip. If internal stresses develop in the paint layer, the substrate will deflect into a curved form. The deflection is measured microscopically with an accuracy of ± 2 μm. The experimental apparatus is shown in Fig. 2 and the sample holder in Fig. 3.

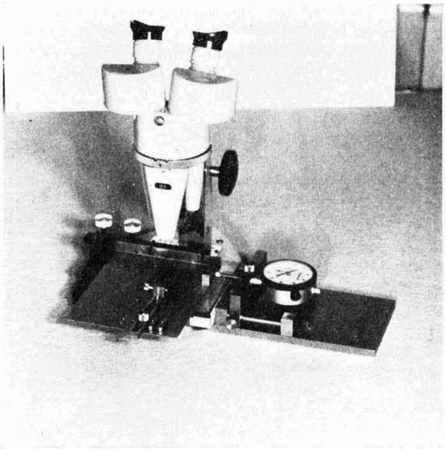


Fig. 2. Apparatus for measuring internal stresses

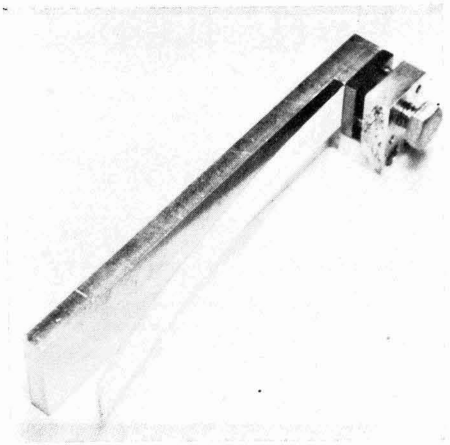


Fig. 3. Specimen holder with a test strip

Calculation

If the Young's modulus of the paint film can be neglected in comparison with the modulus of the steel strip and the internal stress is constant throughout the film, then the internal stress can be calculated[2] according to the formula:

$$s = (dEt^3)/(3cL^2)(t + c)(1 - \nu) \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where s = internal stress
d = deflection of the strip
E = Young's modulus of the steel strip
ν = the Poisson ratio of the steel
t = the thickness of the steel strip
L = the length of the strip
c = the thickness of the paint film

Computer calculations using the "finite element" method showed this simplified formula gives reasonably accurate results (0–5 per cent too high, if the basic assumptions are fulfilled[4]).

If the internal stress in the paint layer is not constant in the film but varies (stress distribution), then the simplified method of calculation gives stresses which vary with the thickness of the substrate. A method of calculation has been developed which enables the determination of the stress profile in the paint film[4]. Measurements are made with two steel strips of different thicknesses coated with identical paint films. The stress in the surface of the paint film S_F and the stress in the layer of paint film adjacent to the substrate s_I are calculated using the following formulae (with the assumption that the stress distribution is linear):

$$s_F = \frac{E}{3c^2L^2(t_A - t_B)(1 - \nu)} \cdot [-(3t_B + 2c)t_A^3 d_A + (3t_A + 2c)t_B^3 d_B] \quad \ldots\ldots\ldots(3)$$

$$s_I = \frac{E}{3c^2L^2(t_A - t_B)(1 - \nu)} \cdot [(3t_B + 4c)t_A^3 d_A - (3t_A + 4c)t_B^3 d_B] \quad \ldots\ldots\ldots(4)$$

A and B are indices which refer to the two tests made on steel strips with different thicknesses.

Reproducibility of the measurement of internal stresses has been studied by three paint research laboratories in different countries, and the authors' laboratory in Scandinavia was one of these. The results, which can be seen in Fig. 4, are not very encouraging. It is possible that the zero-point determination was made at different times, or that differing climatic con-

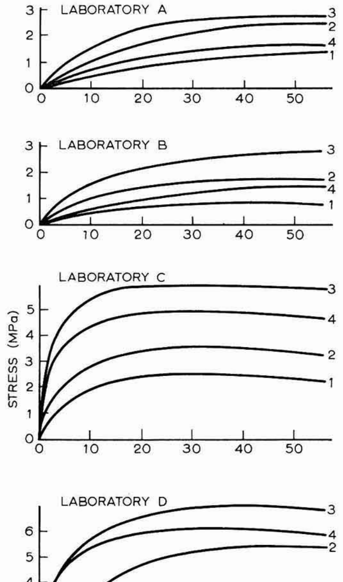


Fig. 4. Determination of internal stresses by four different laboratories using the same paints: 1, 2, 3 and 4

ditions have prevailed. The authors' studies have shown that the climate in the test area must be controlled with extreme care.

If all precautions are taken, then it is possible to achieve satisfactory reproducibility, as can be seen in Table 1.

Table 1

Measurement of internal stresses (average of 6 replicates as a function of drying time)

Time after application (days)	Internal stress (MPa)	Standard deviation*
1	0.09	0.029
2	0.16	0.033
4	0.26	0.039
7	0.32	0.042
14	0.39	0.039
21	0.53	0.030
28	0.63	0.056
37	0.78	0.050

*The mean standard deviation is 0.040 MPa.

Sources of error

An investigation of the possible errors showed that the most important source of error was the variation of in relative humidity during the period of measurement. With the apparatus used, the maximum error was estimated to be ±0.3 MPa.

Results

Most of the work has been done with a commercial furniture enamel, which had shown severe tendencies to crack under practical conditions of application. The main composition of the binder was a non-drying alkyd combined with a urea resin. The cure was catalysed by p-toluenesulfonic acid. The following parameters were investigated:

Curing time

The stress increased most rapidly during the first stages of cure (Fig. 5), but stresses increased all the time during the period investigated (150 days) when low concentrations of curing agent were used. With higher concentrations of hardener, a stress maximum was achieved after about two weeks. After that time, the internal stress was almost constant.

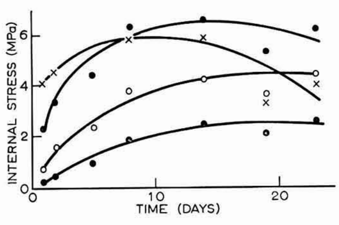


Fig. 5. The internal stress as a function of time for four different paints

Amount of curing agent

At a certain concentration of curing agent (Fig. 6) a stress maximum was obtained. This concentration (8 per cent addition) coincides with the paint manufacturer's recommendation, and probably gives the most efficient cure. Greater amounts of curing agent give more rapid initial growth in internal stress. However, the differences in internal stresses obtained with high and low concentrations of curing agent decrease with time. The stresses are almost equal after half a year.

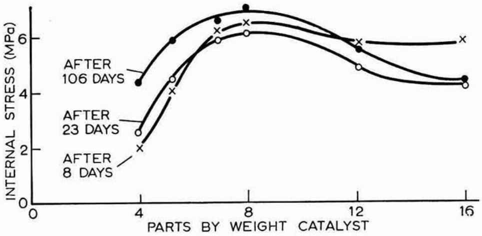


Fig. 6. Effect of the amount of hardener used

Relative humidity

A decrease in the humidity gives a large increase in internal stress. Initially, the change of the internal stress is proportional to the square root of the time (Fig. 7).

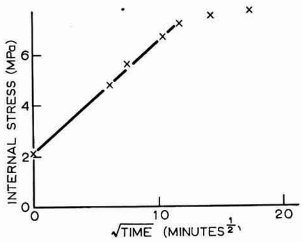


Fig. 7. Effect of decreasing the relative humidity from 75% to 31%

An increase in the humidity has the opposite effect, but even here the change of stress is proportional to $t^{0.5}$ as can be seen in Fig. 8.

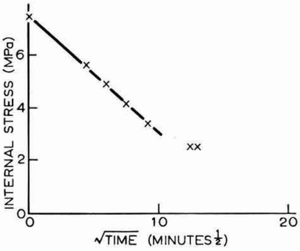


Fig. 8. Effect of increasing the relative humidity from 31% to 75%

In the system investigated, the changes of the internal stress occurred most rapidly when large amounts of catalyst were used. This is probably due to the hydroscopic nature of the catalyst used (p-toluenesulfonic acid), which is retained unreacted, of course, in the paint film.

It is concluded that the internal stress depends on the water content of the film and that the uptake by and loss of water from the paint film can be studied by following the changes of internal stresses.

The relative humidity had no influence, however, on the degree of cure. Test strips which had cured at different humidities between 30 and 90 per cent showed the same internal stress when conditioned to standard climatic conditions of 23°C and 50 per cent relative humidity.

Water

Effects similar to those produced when increasing the relative humidity are obtained with test specimens immersed in water. The change in internal stress is, of course, much faster (Fig. 9). When the test specimen is allowed to dry after water immersion, a slower stress increase occurs (Fig. 10). The sensitivity to water immersion increases with increased hardener content.

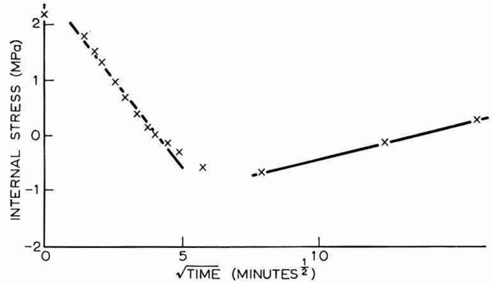


Fig. 9. Effect of immersion in water

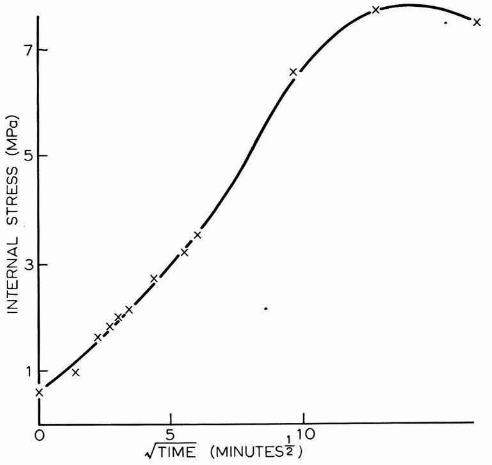


Fig. 10. Drying after water immersion

Thickness of the substrate

The internal stresses developed in identical paint films on 0.100mm and 0.125mm thick steel strips have been compared. The calculated internal stresses for the period up to 23 days are somewhat higher in the paint film applied to the thinner substrate. After a longer time this position is reversed. This anomaly is probably due to the fact that the assumed load distribution does not correspond to the situation in reality, but the magnitude of the internal stress varies across the thickness of the film in a direction at right angles to its surface.

Ultraviolet radiation

The effect of ultraviolet radiation on a polyurethane film cured with an aromatic polyisocyanate has been studied by means of internal stresses. Fig. 11 shows that ultraviolet radiation decreases the internal stress in the paint film. This is probably due to degradation of the polymer, since it is known that polyurethane paints containing aromatic isocyanates chalk and yellow during outdoor exposure.

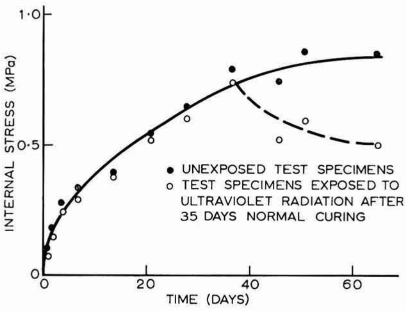


Fig. 11. Effect of UV-exposure

Relaxation

The change of water content of the paint film leads to considerable changes of the internal stress, as seen previously. In all cases investigated, it has been found that after the first pronounced change, a certain relaxation takes place (Figs. 9 and 10). The relaxation is relatively small in most cases.

Conclusion

A simple and reliable method for the determination of internal stresses in paint films has been developed. It has been shown that the customary, simplified method of calculation of internal stresses is not always valid. It must be assumed that the stress can vary in a direction perpendicular to the paint/substrate interface. A method for calculation of the stress distribution of paint film has been developed, and this assumes that the distribution is linear. It is found that the internal stresses increase continuously for a long time (up to half a year) and can reach considerable values (up to 10 MPa for the compositions investigated).

External forces greatly influence the internal stress. Increasing the water content of the paint film, by increasing the relative humidity or by immersion in water, decreases the internal stress, and vice-versa. Initially, the change of the internal stress is directly proportional to the square root of time.

Exposure of the paint film to ultraviolet light has in one case decreased the internal stress.

Internal stresses in a paint film reflect the dimensional changes and the Young's modulus of the paint film. Measurement of the changes in the internal stress allows a study of the various factors which can influence these two properties, such as ageing of the paint film, adsorption and desorption of substances like water, and compositional changes of the paint.

Internal stresses can be very troublesome and tend to downgrade the performance of a coating. A knowledge of how internal stresses develop and change with time is a prerequisite for avoiding them. It is hoped that the present work will elucidate some of the effects of various factors concerned with internal stress and will enable the paint formulator to recognise more clearly those factors which must be considered.

[*Received 24 April 1976*

Acknowledgment

The authors wish to acknowledge grants from the Swedish Board for Technical Development, without which this work would not have been possible.

References

1. Nilsson, E., *NIF report T 16-74 M + T*, Scandinavian Paint and Printing Ink Research Institute, 1974.
2. Corcoran, E. M., *J. Paint Tech.* 1969, **41**, 635.
3. Sanzarovskii, A. T., *Vysokomolekulyarnye Soedineniya*, 1960, **2**, 1698.
4. Kornum, L. O., *NIF report T 9-75 M*, Scandinavian Paint and Printing Ink Research Institute, 1974.
5. Nilsson, E., *NIF report T 2-75 M + T*, Scandinavian Paint and Printing Ink Research Institute, 1975.

J. Oil Col. Chem. Assoc. 1976, 59, 433-438

Comparison of the effects of resin composition and pigments on the anti-corrosive properties of powder coatings*

By A. van de Werff

Scado BV, P.O. Box 15, Zwolle, Netherlands

Summary

The influence on anti-corrosive properties of selected pigments, extenders and thermoplastic additives as constituents of several polyester powder coatings has been evaluated. Anti-corrosive properties on mild steel are expressed as resistance to rusting on outdoor exposure and resistance to salt spray.

Keywords

Types and classes of coatings and allied products
  powder coating
Raw materials:
  binders—resins, etc.
    polyester resin
    thermoplastic resin
  chemically active pigments
    corrosion inhibiting pigment
  extender pigments
    extender pigment

Process and methods primarily associated with:
  analysis, measurement or testing
    salt spray testing
  service or utility
    corrosion
Properties, characteristics and conditions primarily associated with dried or cured films
  weather resistance

Une comparaison des effets des pigments et de la composition des résines sur les caractéristiques anti-corrosives de revêtements en poudre

Résumé

On a évalué l'influence sur les caractéristiques anti-corrosives de plusieurs revêtements en poudre polyester qu'exercent certains pigments, extenders et adjuvants thermoplastiques. On exprime les caractéristiques anti-corrosives de ces revêtements sur acier doux sous termes de la résistance à la formation de rouille lors de l'exposition aux intempéries et de la résistance à brouillard salin.

Vergleich der Auswirkungen von Harzzusammensetzung und Pigmenten auf die Antikorrosiven Eigenschaften von Pulverlacken

Zusammenfassung:

Es wurde der Einfluss von ausgewählten Pigmenten, Extendern und thermoplastischen Zusätzen auf die antikorrosiven Eigenschaften als Bestandteile einiger Polyesterpulverlacke geprüft. Antikorrosive Eigenschaften auf Eisenblech werden als Widerstand gegen Verrostung bei Aussenbewitterung und gegen Salzbesprühung ausgedrückt.

Introduction

Ref. 1

One of the selling points used in the introduction of epoxy powder coatings in the 'sixties was that their quality obviated the need for pretreatment of the substrate. This argument is still applied, although practical experience has shown it to be untrue.

This misunderstanding has been extended to the second generation of powder coatings, which have been developed to produce high gloss retention on outdoor exposure. The protective nature of these new systems may in some cases be of greater importance than with the first generation types, which were only intended for interior use or as primers.

Previous work[1] on semi-commercial systems clearly showed that they exhibited poor corrosion resistance (Table 1), and that pretreatment of the metal was of great importance (Table 2).

Although it had been shown that pretreatment of the metal is necessary, it was hoped that by modifications to binder composition, and by the use of anti-corrosive pigments, extenders and thermoplastic additives, an improvement in the corrosion resistance of coatings applied to untreated metal could be obtained.

---

*Presented at a symposium of the Manchester Section held on 6 and 7 April 1976 at the University of Manchester Institute of Science and Technology.

Table 1†

Rust creepage and loss of adhesion for several semi-commercial powder coating systems

Powder coating system Pigment binder ratio = 0.50 Pigment = TiO_2 Cl 220 (Kronos Titan GmbH)	Rust creepage* (mm from edge)	Loss of adhesion as a result of salt-spray (mm/100 hrs)
Acidic acrylic + oxazoline	7	12
—OH polyester + IPDI-adduct	8	7
—OH polyester + IPDI-adduct + catalyst	14	8
Acidic polyester + TGI	14	5
Acidic polyester + epoxy resin	9	2.5
Epoxy resin + acc. dicyandiamide	9	3

*July 1974–July 1975 outdoor exposure mild steel (Zwolle, Netherlands)

†Abbreviations in Tables 1-11 denote the following:

IPDI	Isophorone diisocyanate
CAB	Cellulose acetate butyrate
TGI	triglycidyl isocyanurate
AC pigment	Anti-corrosive pigment

Table 2

Creepage of powder coatings applied to metal substrates which have received differing pretreatments

	Creepage (mm) after 1000 hrs salt spray, with various metal pretreatments		
Powder coating system	Iron phosphate	Zinc phosphate	Degreased mild steel
Acidic acrylic + oxazoline	13	2	complete failure
—OH polyester + IPDI-adduct	1.5	2	complete failure
—OH polyester + IPDI-adduct + catalyst	3.5	4	complete failure
Acidic polyester + TGI	2.5	1.5	complete failure
Acidic polyester + epoxy resin	3	3	complete failure
Epoxy resin + acc. dicyaniamide	2	2.5	complete failure

Experimental

Ref. 1

From the results of work referred to earlier[1], it was decided to select for examination (Table 6a) an acidic polyester (polyester *1*) combined with an epoxy resin ("Epikote 1004"—Shell International Chemical Co.), in combination with the pigments, extenders and thermoplasts shown in Table 3.

Table 3

Anti-corrosive pigments, extenders and thermoplasts used

Anti-corrosive pigments	
Barium metaborate	Buckman Laboratories
Zinc phosphate ZNP	G. Siegle & Co. GmbH
Strontium chromate AK	G. Siegle & Co. GmbH
Barium chromate 840 SV	G. Siegle & Co. GmbH
Basic lead silico chromate	Titangesellschaft mbH
Zinc phosphate ZNP + Sicorin RZ	G. Siegle & Co. GmbH
Zinc phosphate ZNP + Sicorin RZP	G. Siegle & Co. GmbH
Chromium phosphate FW	G. Siegle & Co. GmbH
Zinc chromate LD-KSH/SM	G. Siegle & Co. GmbH
Extenders	
Rutenia 70 FF	Société des Couleurs Zinciques Aubervilliers
Rutenia 70 FFF	Société des Couleurs Zinciques Aubervilliers
EWO (Eweiss OZ 460)	Deutsche Baryt Industrie Dr Rudolf Alberti
EWO-Albaryt	Deutsche Baryt Industrie Dr Rudolf Alberti
Micromica W1	A/S Norwegian Talc
Microdol Super	A/S Norwegian Talc
Talcum AT extra	A/S Norwegian Talc
Millicarb	Plüss Staufer AG
Dicalite 438	Great Lakes Carbon Corp.
Gasil AF	Joseph Crosfield and Sons Ltd
Thermoplasts	
Neocryl B 814	Polyvinylchemie
Neocryl B 722	Polyvinylchemie
Rhovinal B 7-20	Rhône Poulenc
CAB 551-001	Eastman
Polyamide resin H 105	Dr Plate GmbH
Polyamide resin H 103	Dr Plate GmbH
Silicone resin H 19	Wacker Chemie GmbH
Silicone resin QR 62230	Dow Corning
Anti-corrosive pigments	25% by weight on TiO_2
Sicorin RZ and RZP	5% by weight on TiO_2
Extenders	40% by weight on TiO_2 except for Dicalite 438 and Gasil AF (20% by weight on TiO_2)
Thermoplasts	10% by weight on binder
TiO_2:binder ratio	1:2
Binder composition	acidic polyester/epoxy resin = 1:1

Manufacturing method

All powders examined in this work were prepared by the following procedure. First, premixing of all components. Second, one passage through a Buss-Ko-Kneader PR 46 at a casing temperature of 110°C, and a kneading screw temperature of 60°C, the screw operating at 52 rpm. Then grinding in a Retsch Ultra Zentrifugalmülhe Type ZM 1, followed by sieving to finer than 90 μm.

General powder composition

TiO_2/binder ratio	1:2
Binder composition	Polyester *1*/"Epikote 1004" = 1:1
TiO_2 grade	"RCR-3" (Tioxide International Ltd)
Anti-corrosive pigments	25% by weight on RCR-3
"Sicorin RZ" and "Sicorin RZP" (corrosion inhibitors from BASF)	5% by weight on RCR-3
Extenders	40% by weight on TiO_2 except for "Dicalite 438" and "Gasil AF" (20% by weight on TiO_2)
Thermoplasts	10% by weight on binder.

Application

All powders in this work were applied to vapour-degreased, mild steel panels to give a film thickness of between 50 and 60 μm. A Sames manual spray gun type "Stajet JR 50" was used at a voltage of 60 kV. The films were cured for 10 minutes at 200°C in an air-circulated oven.

After a vertical scratch mark had been made in the coated panels, they were tested as follows:

1. Salt spray resistance according to ASTM B 117-61.
2. Natural exposure at 45° facing south in a rural atmosphere for six months (Zwolle, Netherlands).

The results obtained are shown in Table 4. It can be seen that in some cases there is good agreement between the results obtained after salt spray and after outdoor exposure; for example, polyamide resin "H 105" and "Gasil AF".

Table 4

Results of salt spray and natural exposure tests

Exposure number	Loss of adhesion as a result of salt spray (mm/100 hrs)	Rust creepage* on outdoor exposure (mm/month)
Anti-corrosive pigments		
906 Barium metaborate	2.00	1.50
907 Zinc phosphate	1.48	1.50
908 Strontium chromate	2.37	1.50
909 Barium chromate	2.12	1.58
910 Basic lead silico chromate	1.64	1.33
911 Zinc phosphate + S. RZ	2.99	2.08
912 Zinc phosphate + S. RZP	2.37	1.67
913 Chromium phosphate	2.25	1.08
914 Zinc chromate	2.99	1.78
Extenders		
915 Rutenia 70 FF	1.60	1.33
916 Rutenia 70 FFF	1.59	1.42
917 EWO	1.87	1.50
918 EWO-Albaryt	2.17	1.58
919 Micromica W1	1.40	1.17
920 Microdol Super	1.72	1.17
921 Talcum AT extra	1.60	1.17
922 Millicarb	1.39	1.33
923 Dicalite 438	6.68	1.42
924 Gasil AF	1.15	0.42
Thermoplasts		
925 Neocryl B 814	2.41	1.33
926 Neocryl B 722	2.04	1.58
927 Rhovinal B 7-20	2.99	1.42
928 CAB 551-001	4.10	1.83
929 Polyamide resin H 105	1.13	0.92
930 Polyamide resin H 103	2.27	1.50
931 Silicone resin H 19	2.44	0.10
932 Silicone resin QR 62230	3.80	0.67
902 Standard (TiO_2 RCR-3)	2.15	1.75

* over a period of six months (June to November 1975)

The result of incorporating anti-corrosive pigments was disappointing. For the silicone resins no correlation could be found. Since the level of anti-corrosive pigment could be too low, further powder coatings were prepared pigmented solely with anti-corrosive materials. The results, shown in Table 5, confirm the earlier salt spray results.

However, resistance to rust creepage on outdoor exposure is much better, particularly with zinc phosphate.

Table 5

Salt spray and natural weathering results for coatings pigmented solely with AC pigments

Exposure number	Loss of adhesion as a result of salt-spray (mm/100 hrs)	Rust creepage** on outdoor exposure (mm/month)
977 Barium metaborate	6.03	0.67
978 Zinc phosphate	1.94	0.38
979 Strontium chromate	6.03	0.58
980 Barium chromate	2.85	0.88
981 B. lead silico chromate	2.44	0.75
982 Zinc phosphate + sicorin RZ	2.59	.067
983 Zinc phosphate + sicorin RZP	3.92	0.50
984 Chromium phosphate	1.48	.071
985 Zinc chromate	5.30	0.63

Pigment:binder ratio 1:2
Binder polyester 1/Epikote 1004 = 50/50

** Over a period of six months (July to December 1975)

Experimental II

Based on the results of Table 4, two raw materials from each group were selected for further evaluation:

Zinc phosphate

Basic lead silicochromate ("Oncor M 50" NL Industries Inc.)

"Millicarb"

"Gasil AF"

Polyamide resin "H 105"

Silicone resin "H 19".

The six selected additives were examined in combination with binders shown in Table 6a.

Polyester *2* and *3* for combination with epoxy resin.

Polyester *4* for combination with an isocyanate adduct.

Polyester *5* for combination with triglycidylisocyanurate.

Table 6

Results of salt spray resistance and the binders used

Exposure number	Loss of adhesion as a result of salt spray (mm/100 hrs)
993 Polyester *3* TiO_2 (RCR-3, BTP Tioxide Ltd)	1.71
994 Zinc phosphate	1.67
995 Basic lead silico chromate	1.11
996 Millicarb	0.82
997 Gasil AF	1.48
998 Polyamide H 105	0.76
999 Silicone H 19	1.21
1000 Polyester *2* TiO_2 (RCR-3, BTP Tioxide Ltd)	5.23
1001 Zinc phosphate	3.23
1002 Basic lead silico chromate	1.67
1003 Millicarb	1.96
1004 Gasil AF	2.01
1005 Polyamide H 105	1.04
1006 Silicone H 19	2.57
1007 Polyester *4* TiO_2 (RCR-3, BTP Tioxide Ltd)	2.90
1008 Zinc phosphate	2.65
1009 Basic lead silico chromate	3.50
1010 Millicarb	2.26
1011 Gasil AF	1.79
1012 Polyamide H 105	7.82
1013 Silicone H 19	3.23

Table 6 Continued

1021	Polyester *5* TiO$_2$ (RCR-3, BTP Tioxide Ltd)	3.51
1022	Zinc phosphate	2.07
1023	Basic lead silico chromate	3.07
1024	Millicarb	2.13
1025	Gasil AF	1.67
1026	Polyamide H 105	1.04
1027	Silicone H 19	4.38
1028	Alkyd melamine primer + Alkyd melamine topcoat	4.04
1029	as 1028 over washprimer	1.55
1030	Epoxy-ester (D4) melamine primer + Alkyd melamine topcoat	5.21
1031	as 1030 over wash primer	8.65
1032	Commercial alkyd melamine primer + alkyd melamine topcoat	4.21
1033	as 1032 over wash primer	4.75
1034	Commercial epoxy primer + alkyd melamine topcoat	3.90
1035	as1034 over wash primer	0.79

Table 6a: Binders used

Polyester *1* —COOH polyester for combination with epoxy resins
Polyester *2* —COOH polyester for combination with epoxy resins
Polyester *3* —COOH polyester for combination with epoxy resins
Polyester *4* —OH polyester for combination with isocyanate adducts
Polyester *5* —COOH polyester for combination with triglycidylisocyanurate
Polyester *6* —COOH polyester for combination with epoxy resins
Polyester *7* —COOH polyester for combination with triglycidylisocyanurate
Epoxy resin: Epikote 1004 (Shell Int. Chemical Co.) polyester/epoxy ratio = 50/50
Isocyanate adduct: B 989 (Veba Chemie) polyester/adduct ratio = 80/20
Triglycidylisocyanurate: Araldite PT 810 (Ciba Geigy) polyester/TGI ratio = 90/10

The 36 systems were tested for:

1. Salt spray resistance for 400 hours (ASTM B 117-61)
2. Natural exposure for three months (Zwolle, Netherlands).

The systems based on polyester *5* were also tested for accelerated weathering resistance according to ASTM G 23-69. The results of salt spray resistance are shown in Table 6. The results of the natural exposure are shown in Table 7 and the results of the accelerated weathering are shown in Table 8.

It can be seen from Table 6 that:

(a) Powder coating is, in general, better than conventional systems.

(b) Taking the best four from each series the following sequence results:

Polyester 3—epoxy	1. Polyamide resin "H 105" 2. "Millicarb" 3. "Oncor M 50" 4. Silicone resin "H 19"
Polyester 2—epoxy	1. Polyamide resin "H 105" 2. "Oncor M 50" 3. "Millicarb" 4. "Gasil AF"
Polyester 4—IPDI adduct	1. "Gasil AF" 2. "Millicarb" 3. Zinc phosphate 4. Silicone resin "H 19"
Polyester 5—Triglycidyl isocyanurate	1. Polyamide resin "H 105" 2. "Gasil AF" 3. Zinc phosphate 4. "Millicarb"

(c) Polyester *3* is better than polyester *2*, and polyester *5* is better than polyester *4*.

(d) The poor results obtained with polyester *4* in combination with polyamide resin "H 105" are probably the result of the blocking of isocyanate groups by the polyamide resin.

It can be seen from Table 7 that:

(a) Powder coating is, in general, equal to conventional systems for resistance to rusting. However, when applied over a wash primer, the conventional systems are superior.

(b) Taking the best two from each series, the following sequence results:

Polyester 3—epoxy	1. Polyamide resin "H 105" 2. "Gasil AF"
Polyester 2—epoxy	1. Polyamide resin "H 105" 2. "Gasil AF" and "Oncor M 50"
Polyester 4—IPDI adduct	1. "Millicarb" 2. Polyamide resin "H 105", "Gasil AF" and zinc phosphate
Polyester 5—TGI	1. Polyamide resin "H 105" 2. "Gasil AF"

(c) Polyester *2* is equal to polyester *3*, and polyester *4* is slightly better than polyester *5*.

(d) The interaction between binder and additives appears to be general for a given curing mechanism (carboxyl/epoxy).

(e) The good results shown in Table 4 for polyester *1* in combination with silicone resins could not be confirmed.

The differences obtained with polyester *2* and *3* coupled with work on melt viscosity, reactivity and saponification resistance indicated that further improvements in the binder should be possible. This resulted in the production of a further acidic polyester resin for combination with epoxy resin, and this is designated polyester *6*.

The same considerations led to the development of further acidic polyester for combination with TGI (polyester *7*), also designed to have better gloss retention.

Although polyester *4* showed better rust resistance on exposure than did polyester *5*, it was decided to proceed with the latter type of resin due to its lower emission on curing.

In spite of the useful results obtained using "Oncor M 50" and zinc phosphate, it was decided to omit these materials from the later stages of this work.

Table 7

Results of natural exposure

Exposure number		Rust creepage on outdoor exposure* (mm/month)
993	Polyester *3* TiO$_2$ (RCR-3, BTP Tioxide Ltd)	1.40
994	Zinc phosphate	1.20
995	Basic lead silico chromate	1.20
996	Millicarb	1.20
997	Gasil AF	1.10
998	Polyamide H 105	0.80
999	Silicone H 19	1.20
1000	Polyester *2* TiO$_2$ (RCR-3, BTP Tioxide Ltd)	1.20
1001	Zinc phosphate	1.20
1002	Basic lead silico chromate	0.80
1003	Millicarb	1.00
1004	Gasil AF	0.80
1005	Polyamide H 105	0.70
1006	Silicone H 19	1.20
1007	Polyester *4* TiO$_2$ (RCR-3, BTP Tioxide Ltd)	0.80
1008	Zinc phosphate	0.60
1009	Basic lead silico chromate	1.20
1010	Millicarb	0.40
1011	Gasil AF	0.60
1012	Polyamide H 105	0.60
1013	Silicone H 19	1.00
1021	Polyester *5* TiO$_2$ (RCR-3, BTP Tioxide Ltd)	1.20
1022	Zinc phosphate	1.20
1023	Basic lead silico chromate	1.40
1024	Millicarb	1.40
1025	Gasil AF	0.90
1026	Polyamide H 105	0.80
1027	Silicone H 19	1.60
1028	Alkyd melamine primer + Alkyd melamine topcoat	0.80
1029	as 1028 over wash primer	0.60
1030	Epoxy-ester (D4) melamine primer + alkyd melamine topcoat	1.00
1031	as 1030 over wash primer	0.60
1032	Commercial alkyd melamine primer + alkyd melamine topcoat	1.00
1033	as 1032 over wash primer	0.00
1034	Commercial epoxy primer + alkyd melamine topcoat	1.80
1035	as 1034 over wash primer	1.00

*Over a period of three months (November 1975 to January 1976)

Experimental III

As a result of the above considerations the next stage of the work consisted of an examination of the following materials:

"Millicarb"
"Gasil AF"
Polyamide resin "H 105"
Silicone resin "H 19"

The general powder composition is given in Table 9. In view of their previously observed yellowing on stoving and the somewhat poor exterior gloss retention of powders containing polyamide resin, silicone resin "H 19" was substituted for the system intended for exterior use (polyester *7*). Since systems based on polyester/epoxy are intended for use as primers or primer-surfacers, discoloration of the coating is not important and polyamide resin can be used.

Table 8

Accelerated weathering results

Exposure number		Gloss retention* on accelerated weathering (% of original gloss)	Rust creepage on accelerated weathering (mm/100 hrs)
1021	Polyester *5* TiO$_2$ (RCR-3, BTP Tioxide Ltd)	76	0
1022	Zinc phosphate	80	0
1023	Basic lead silico chromate	75	0
1024	Millicarb	75	0
1025	Gasil AF	83	0
1026	Polyamide H 105	72	0
1027	Silicone H 19	84	0

* Over a period of 600 hrs (ASTM G 23-69) measured on a 60° Gardner gloss meter.

The 16 systems were tested for:

1. Salt spray resistance for 400 hours (ASTM B 117-61)
2. Natural exposure for two months (Zwolle, Netherlands).

Table 9

Results of salt spray resistance

Exposure number	Loss of adhesion as a result of salt spray (mm/100 hrs)
Binder composition: polyester *6*/epoxy resin = 1/1 TiO$_2$ RCR-3/binder ratio = 1:2	
1057 RCR-3 (Tioxide International)	0.50
1058 Gasil AF	0.25
1059 Millicarb	0.50
1060 Polyamide resin H 105	0.25
1061 Gasil AF, Millicarb	0.25
1062 Gasil AF, polyamide resin H 105	0.25
1063 Millicarb, polyamide resin H 105	0.50
1064 Gasil AF, Millicarb, polyamide resin H 105	0.25
Binder composition: polyester *7*/triglycidyl isocyanurate = 9/1 TiO$_2$ RCR-3/binder ratio = 1:2	
1065 RCR-3 (Tioxide International)	3.80
1066 Gasil AF	1.80
1067 Millicarb	2.70
1068 Silicone Resin H 19	5.30
1069 Gasil AF, Millicarb	2.30
1070 Gasil AF, Silicone Resin H 19	2.80
1071 Millicarb, Silicone Resin H 19	6.00
1072 Gasil AF, Millicarb, Silicone Resin H 19	5.20

Gasil AF	10% by weight on TiO$_2$
Millicarb	20% by weight on TiO$_2$
Polyamide Resin H 105	10% by weight on binder
Silicone Resin H 19	10% by weight on binder

The systems based on polyester *7* were also tested for accelerated weathering resistance according to ASTM G 23-69. The results of salt spray resistance are shown in Table 9. The natural exposure period is too short to enable significant variations to be detected (Table 10). The results of the accelerated weathering tests are shown in Table 11.

It can be seen from Table 9 that:

(a) Polyester *6* has excellent salt spray resistance.

(b) The use of additives has no significant effect when the binder has adequate resistance.

(c) The use of "Gasil AF" as the sole additive in the gloss retentive system polyester *7* gives the best salt spray resistance.

(d) Silicone resin "H 19" adversely affects salt spray resistance. This effect can be reduced by the combination of "Gasil AF" and Silicone resin "H 19". No further synergistic effects can be found.

The results from Table 10 again indicate that the good results obtained with silicone resin shown in Table 4 cannot be reproduced. The activity of the silicone resins appears to be specific to polyester *1*.

Table 10

Results of natural exposure for two winter months

Exposure number	Rust creepage* on outdoor exposure (mm/month)
Binder composition: polyester 6/epoxy resin = 1/1 TiO_2 RCR-3/binder ratio = 1:2	
1057 RCR-3 (Tioxide International)	0.75
1058 Gasil AF	0.50
1059 Millicarb	0.75
1060 Polyamide resin H 105	0.75
1061 Gasil AF, Millicarb	0.50
1062 Gasil AF, polyamide resin H 105	0.75
1063 Millicarb, polyamide resin H 105	0.50
1064 Gasil AF, Millicarb, polyamide resin H 105	0.50
Binder composition: polyester 7/triglycidyl isocyanurate = 9/1 TiO_2 RCR-3/binder ratio = 1:2	
1065 RCR-3 (Tioxide International)	1.25
1066 Gasil AF	0.75
1067 Millicarb	0.50
1068 Silicone Resin H 19	1.25
1069 Gasil AF, Millicarb	0.50
1070 Gasil AF, Silicone Resin H 19	0.75
1071 Millicarb, Silicone Resin H 19	1.00
1072 Gasil AF, Millicarb, Silicone Resin H 19	0.75

Gasil AF	10% by weight on TiO_2
Millicarb	20% by weight on TiO_2
Polyamide Resin H 105	10% by weight on binder
Silicone Resin H 19	10% by weight on binder

* Over a period of two months (December 1975 and January 1976)

Table 11

Accelerated weathering results

Exposure number	Gloss retention* on accelerated weathering (% of original gloss)	Rust creepage on accelerated weathering (mm/100 hrs)
Binder composition: polyester 7/triglycidylisocyanurate = 9/1 TiO_2 RCR-3/binder ratio = 1:2		
1065 RCR-3 (Tioxide International)	85	0
1066 Gasil AF	86	0
1067 Millicarb	83	0
1068 Silicone Resin H 19	86	0
1069 Gasil AF, Millicarb	80	0
9070 Gasil AF, Silicone resin H 19	88	0
1071 Millicarb, Silicone resin H 19	86	0
1072 Gasil AF, Millicarb, Silicone resin H 19	89	0

* Over a period of 600 hrs (ASTM G 23-69). Gloss: Gardner 60°

It can be seen from Table 11 that:

(a) Polyester *7* has better gloss retention after accelerated weathering than polyester *5* (Table 8).

(b) Incorporation of silicone resin appears to offer no significant improvement in gloss retention.

(c) Accelerated weathering is not a useful tool in assessing rust creepage (see also Table 8).

Discussion

Anti-corrosive pigments

Anti-corrosive pigments offer little improvement at low concentrations. At high concentrations, anticorrosive pigments increase resistance to rusting on outdoor exposure. With the exception of zinc phosphate and chromium phosphate, the anticorrosive pigments investigated had an adverse effect on salt spray resistance. Zinc phosphate, which has hardly any influence on colour and gloss retention, is to be preferred. The synergistic effect claimed for corrosion-inhibitors "Sicorin RZ" and "Sicorin RZP" has not been confirmed.

Extenders

With the exception of "Dicalite 438", extenders offer an improvement in salt spray resistance and resistance to rusting. "Micromica", "Millicarb" and especially "Gasil AF" are particularly good in this respect.

Thermoplasts

Polyamide resin "H 105" offered significant improvement in all the systems examined, except for the polyurethane system. Silicone resin gives spectacular results only in combination with polyester *1*. The explanation for this specific behaviour is not known.

Binder composition

"Weak" binders can be improved by additives. The use of additives has no significant effect, however, when the binder has adequate resistance.

This investigation was not intended to advocate the omission of pretreatment—even the best overall result (0.5 mm rust creepage per month) is inadequate for practical purposes.

It was, however, intended by the use of untreated metal, to obtain rapid results, which it is hoped will be applicable to pretreated metals.

[*Received 24 April 1976*

Reference

1. Gulpen, N. J. H., and van de Werff, A. J., *J. Paint Tech.*, 1975, **47**(9), 81.

J. Oil Col. Chem. Assoc. 1976, **59**, 439-442

Progress towards international agreement on gloss measurement of paint films

By U. Zorll

Forschungsinstitut für Pigment und Lacke e.v., Stuttgart, Germany

Summary

Based on the experience of various member bodies of ISO/TC 35/SC 9, a working group of that committee has successfully completed a programme of standardisation of reflectometer systems for the evaluation of various degrees of gloss. The gloss meters defined, employing an angle of incidence of 60° for general use, 20° for high gloss surfaces and 85° for fairly matt ones, combine adequate accuracy with simple instrumentation. Details of the 60° system are already laid down in ISO 2813, and those for the other two angles will be incorporated in the same document, which will then conform to present requirements in the field of paint testing. In addition, results of an international cooperative test have confirmed that with matt surfaces, for which gloss measurement used to be more difficult, sufficient reproducibility can be obtained by employing either the 60° or 85° reflectometer systems.

Keywords

Equipment primarily associated with analysis, measurement or testing

glossmeter
reflectometer

Specifications, standards and regulations

specification

Le progrès vers un accord international sur la mesure du brillant des films de peintures

Résumé

Fondé sur l'expérience de plusieurs organisations constituantes de l'ISO/TC35/SC9, un groupe de travail de ce comité a achevé, avec succès, un ce programme de normalisation des systèmes réflectométriques pour déterminer les divers niveaux de brillant. Les appareils définis utilisent un angle d'incidence de 60° en général, de 20° pour les surfaces de haut brillant, et de 85° pour les surfaces quasi-mattes, et ils possèdent à la fois une précision convenable et une simplicité opératoire. Les détails en ce qui concerne le système à 60° sont déjà établis en l'ISO 2813, et dans le cas des deux autres angles, les détails seront incorporés dans le même document, qui sera alors conformément aux besoins actuels dans le domaine des épreuves de peintures. D'ailleurs, les résultats d'une coopérative investigation internationale ont confirmé que, dans le cas des surfaces mattes, où la mesure de brillant était toujours plus difficile, on peut obtenir une reproductibilité suffisante en utilisant les systèmes réflectrométriques soit de 60° soit de 85°.

Internationales Einverständnis über Glanzmessung von Lackfilmen geht voran

Zusammenfassung:

Eine Arbeitsgruppe des ISO/TC 35/SC9 Komitees brachte ein Programm zur Normierung von Reflectometersystemen für die Bewertung verschiedener Glanzgrade zu einem erfolgreichen Abschluss. Das Ergebnis basiert auf der Erfahrung der verschiedenen Mitglieder-Gremien. Die beschriebenen Glanzmessgeräte, welche für allgemeinen Gebrauch einen Einfallwinkel von 60°, für hochglänzende Oberflächen von 20° und für ziemlich matte von 85° verwenden, kombinieren ausreichende Genauigkeit mit einfacher Instrumentierung. Einzelheiten für das 60° System wurden bereits in ISO 2813 festgelegt, und die für die anderen zwei Winkel werden in dieses Dokument, das sich dann den gegenwärtigen Erfordernissen für das Gebiet der Lackprüfung anpassen wird, eingearbeitet werden. Ausserdem bestätigten die Ergebnisse einer internationalen, kooperativen Untersuchung, dass für matte Oberflächen, deren Glanzbestimmung bisher schwieriger war, durch Verwendung der einen oder anderen, d.h. der 60° oder 80° Reflektometersysteme, ausreichende Reproduzierbarkeit erhältlich ist.

Gloss of paint films and its standardisation

Several degrees of gloss are nowadays specified for goods or objects decorated or protected with organic coatings. For example, stringent requirements for high gloss paints may be found in the automotive industry; furniture makers often have to produce surfaces with a silky-gloss appearance; and a high degree of mattness is necessary for optical instruments. Furthermore, it is not only the initial gloss which must be specified when the properties of coatings are defined: the extent to which the original gloss is retained under adverse conditions is one of the more important properties of a coating material.

It has been evident for a long time that visual assessment of gloss, even with the help of reference standards, cannot satisfy present quality specifications. The need for systems of measurement, which furnish exact data about gloss, has resulted in several types of instrument, which differ in the degree of sophistication as well as in their range of applicability. This is a typical situation and it can be dealt with adequately only by strict standardisation. Valuable work in this context had already been carried out by various national standardisation bodies or by other groups interested in creating a common basis of communication about glossy paints. Hence, there was a basis for reaching international agreement on the methods for gloss measurement within the framework of the International Organisation for Standardisation (ISO). It seems appropriate now to present a record of the activities in this field during the past few years. The results obtained will allow specialists in the paint field all over the world to speak a common language in terms of characterisation and measurement of gloss.

Review of the activity within ISO/TC 35/SC 9

It became clear at the outset of all work on gloss standardisation that the problem should be assigned to Technical Committee (TC) 35 of ISO which is concerned with the whole field of paints and pigments and, in particular, to its Sub-Committee (SC) 9, established for the study of paint testing.

Since an easy selection from existing methods of gloss measurement did not seem feasible, the matter was given to a task group of experts. They were required to estimate the usefulness of the various methods, try to determine common features to be considered in the anticipated international standard, and finally submit material for such a standard to SC 9. After further discussion, a recommendation for an internationally accepted document on gloss measurement would be issued.

The special problems which the task group had to overcome could not be evaluated adequately without first considering how the gloss of paint films was measured and what principles of instrumentation could be used. An in-depth study of the possibilities was carried out by the task group, and led to the decision to give priority to the system described in ISO Standard 2813. Furthermore, this study will now provide the basis for the continuation of standardisation work on gloss measurement in ISO/TC 35/SC 9. The most important issues the task group had to deal with will be briefly mentioned here to illustrate the progress made as well as the problems which remain to be solved.

Classification of methods for gloss measurement

Certain restrictions on the work within the task group, eventually seen to be beneficial for its concentration on the system now standardised in ISO 2813, were due to a tendency existing in the instrumental field to employ systems permitting a completely objective measurement of the gloss phenomenon, thus avoiding instruments in which the human eye takes part in the procedure of measurement. This limitation does not mean, however, that subjective methods, in particular those based on the assessment of "distinctness-of-image", should not play an important role in the field of paint testing; a very good reason is the simplicity with which such instruments can be designed. On the other hand, instrument makers are in a position to benefit from the remarkable progress in optical and photo-electronic techniques for the development of systems, based on utilising the mode of scattering and/or reflection of light at paint film surfaces as a criterion for the gloss perceived by a human observer.

According to this "scattering" concept, gloss is produced not only when beams of light are reflected from a surface specularly (this being the limit of extreme high-gloss), but also when they are scattered into a spatial angle of smaller or greater extent. Hence, the more light is scattered in various directions deviating from that where perfect reflection would occur, the less an observer will evaluate such a surface as glossy. The other limiting case, complete mattness, consequently corresponds to considerable scattering over the half-space. The objective measurement of gloss thus requires nothing other than a determination of the distribution of light intensity in the spatial angle and then characterising this distribution to obtain a quantity representing the gloss of the sample under investigation. The degree to which this characterisation can be made differs in the various instruments, and it was from this variety that the task group had to start its work. At present, the methods available can be classified in the following way:

Reflectometers

For this widely used class of instrument, the simple yet instructive name "gloss meter" is often used. Determination of the intensity distribution by means of this type of instrument is based on an assessment of the light reflected and scattered from the surface at a particular angle. A typical parameter for a reflectometer is the angle of incidence, with small angles suited best for high gloss and more oblique illumination for matt samples. Since all the light from a polished plate of black glass is "reflected" rather than scattered, this material provides a suitable high gloss standard, set equal to 100, provided that the refractive index of the glass, which determines the intensity of reflected light, is specified.

Because of their practicability, reflectometers are more or less the only instruments for which national standards have been worked out, the best-known example being ASTM D 523, employing angles of 20°, 60° and 85°, either in separate instruments or in a single device allowing for fast switching from one angle to another. It was upon this kind of gloss measurement that the task group concentrated its efforts in the first place.

Two-diaphragm reflectometers

The distribution of scattered light intensity can be measured more exactly when two diaphragms of different size are provided in a reflectometer; a more detailed discrimination of gloss can thus be obtained. It is possible to distinguish between the intensity components for assessment of gloss and for distinctness-of-image, observed by considering the surface as part mirror/part diffuser. Prospects of the two-diaphragm reflectometer appear promising. Instruments of this type are used in Sweden and Germany, for instance, and the experience acquired there might lead to a consideration of the two-diaphragm reflectometer as an item for international standardisation.

Goniophotometers

The reflectometers mentioned above are capable of giving only an average measurement of the intensity of scattered light. The distribution of that intensity can be exactly determined by means of a goniophotometer. This type of instrument furnishes the most meaningful data about gloss, and should always be used, therefore, in cases of dispute as well as for scientific purposes. Standardisation of goniophotometers will be considered after the simpler programme on reflectometers has been finished. It is known, however, that various types of goniophotometer have been developed, for which generally high standards can be claimed in terms of instrumental design, and these are widely used in several countries, such as France, Germany, the United Kingdom, and the United States.

The fact that the performance of a reflectometer can be simulated with a goniophotometer is essentially a matter for investigation in the future. It was the main reason, however, why goniophotometers were included in the cooperative tests which were otherwise carried out with the reflectometers to be described in the rest of this report.

Applicability range of ISO 2813

The basic philosophy behind the reflectometer which has been standardised internationally according to ISO 2813 is apparent in the principle that various ranges of applicability be allocated to specific angles of incidence. The angle of 60°, together with defined aperture angles, was chosen to give best representation of visual impression over the whole range of gloss. That this was the optimum angle was confirmed by comparison of a series of samples, as indicated in Fig. 1. The visual assessments were made by ten observers, and the diagram clearly shows the excellent linear relationship between the averaged visual results and those measured with the reflectometer.

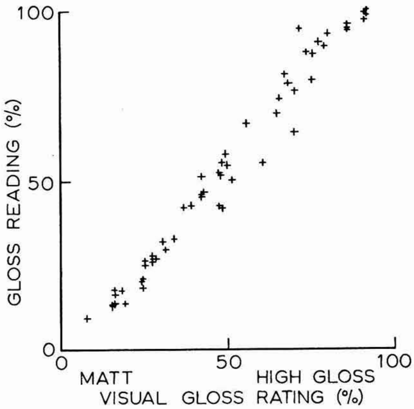


Fig. 1. Visual versus instrumental gloss ratings with a 60° gloss head (ISO 2813)

The two other angles of incidence, 20° and 85°, are related o the high and low gloss regions, respectively. Fig. 2 indicates that for the 20° system, the slope of the curve relating visual assessment and measured results is much steeper in the region in which samples with high gloss are encountered. The converse situation exists, as can be seen from Fig. 3, for the 85° system. Here the most favourable resolution of gloss values instrumentally is achieved for samples at the low end of the scale.

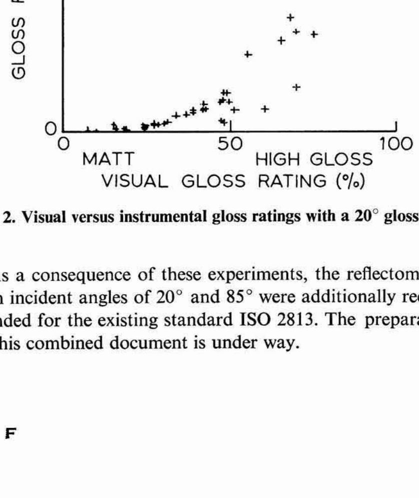


Fig. 2. Visual versus instrumental gloss ratings with a 20° gloss head

As a consequence of these experiments, the reflectometers with incident angles of 20° and 85° were additionally recommended for the existing standard ISO 2813. The preparation of this combined document is under way.

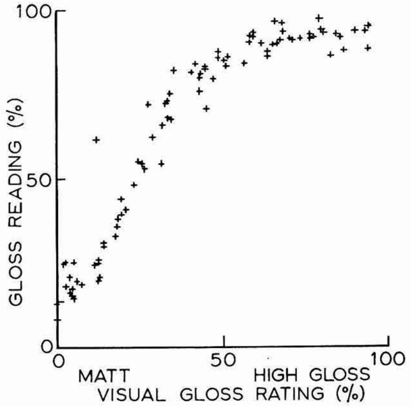


Fig. 3. Visual versus instrumental gloss ratings with a 85° gloss head

Cooperative test on measurement of matt samples

Although, in terms of standardisation, all sectors of the gloss range should be considered of equal importance, the predominance of paint surfaces with higher gloss means that more experience with gloss measurement exists in that range. Accordingly, the reliability of the 20° and 60° systems had been considered as better than that of the 85° system recommended for low gloss values.

A cooperative test was carried out on an international basis by members of the task group with the specified aim of checking the practicability of the 85° system as an appropriate extension of the approved 60° system.

The participants in the test were each given seven samples of black paint films of differing gloss, but all belonging to the matt range. The instruments to be employed were required primarily to correspond to the specifications of ISO 2813 for the 60° system and to the supplement of that document related to the peculiarities of the 85° system.

In order to compare the systems used in the test, the individual gloss values measured at 85° were related to their common means and the results are plotted in Fig. 4. With

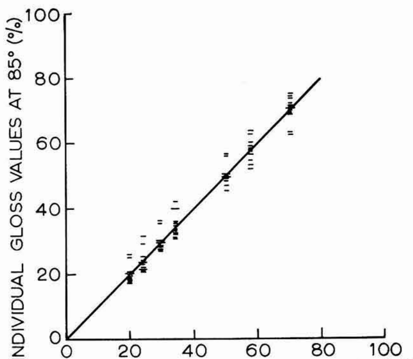


Fig. 4. Comparison of glossmeters at 85° incidence

only a few exceptions, the results appear not far from the diagonal line which corresponds to perfect correlation with the mean values. Since the range covered by the samples selected includes 85° gloss values from 20 to 80 per cent, the result can be considered as sufficiently representative to demonstrate the usefulness of the 85° system.

The 60° system is often used as a reference method because of its wide range of applicability, so the test results obtained with this system for the matt samples were of particular interest. Individual gloss values are presented in Fig. 5 for this angle of incidence, and it is understandable that the relationship with the mean of the 85° gloss values is no longer linear. Yet again a significant correlation can be found between the individual results and the curve corresponding to the best fit of the mean values measured for either of the two angles of incidence.

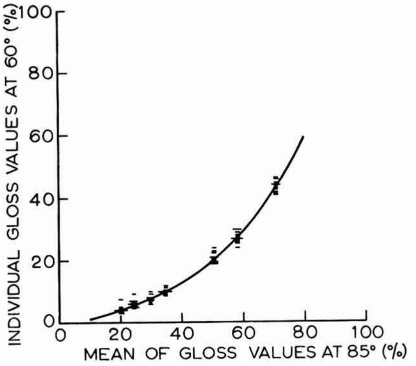


Fig. 5. Comparison of 60° gloss and 85° gloss for matt samples

It is noteworthy that other apparatus, including a goniophotometer, with an angle of incidence of 60° but with other optical parameters not conforming exactly to ISO 2813, did not lead to different results. Another question to be discussed in the cooperative test was the role of the gloss standard. Generally, the procedure of measurement of gloss is based on the use of polished glass plate for calibration over the whole gloss range. This method appeared appropriate for surfaces of rather high gloss, but there were some doubts whether it would also be adequate for near-matt surfaces.

In Fig. 6, a comparison is shown for a group of samples whose individual gloss values were related either to the general standard (polished glass plate) or to a matt standard similar in appearance to that of the samples being measured. The difference between the two methods of calibration is barely significant, but because it will be difficult to define matt standards precisely, it seems preferable to continue using the polished glass standard, as characterised by ISO 2813.

Apparently, the deviation becomes larger if an 85° system different from that considered for specification in ISO 2813 is used for the measurement. The requirements to be fulfilled are obviously more stringent than with 60° systems.

The general conclusion of the cooperative test is that, in addition to the proven 20° and 60° systems, the 85° system—apparently because it is based on the same principles—permits the same degree of reliability to be obtained for gloss measurement in the matt region as is possible with the other systems for ranges of higher gloss.

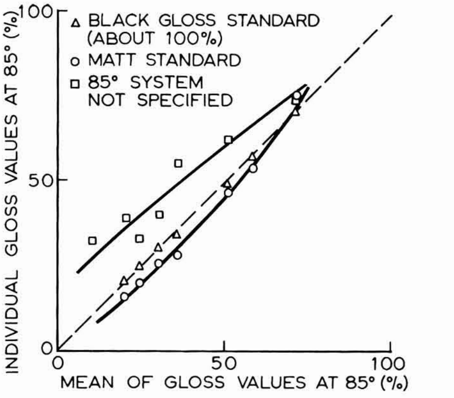


Fig. 6. Effect of using different standards (black plate glass and matt surfaces) and a different 85° system

Future international standardisation work on gloss measurement

As indicated earlier, only the first stage of standardisation has been reached for gloss measurement in the paint field. It would probably be useful to extend the preparation of international standards to the two-diaphragm reflectometer, since it seems to have the potential to yield data related to visual assessment. Because of its wide range of applicability, the goniophotometer should also become a candidate for standardisation. The difficulties to be overcome are mostly concerned with the derivation of information from the curve for the intensity distribution of scattered light which is measured with such an instrument. It seems that any progress in this direction should be accompanied by a comprehensive collection of experience with the distribution curves (or "Indicatrices") obtained with these instruments: the maximum height and half-width of these bell-shaped curves are only two of the quantities which might be considered. Their usefulness is well known, yet it must not be overlooked that an indicatrix contains a great deal of information about the optical properties of a surface. Such other parameters, however, should first be confirmed by broad experimental studies before further standardisation work is started in the field of goniophotometry. Hence, for the time being, it can be said that with ISO 2813, an international standard is available which meets most practical needs; any future system should be standardised in the same way, as the requirements for the definition of gloss of paint surfaces become more stringent.

Finally, a report such as this offers a rare opportunity to thank those specialists all over the world who have given valuable contributions to the cooperative test and who were helpful in the general preparation of ISO 2813, intended to serve the technical community world-wide.

[*Received 29 April 1976*

J. Oil Col. Chem. Assoc. 1976, 59, 443-452

Optical properties of films*

By W. Carr

Pigments Division, CIBA GEIGY (UK) Limited, Roundthorn Industrial Estate, Manchester M23 9ND and the Department of Colour Chemistry, University of Leeds

Summary

The optical properties of any given resin-based, pigmented film are very dependent on both the pigment concentration and the degree of dispersion of the pigment.

The effect of this latter parameter on the optical properties of a number of organic pigments in various films is reported. The films have been cast from decorative paints, industrial finishes and publication gravure inks, and the optical properties studied include strength, brightness, shade, gloss, opacity, flocculation, flotation and flooding.

In decorative paints, dispersion of the pigment is an important parameter, and the experimental relationship between dispersion and colour strength corresponds closely with theoretical predictions.

With industrial finishes, this correspondence is not so close. In the case of publication gravure inks, dispersion of the pigment is not a significant parameter controlling the optical properties of the prints: in these systems, the composition of the solvent blend appears to outweigh differences in levels of pigment dispersion.

These differences are discussed and a possible qualitative explanation is put forward.

Keywords

Types and classes of coatings and allied products

house paint
industrial coating
printing ink

Processes and methods primarily associated with manufacturing or synthesis

pigment dispersion

Properties, characteristics and conditions primarily associated with:

materials in general

opacity

bulk coatings and allied products

pigment volume concentration

dried or cured films

gloss
gloss retention

Les caractéristiques optiques des films

Résumé

Les caractéristiques optiques d'un film quelconque, pigmenté et à base de résine se dépendent fortement à la fois de la pigmentation et de l'état de dispersion du pigment. On donne un compte rendu sur l'effet de ce dernier paramètre sur les caractéristiques d'un nombre de pigments organiques dans de divers films. Ces films ont été coulés à partir des peintures décoratives de bâtiment, des peintures industrielles et des encres d'imprimerie pour les procédés gravures. Les caractéristiques optiques qui font l'objet de cette étude comprennent pouvoir colorant, brillant, nuance, brillance, opacité, flocculation, flottation et séparation de couleur.

En ce qui concerne les peintures décoratives de bâtiment, l'état de dispersion du pigment est un paramètre important, et le rapport experimental entre l'état de dispersion et le pouvoir colorant se conforme étroitement aux prédictions théoriques.

A l'égard des peintures industrielles, cet accord n'est pas si étroit. Dans le cas des encres d'imprimerie pour les procédés gravures, l'état de dispersion du pigment n'est pas un des paramètres qui exercent une influence importante sur les caractéristiques optiques des impressions: dans ces systèmes, l'influence qu'exerce la composition du melange de solvants semble débasser celle des différences dans les niveaux de dispersion pigmentaire.

On discute ces différences et l'on propose, d'ailleurs, une explication quantitative éventuelle.

Optische Eigenschaften von Filmen

Zusammenfassung:

Die optischen Eigenschaften irgendeines harzhaltigen, pigmentierten Films sind stark sowohl von der Pigmentkonzentration als auch dem Dispersionsgrad des Pigmentes abhängig.

Über den Einfluss, welchen diese beiden Parameter auf die optischen Eigenschaften einer Anzahl organischer Pigmente in verschiedenen Filmen haben, wird Bericht erstattet. Die Filme wurden aus Malerlacken, Industrielacken und Druckschriften-Tiefdruckfarben, angefertigt, und die optischen Eigenschaften einschliesslich Farbkraft, Helligkeit, Farbton, Glanz, Opazität, Ausflocken,Aufschwimmen und Verlaufen untersucht.

In Malerlacken ist die Dispergierung des Pigments ein wichtiger Parameter, und die experimentellen Beziehungen zwischen Dispersion und Farbkraft kommen theoretischen Voraussagen ziemlich nahe.

Bei Industrielacken ist diese Übereinstimmung nicht so eng. Bei Druckschriften-Tiefdruck ist Dispergierung des Pigments kein wesentliches, die optischen Eigenschaften der Drucke kontrollierendes Parameter: in diesen Systemen scheint die Zusammensetzung der Lösungsmittelmischung wichtiger als die Unterschiede im Grade der Pigmentdispersion zu sein.

Diese Unterschiede werden besprochen, und eine mögliche, qualitative Erklärung gegeben.

---

*Paper presented at a symposium of the Manchester Section held on 6 and 7 April 1976 at the University of Manchester Institute of Science and Technology.

Introduction

The optical properties of films, whether they are derived from paints or inks, include the colour strength, the shade, the brightness, the gloss, the opacity and the presence or absence of bronzing. Moreover, in any specific film, these properties should be uniform and not vary from one part of the film to another. Variations can be caused during the drying and application processes by the flocculation, flotation and flooding tendencies of the pigments.

Practical experience has shown that these optical properties, for any particular resin binder, are a function of the pigments used, their concentration and degree of dispersion in the final film. Variations in the optical properties of a film are usually associated with changes in pigment dispersion or concentration brought about during the application and drying processes.

Direct assessment of the level of pigment dispersion in paint and ink films is a difficult task. Electron microscopy coupled with electronic counting and sizing of particles is a possible way, but this is a highly specialised field requiring very sophisticated and expensive equipment.

Assessment of pigment dispersion in wet paints and inks is now possible on a semi-routine basis, using a disc centrifuge. Measurements of degree of dispersion are now being made in a wide variety of systems and the relationships between the dispersion and optical properties of films are being determined. These relationships can vary from system to system, even where the same pigments are used. In this paper, the nature of these relationships and the reasons for their variation from system to system are discussed.

Earlier work—decorative paints

In a paper[1] presented at the Torquay conference of the Association in May 1971, the author presented the results obtained with six organic pigments in air drying, alkyd resin based, decorative paints. The degree of pigment dispersion was determined in the wet paint and the optical properties of the dry films were examined. The results can be summarised as follows:

> *Colour strength.* This increased dramatically once the mean particle diameter was reduced below 0.5μm.
>
> *Colour shade.* With some pigments, the shade can alter with the degree of dispersion. With others, it is unaffected.
>
> *Brightness.* As dispersion improves, brightness increases very slowly until a mean diameter of about 0.4μm is reached. Further dispersion then gives a more rapid increase.
>
> *Gloss.* As dispersion improves, the main visual effect is an increase in specular reflection, which continues until the mean particle size is about 0.3μm. As dispersion improves still further, the haze decreases and this too is clearly visible to the eye.
>
> *Transparency.* It was found qualitatively that transparency increases with dispersion.
>
> *Opacity.* The opacity is substantially independent of pigment dispersion once the particle size is below about 0.6μm.
>
> *Bronzing.* Where this occurs at all, it occurs at coarse levels of dispersion, and disappears at finer levels.
>
> *Flocculation.* The so-called "flocculation effect" occurred with five out of the six pigments examined. It disappeared when the 50 per cent diameter was reduced below 0.2μm.
>
> *Flotation and flooding.* The extent of these phenomena was found to be very little dependent on the dispersion of the organic pigment.

Overall, it was found that where pigment dispersion does affect the appearance of a paint film, its effect is most marked when the mean diameter is reduced to 0.5μm or less. It is in this size region that small improvements in dispersion give significant improvement in a film's optical properties.

Further work—decorative paints

Using the same experimental techniques and the same alkyd resin system, the earlier work has been extended to at least ten other types of organic pigments. These include a manganese 2B toner, a calcium 4B toner, a metal free phthalocyanine blue, a BON bordeaux, arylamide yellow G and 10G, Pigment Yellow 73 (Dalomar yellow), dinitraniline orange, *o*-aniside and *m*-xylidide yellows.

The relationships between the optical properties of the films derived from these pigments and the degree of dispersion of the pigments in the wet stainers, followed the same pattern as in the earlier work:

> *Colour strength.* There was a rapid increase in colour strength as the pigment particle size was reduced below 0.5μm.
>
> *Opacity.* In all cases, the opacity is independent of the degree of dispersion.
>
> *Gloss.* It was again found that the specular gloss increased with dispersion until the mean diameter was 0.3μm. On further dispersion, the haze decreased.

These results, taken in conjunction with the earlier work, prove conclusively that in air drying, alkyd based decorative paints, all organic pigments follow the same pattern. As dispersion increases, colour strength, brightness and gloss increase; opacity is unaffected. Flocculation tendencies disappear at small particle sizes.

Some elaboration of these relationships is now possible.

Colour strength

From experiments, curves have been obtained of colour strength versus particle size for a large number of pigments. The particle sizes in the wet stainers were determined using a disc centrifuge. The colour strengths were measured as k/s values for films made from reductions of the stainer with a standard white based on the same alkyd resin.

Theoretically, if the optical constants, the refractive index n, and the absorption constant k, of a pigment are known, then using the Mie theory, it is possible to work out the relationship between colour strength of a film and the particle size of the pigment in it. Hence, theoretical curves can be drawn plotting k/s against pigment particle size. Nowadays it is possible to measure n and k by using an ellipsometric technique on a compressed tablet of the pigment. If a computer is available, it is then possible to work out the relationship between k/s and the particle size and hence to plot a curve of k/s versus size.

This has been done by the author's colleagues for eight different types of organic pigments, namely a phthalocyanine blue, a pigment green B, a dioxazine violet, a calcium 4B toner, a Dalomar Yellow, an arylamide yellow G, an arylamide yellow 10G, and a dinitraniline orange.

The experimental curves for these pigments have then been compared with the theoretical curves obtained by the Mie theory. For each of the eight pigments, the agreement between the experimental and the theoretical curves has been surprisingly good. The results for two of the pigments, a dioxazine violet and a calcium 4B toner, are shown in Figs 1 and 2.

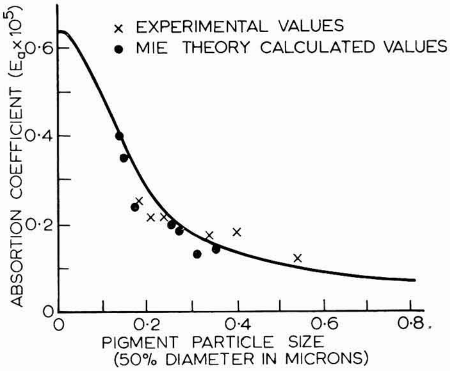


Fig. 1. Colour strength versus pigment particle size for dioxazine pigment Irgazin Violet 6RLT (CIBA GEIGY AG) with λ_c=550nm

When it is borne in mind that the theoretical curve relates *k/s* in the film to particle size in the film, and the experimental curve relates *k/s* in the film to particle size in the wet paint, the good agreement between the curves for such a broad array of pigments shows that in such an air drying, alkyd based, decorative paint, the pigment particle size in the wet paint is the same as the pigment particle size in the dry film. This means that if the paint maker builds a good level of pigment dispersion into his product, this persists into the final film. It also means that if the paint manufacturer, using the same raw materials, can increase the degree of pigment dispersion in his products, the end user of his paint will get stronger, brighter and more glossy films.

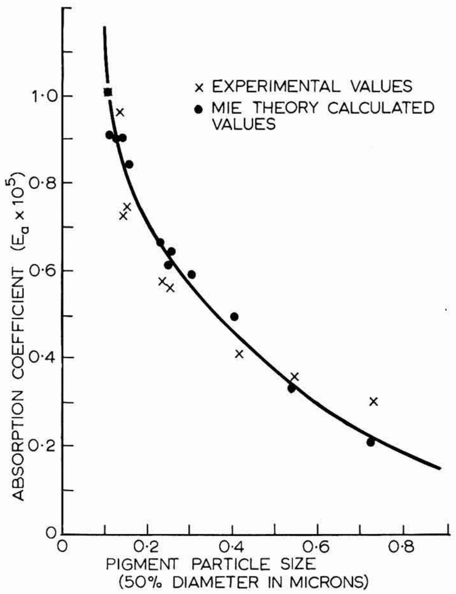


Fig. 2. Colour strength versus pigment dispersion for a calcium 4B toner (Rubine 4BP—C.I. Pigment Red 57) in decorative paints

With respect to gloss, some further facts about the effect of dispersion have come to light and have been examined in detail. In general, as has been already pointed out, improved dispersion gives improved specular gloss down to particle sizes of 0.3µm. Improved dispersion beyond this leads to reduction in haze. Both effects are clearly visible to the eye.

Recent work by the author has also shown that once the particle sizes are below a certain level, this improvement in gloss and haze in the resulting films is maintained over considerable periods of time. The type of results obtained is illustrated in Tables 1 and 2. These Tables give specular gloss and haze figures on panels prepared from arylamide yellow G stainers. Measurements were made on the panels immediately after drying and after they had been stored in the dark for varying periods of time. The resin binder was Beckosol P470 (Synthetic Resins Ltd), and the dispersion levels were varied by varying the ball milling times. The degree of dispersion was determined on a disc centrifuge. The films were obtained by drawing down 150µm (0.006 inch) wet films on clean glass. The gloss and haze measurements were carried out using an automated goniophotometer[2].

The corresponding haze results are given in Table 2. The haze figures are expressed as a percentage figure relative to the reflection of a standard white matt tile when measured at

Table 1

Percentage gloss measurements (Arylamide yellow G in Beckosol P470 on glass)

50% diameter (µm)	Age of film						
	1 day	2 days	3 days	1 week	1 month	2 months	3 months
0.51	8	8	8	8	9	9	9
0.365	86	85	83	69	56	50	44
0.33	89	88	89	83	73	76	69
0.275	95	94	94	96	91	93	88
0.27	96	88	94	91	89	93	90
0.245	100	92	96	94	94	97	97
0.175	98	94	97	95	94	95	97

angles 2° less and 2° greater than the specular angle. Here the incident light was at 45° and the percentage haze was calculated from the reflectances measured at 43° and 47°.

Corresponding results from films of stainers of dinitraniline orange are given in Tables 3 and 4. The experimental procedure was exactly the same as for the yellow stainers.

A study of these Tables illustrates the author's findings that improved dispersion of pigment improves the gloss and haze of new films. It also shows that this improvement in the gloss and haze of the films is maintained over lengthy periods of time for those systems where the dispersion has improved to a certain value. This value appears to be in the region of a 50 per cent diameter of 0.33μm—see the broken lines in the Tables. Dispersions coarser than this do not give any improvement in gloss retention or haze figures with regard to ageing.

It is believed that this aspect of gloss warrants further investigation and it is suspected that the resistance to gloss deterioration on ageing is associated with the complete absence of large particles. When sufficient energy has been put into the system to give a 50 per cent diameter of 0.33μm, there is usually a complete absence of particles greater than 1.0μm.

The independence of opacity and pigment particle size in the submicron region has now been confirmed experimentally for a large number of pigments of differing chemical types and, therefore, must be considered as real. The author still favours the view put forward at Torquay[1], that opacity is a function of the combined action of absorption and scattering. As the pigment particle size is reduced below 1.0μm, the absorption increases and the scattering decreases. Between a size range 0.1 to 0.6μm, the two components tend to balance one another, so that in this region the opacity is virtually independent of the particle size.

Table 2

Percentage haze measurements (Arylamide yellow G in Beckosol P470 on glass)

50% diameter (μm)	Age of film						
	1 day	2 days	3 days	1 week	1 month	2 months	3 months
0.51	>200	>200	>200	>200	>200	>200	>200
0.365	135	184	189	>200	>200	>200	>200
0.33	99	110	146	>200	>200	>200	>200
0.275	55	66	64	81	97	97	104
0.275	55	66	64	81	97	104	129
0.27	64	67	62	76	84	89	110
0.245	43	41	43	45	54	50	59
0.175	43	40	39	45	51	51	59

Table 3

Percentage gloss measurements (Dinitraniline range in Beckosol P470 on glass)

Balling milling time (hours)	50% diameter (μm)	Age of film			
		1 day	4 days	15 days	26 days
0.5	0.95	44	39	24	21
1	0.70	60	50	38	36
2	0.52	76	64	56	56
5	0.45	88	81	71	73
16	0.34	96	95	94	78
24	0.295	97	96	94	94
36	0.26	94	93	93	93
48	0.26	95	95	95	94
72	0.225	96	96	96	94

Table 4

Percentage haze measurements (Dinitraniline orange in Beckosol P470 on glass)

Ball milling time (hours)	50% diameter (μm)	Age of film			
		1 day	4 days	15 days	26 days
0.5	0.95	>200	>200	>200	>200
1	0.70	>200	>200	>200	>200
2	0.52	>200	>200	>200	>200
5	0.45	178	>200	>200	>200
16	0.34	60	68	89	105
24	0.295	50	56	53	69
36	0.26	47	56	54	68
48	0.26	47	55	54	68
72	0.225	52	57	56	68

Industrial paints

The effect of pigment dispersion on the optical properties of films of industrial paints and stoving lacquers has been investigated, but not in the same depth as with decorative paints. As experimental systems, they are more difficult to handle, firstly because they are much more liable to dilution shock and secondly the high quality pigments used in them often present analytical difficulties. Both of these factors are of major importance in measuring dispersion levels by the disc centrifuge technique.

With any given pigment, it is usually much more difficult to get a wide range of dispersion levels in stoving lacquers, so that it becomes difficult to assess the level of dispersion over a wide range.

One pigment which has been examined in depth is a dioxazine violet, C.I. Pigment Violet 23. In stoving lacquers, the determination of its particle size distribution is relatively straightforward since dilution shock does not appear to be a major danger, there are no awkward analytical problems associated with the pigment, and finally the longer the time that stainers based on it are ball milled, the finer does the dispersion become. Its behaviour in decorative, air drying paints has already been investigated in detail, so a direct comparison of the properties of air dried and stoved films could be obtained.

Colour strength and tendency to flocculate have been the two properties most closely examined. The colour strength was determined by measuring the k/s values of white reductions on films prepared by application, flash off and stoving. The white paint for the reductions was based on titanium oxide ground into the same stoving medium under standard conditions.

One application method was by spraying under standard conditions of viscosity and pressure. The other was by drawdown with a block applicator[3].

The curves of k/s versus particle size were plotted for the sprayed films and also for the drawdown films. They were found to be similar to each other in general shape, but the curve for the drawdown films is below that of the sprayed films. This means, in general, that the colour strength of a drawdown film (P) is less than that of the sprayed film (S) obtained from the same stainer.

Both the curves and the corresponding curve for this pigment in decorative paints are illustrated in Fig 3. As has already been shown, the curve for the decorative paint is identical with the theoretical curve predicted from the Mie theory, and the question arises why these curves for the sprayed and drawdown films are different from one another and why they are different in shape from the theoretical curve.

One qualitative explanation would be to attribute the differences to the effect of the application conditions and drying mechanisms on the pigment dispersion. If these factors do affect the pigment dispersion, the particle size of the pigment in the dry films would be different from the particle size of the pigments in the corresponding wet paints. Consequently, the Mie theoretical curve relating particle size in the film to colour strength would be different from the experimental curve of particle size in the wet paint versus colour strength. Moreover, the application conditions in the spraying process are markedly different from those operating when preparing drawdowns, and this difference might give rise to different particle sizes in the final films and hence different colour strengths and differing colour strength versus particle size curves.

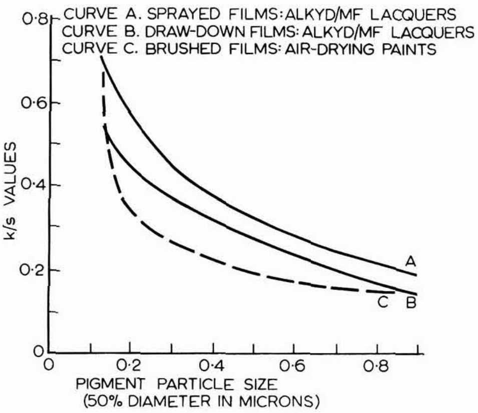


Fig. 3. Comparison of colour strength versus pigment particle size for industrial paints applied by (a) spraying and (b) draw-down bars and thirdly for the corresponding pigment incorporated in a decorative house paint and applied by brushing

Before discussing this qualitative explanation further, the so-called "flocculation effect" encountered with this pigment in stoving lacquers will be considered. This effect is similar to that encountered with phthalocyanine blue in stoving lacquers. Its outward sign is in the different colour strengths obtained when the lacquer is applied by different methods. In general, the sprayed films are stronger than poured down films and the ratio P/S of the strengths of the poured down film to that of the sprayed film is sometimes used as a measure of the degree of flocculation. The commonly accepted reason for the colour differences is attributed to the flocculating tendencies of the blue and violet pigments on standing in the wet paints. On application, these flocculates are broken down to a greater or lesser extent according to the shear applied and hence different methods of application tend to give films of different colour strength.

The picture outwardly is the same as that which was noted for the same two pigments in air drying, alkyd based decorative paints, where the colour strength of the final film depended on the brushing shear applied, and the phenomenon was attributed to the flocculating tendencies of the pigment.

In decorative paints, however, the phenomenon was found (i) to be independent of the grade of white pigment, (ii) to disappear at small particle diameters and (iii) to be associated to a greater or lesser extent with most organic pigments, except those which were tinctorially weak, such as Pigment Green B.

In stoving lacquers, the phenomenon was found (i) to be dependent on the grade of white pigment used, (ii) not to disappear at small particle sizes, and (iii) to be equally applicable to weak pigments, such as Pigment Green B. Moreover, it was reversible in that under some circumstances the pourdown film was stronger than the sprayed film[3].

In decorative paints, the explanation put forward was that in moderately dispersed paints, heavy brushing could increase the pigment dispersion slightly. With pigments such as the blue and violet, these small increases in dispersion would give appreciable increases in colour strength because of the sensitivity of their colour strength versus particle size curves. In very well dispersed paints, heavy brushing could not improve the dispersion and hence the effect disappeared. With a pigment such as Pigment Green B, a slight improvement in dispersion level, brought about by heavy brushing, gave no significant increase in strength, because of the shape of its colour strength versus particle size curve.

With a normally well dispersed white base paint, the degree of dispersion of the titanium oxide would not be altered by either heavy brushing or by the drying process, so that the phenomenon was independent of the white pigment.

In stoving lacquers applied by spraying, the lacquer is submitted to heavy shear in the spray gun, and to rapid evaporation of solvent both whilst in droplet form and when the wet film is being allowed to flash off and subsequently stoved.

Shear in the gun could conceivably improve the level of dispersion of both the organic pigment and the white, but it is uncertain what effect rapid solvent evaporation would have on dispersion. It would certainly set up considerable physical forces. When it is remembered that in a normal paint, the pigment particles are usually well below 1.0µm in size, so that the system is partly or wholly in a colloidal state, then it must be appreciated that such a state is an equilibrium, with forces of attraction balancing forces of repulsion. This equilibrium is quite sensitive to alterations in the system (*cf.* dilution shock) so that it would not be surprising if the physical forces set up by rapid evaporation were to affect it. In such a case, the result would almost certainly be some coarsening or flocculation of the pigment particles.

Because both the organic pigment, in this case the dioxazine violet, and the titanium oxide are equally subjected to the effect of rapid evaporation of the solvent, they are both liable to flocculation due to the physical forces set up by the evaporation process. The effect may well be greater with the white pigment because it is present at much higher concentration. The nett effect on the colour strength is impossible to predict from the present state of knowledge. What is certain is that if rapid solvent evaporation does cause flocculation, neither the organic pigment nor the titanium oxide will have the same particle size in the final stoved films as they had in the wet paints. Consequently, the experimental curve of a dry films' colour strength versus pigment particle size in the wet paint will be different from the theoretical Mie curve of the films' colour strength versus particle size in the film.

When considering application by pouring, dipping or drawdown, the paint is never in droplet form, but nevertheless the solvent does flash off rapidly and the physical forces set up by this may again be sufficient to cause some flocculation of both the violet and the titanium oxide. It is likely that the extent of such flocculation will be different in films obtained by dipping and spraying, and this would account for the differences in strength which are usually found in practice. It would also explain why the phenomenon was found with all pigments, including weak pigments such as Pigment Green B, because both the organic pigment and the inorganic white are involved. It is also possible to imagine circumstances where the flow-down film would be stronger than the sprayed film. As the titanium oxide is involved in the phenomenon, this would account for the fact that the grade of this pigment affects the degree of change of strength. Different grades would probably be affected by the solvent evaporation to differing extents. Flocculation due to rapid release of solvent would also explain why the phenomenon did not disappear at small particle sizes of the violet. Such finely dispersed systems would still suffer some flocculation damage on rapid solvent release, and the titanium oxide would still be affected.

This possibility of flocculation due to rapid solvent evaporation will, therefore, explain qualitatively all the facts associated with the so-called "flocculation phenomena" associated with strong pigments like phthalocyanine blue and dioxazine violet in stoving lacquers. It is not an unlikely possibility from considerations of colloidal theory.

This possibility and its implications will be referred to again after the study of another system where the solvent evaporation is even more rapid.

Gravure printing

The ink system for publication gravure printing is widely used for the printing of mass circulation magazines in colour. The inks consist of a pigment, resin and solvent blend. The main pigments used are a carbon black, a β-phthalocyanine blue, a calcium 4B toner and a diarylide yellow. The resins used are usally either a calcium-zinc resinate or a modified phenolic resin. The solvent is usually a blend of toluene and an aliphatic petroleum distillate fraction. In gravure printing the cylinders are etched to different depths according to the image design, and hence ink is transferred to the paper at differing film thicknesses. The ink films dry partly by solvent evaporation and partly by absorption into the paper. The solvent content of the ink is usually about 65 per cent and the printing speed can be up to 50 m s^{-1} (1000 ft/min), so that the time from wet ink on the paper to dry film is of the order of one second. This system is of particular interest to any discussion on the optical properties of films. Obviously, colour strength, brightness and gloss are important as they have visual appeal. Transparency is also of technical importance since multi-colour printing is used, the films being superimposed one on the other. Moreover, as opaque white pigments are never used the optical properties of the films are a function of the organic pigment alone.

In this industry, one of the great problems lies in assessing whether an ink is up to standard or is better or worse than a competitive ink. This problem arises from the fact that if two inks are compared in the laboratory, using either drawdowns, proofing units or small scale printing presses, the comparisons so obtained are frequently very different from comparisons obtained when the same two inks are run on full scale high speed commercial presses. The reasons for this type of discrepancy have been speculated on at length, but never decisively confirmed.

The author believed that many of the differences could probably be attributed to the fact that the inks were never compared at equal dispersion levels. It was thought that if this could be arranged, laboratory trials would be more meaningful. Moreover, it was confidently expected that for any given ink formulation, the strength, brightness and gloss of the prints obtained would be dependent on the degree of dispersion of the pigment in it, in much the same way as had been found with decorative paints.

Once the disc centrifuge had been fitted with a solvent resistant disc it became possible to measure the particle size distribution of pigments in this class of ink, including carbon black. The technique used for this latter pigment has been described[4]. Under the auspices of the European Rotogravure Association, collaboration was arranged with Sun Printers, Watford. It was possible to prepare inks, measure the degree of pigment dispersion, and carry out high speed printing trials on the premises of Sun Printers and this work was supervised by Dr Fuchs.

The resultant prints would be assessed by both parties for strength, brightness and gloss. The inks would be printed on both coated and uncoated papers using an etched cylinder to give five different depths of etching and, therefore, five different wet film thicknesses.

Much work was carried out along these lines and the author is grateful to Dr Fuchs for his cooperation. It is proposed to summarise the results here rather than give them all in detail.

Varying levels of dispersion of a specific pigment in an ink were obtained by varying the ball milling times and varying the composition of the solvent blend. Printing trials were carried out on the inks.

Results

These results showed that there was no direct connection between degree of dispersion in the inks and colour strengths of the prints.

They showed that the composition of the solvent blend appeared to have a major influence on the colour strength and the gloss of the prints.

In general, the higher the aromatic content of the inks, the better was the colour strength and gloss.

These results were unexpected and caused much speculation. Eventually an extensive series of trials was carried out to investigate in detail the effect of the solvent composition.

The basis of these trials was to prepare inks based on the same pigment and resin, with the same pigmentation level and same pigment/binder ratio and differing only in the ratio of toluene to aliphatic distillate (SBP3) in the solvent blend.

The grinding times of the inks were controlled to ensure that both inks had the same degree of pigment dispersion. The inks were then printed at Watford on coated and uncoated papers using a stepped wedge cylinder to give different depths of shade.

The prints were then examined on a densitometer and a reflectance spectrophotometer for strength and brightness, and on an automated goniophotometer for gloss.

The pigments used were a carbon black, a β-phthalocyanine blue and a calcium 4B toner, all being commercial brands normally used in this type of printing. Three resins were used, one being a calcium-zinc resinate and the other two being modified phenolic resins. Again, all were commercial brands normally used in this application. The solvents were blends of toluene and SBP3.

When the prints from corresponding pairs of inks were examined, the results in every case followed the same pattern, which could be summarised as follows: the ratio of the colour strengths of the pairs of inks varied both with the substrate and the depth of etching or printing. The extent of the variations was considerable and is illustrated in Tables 5, 6 and 7, which are typical of the results obtained.

Each Table illustrates the results of the experiments with different solvent blends. The relative colour strengths of the inks, despite the equal dispersion levels of the pigments in them, vary widely both with the substrate and the depth of etch or printing. In general, the ratio alters in favour of the toluene rich ink as the depth of etch is reduced.

These findings occur with different pigments and different resins. In order to test the techniques used and to emphasise the importance of solvent blend, three inks were made up from Blue GLSM in three different resins, the solvent in each case being 100 per cent toluene. The degrees of dispersion of the blue were adjusted for each ink, to give a 50 per cent diameter of 0.27μm. Two of the resins were modified phenolics, the other was a calcium-zinc resinate.

Table 5

Colour strengths—phenolic gravure inks based on Rubine SC (calcium 4B toner)
Ink Reference A – 80/20 toluene/SBP3 – 0.15μm, 50% diameter
Ink Reference B – *25/75* toluene/SBP3 – 0.15μm, 50% diameter
Pigmentation levels as printed, A = 5.0%, B = 4.8%

Sample and print step	Coated paper		Uncoated paper	
	k/s	Colour strength (%)	*k/s*	Colour strength (%)
A/1	5.43	100	1.76	100
B/1	5.28	97.2	2.81	159
A/2	1.04	100	0.65	100
B/2	0.87	83.6	0.73	112
A/3	0.071	100	0.074	100
B/3	0.054	76	0.067	90
A/4	0.045	100	0.048	100
B/4	0.035	77.7	0.044	91

Table 6

Colour strengths – Phenolic gravure inks
Pigment – Blue GLSM (β-phthalocyanine blue)
Solvent blend – Ink A – 90/10 toluene/SBP3
Ink B – 25/75 toluene/SBP3
50% *diameter* – Ink A – 0.33μm
Ink B – 0.37μm
Pigmentation levels as printed – Ink A – 3.47%
Ink B – 4.09%

Sample and print step	Coated paper		Uncoated paper	
	k/s	Relative strengths	k/s	Relative strengths
A/1	5.698	100	1.196	100
B/1	4.31	75.6	1.38	115.8
A/2	3.886	100	1.009	100
B/2	3.067	78.9	1.137	112.7
A/3	2.115	100	0.761	100
B/3	1.78	84.2	0.795	104.4
A/4	0.318	100	0.269	100
B/4	0.197	62	0.197	73
A/5	0.036	100	0.037	100
B/5	0.024	66.7	0.026	70.3

Table 7

Colour strengths – Phenolic gravure inks
Pigment – Regal 300 Carbon black
Solvent blend – Ink A 100% toluene
Ink B 40/60 toluene/SBP3
50% *diameter* – Ink A – 0.30μm
Ink B – 0.30μm
Pigmentation levels as printed – Ink A – 2.3%
Ink B – 2.2%

Sample and print step	Coated paper		Uncoated paper	
	k/s	Relative strengths	k/s	Relative strengths
A/1	4.12	100	0.80	100
B/1	2.23	54	0.89	111
A/2	1.185	100	0.55	100
B/2	1.045	88	0.53	97
A/3	0.130	100	0.114	100
B/3	0.066	50.8	0.066	58
A/4	0.061	100	0.068	100
B/4	0.032	52	0.038	56
A/5	0.022	100	0.034	100
B/5	0.014	64	0.021	62

Printing trials were carried out at Watford as before, on coated and uncoated papers, giving prints of differing depths. These were assessed on a reflectance spectrophotometer for relative strengths. The results showed the following:

(a) The strength comparisons for the prints from the three inks on coated papers are virtually independent of the strength of the print, i.e. the depth of etch.

(b) Similarly, on uncoated papers, the strength ratios are independent of the actual steps.

(c) The strength ratios from prints on coated papers are fairly close to those obtained from prints on uncoated papers.

(d) The strength ratios correspond to the pigmentation levels of the inks.

These results were expected. The three inks have the same pigment and the same degree of dispersion and the same solvent. The relative print strengths in all circumstances are dependent solely on the corresponding pigmentation levels.

It must be asked, therefore, how the apparently chaotic set of results illustrated by Tables 5, 6 and 7, where the relative strengths depend on both the substrate and the depth of print, can be explained. Here the inks have the same degrees of pigment dispersion, but differ in their solvent composition.

The following explanation can be advanced which will explain the results qualitatively. This explanation is based on two assumptions; firstly, the rapid drying of the inks after printing gives rise to marked flocculation of the pigment, and the extent of this flocculation differs with the composition of the solvent, being less in the toluene rich inks and greater in the toluene lean inks; secondly, the toluene rich inks give greater penetration into the paper or "strike-through", particularly on uncoated papers.

These two assumptions help to explain the observed phenomenon in the following way. If the extent of flocculation of the pigment (brought about by rapid drying) is reduced where the solvent is rich in toluene, such toluene rich inks will tend to have better pigment dispersion in the prints and, therefore, better colour strength.

Greater strike-through of the inks, brought about by higher toluene contents, will lead to weaker and duller prints, because the ink film on the surface of the paper is thinner.

The two factors would be in opposition. The extent of the second factor will be more pronounced with thick films and less with thin films. It will also be more marked on uncoated papers because of their greater absorbency.

The nett effect of the two factors will vary with the film thickness, that is with the print step, and with the absorbency of the paper.

This is what has been found experimentally. It will be asked, however, whether the two assumptions have any factual or theoretical basis.

With regard to the flocculation on rapid drying, the author's views have already been explained. Rapid drying must set up considerable physical forces and these could well upset the dispersion equilibrium; toluene is a good solvent for all the resins, whereas they are virtually insoluble in the aliphatic component SBP3. On evaporation of solvent, the toluene rich ink may hold the resin in solution a fraction longer than the ink with less toluene, and hence give less flocculation. Therefore, although as yet there is no factual evidence on the point, the assumption that toluene rich inks give somewhat less flocculation on drying is by no means unreasonable.

With regard to the greater strike-through, the grounds for making the assumption are firmer. Toluene rich inks do give more strike-through on the deeper shades than toluene lean inks. This is apparent visually, particularly on uncoated papers. The strike-throughs can also be compared quantitatively by measuring the colour strengths of the reverse side of the prints. These measurements confirm the visual impression. They also demonstrate that the strike-through differences are negligible at low etchings or print depths on either papers. Furthermore, the surface tension of toluene-rich solvent blends has been measured and it is definitely greater than that of solvent blends containing little toluene. This would promote greater penetration.

To sum up, therefore, it is believed that gravure inks dry partly by evaporation and partly by absorption, the absorption being appreciable only in deep shades or thick films. The rapid drying causes some flocculation of the pigment and hence some loss in colour strength. The extent of this loss is reduced by increasing the toluene content of the solvent blend, probably because the toluene is a good solvent for the ink's resin. Increasing the toluene content, however, increases the degree of strike-through of the inks, particularly on uncoated paper and in thick films and hence gives lower strengths.

The net result of these two opposing effects means that a comparison of the relative strengths of two inks, which differ only in the composition of their solvent blend, depends markedly on the substrate and the depth of print. As the depth of print decreases, the relative strengths increase in favour of the toluene rich inks.

Discussion

This explanation, which certainly explains the results of the printing trials qualitatively, rests on the assumption that rapid evaporation of solvent can and does lead to some flocculation of the pigment. It reinforces the evidence derived from the work on stoving lacquers, which led to the same conclusions. The possibility of such flocculation is not unreasonable, and it is known that pigment dispersions in the wet state represent an equilibrium between forces of attraction and repulsion. The possibility of altering such an equilibrium unfavourably by applying outside forces is a well known and accepted fact. This is illustrated by the phenomenon of "dilution shock" in which the dispersion level of a pigment in a given medium can be drastically impaired merely by a fairly rapid dilution with an added solvent, even when the solvent is the same one as that in the original dispersion. If rapid addition of a solvent can cause considerable flocculation, it seems reasonable that rapid removal of solvent will also have some effect; the equilibrium is bound to be upset in most circumstances, and it is more than likely that some flocculation may again occur.

If it is accepted that flocculation can occur when films dry by solvent evaporation, some very interesting questions can be put to both paint and ink formulators: What is the extent of the flocculation? Is it considerable or is it so small as to be ignored? If it is considerable, can it be reduced in extent by modifying the formulation?

The people who use paints and inks are also much concerned. If the degree of flocculation is considerable, can it be reduced significantly by altering the application conditions and drying mechanisms, and would such alterations be worthwhile? If it is assumed that flocculation can happen on drying whenever this is brought about by fairly rapid solvent evaporation, then the list of products concerned is considerable and includes:

Emulsion paints,

Industrial paints, both solvent and water based,

Gravure inks, both solvent and water based,

Flexographic inks, both solvent and water based,

Wallpaper printing inks,

Paper coating compositions.

This is a formidable list. The optical properties of paint, ink and paper coating films are undoubtedly dependent on the concentration and degree of dispersion of the pigment in the final films. In the present state of knowledge, the surface coating manufacturer of the above products does not know whether the dispersion level he so painstakingly builds into his products persists into the final film. The users of these products do not know whether by their conditions of application and drying, they are impairing the optical properties which they are so anxious to obtain.

If there are substantial differences between the degrees of dispersion in the wet and dry states for such a wide list of products, then it is a cause of some concern. To keep things in perspective, however, it must be pointed out that as yet there is no concrete, direct evidence that this is the case, and the author's suspicions are based on indirect evidence. The assumptions made to explain the observed phenomena may be erroneous, and other explanations may exist.

It is believed, however, that the possibility of flocculation on solvent evaporation is serious enough to warrant some investigation in depth. Essentially what is required is to assess pigment dispersion in both wet and dry systems by the same method so that direct comparisons are made.

The author has carried out some work in this connection and hopes to be able to report on it in the near future.

[*Received 24 April 1976*

References

1. Carr, W., *JOCCA*, 1971, **54**, 1093.
2. Carr, W., *JOCCA*, 1974, **57**, 403.
3. Carr, W., *J. Paint Tech.*, 1974, **46**, 96.
4. Lombard, G. A. L., and Carr, W., *JOCCA*, 1975, **58**, 246.

Next month's issue

The Honorary Editor has accepted the following papers for publication, and they are expected to appear in the January 1977 issue of the *Journal*:

Molecular structure and film properties of alkyd resins *by G. Walz*

Recent aspects of the preparation and evaluation of some polyesteramides for surface coatings. Part I: Parameters affecting the formation of various dihydroxy-diethylamide derivatives of fatty acids *by A. M. Naser, M. A. El-Azmirly and A. Z. Gomaa*

Surface films produced by electrostatic powder deposition *by A. W. Bright*

Colour, structure and electrons—*a Student Review by C. H. J. Wells*

Section Proceedings

Hull

Safety, pollution and effluent disposal

The first ordinary meeting of the 1976/77 session was held at the Haven Inn, Barrow Haven, Lincolnshire, on Monday 4 October 1976. This was a joint meeting with the Institution of Chemical Engineers. Mr T. W. Wilkinson, the section chairman, introduced Mr J. Alexander of P.D. Pollution Control Ltd who gave a lecture entitled "Safety, pollution and effluent disposal".

Mr Alexander reviewed the latest legislation relating to pollution and effluent disposal; the most important were the Control of Pollution Act and the Disposal of Poisonous Waste Act. Under the latter Act, waste disposal sites now had to be licensed.

The disposal of hazardous wastes was a national problem, about 3 million tonnes being cleared each year. There were four main disposal methods, namely chemical treatment, marine, incineration and land fill. Marine disposals were monitored by the Ministry of Fisheries and Food. Incineration was very costly and only suitable for waste hydrocarbons and other solvents. Land fill was thought to be the most important method for the future.

A new concept for the disposal of inorganic liquids and sludges was the "Chemfix" process. This patented process involved the reaction of a number of inorganic chemical reagents with waste liquids and sludges to form easily manageable solids. The process was fully illustrated with slides and a film. A leachate test was described. This test was used to determine the leaching properties of the solidified material: the solid is examined by column chromatography using distilled water and the leachate is analysed by atomic absorption spectroscopy, colorimetric or wet methods to determine the concentration of any constituents which have leached from the material under analysis.

The lecture, which was attended by 22 Members and visitors, was followed by a prolonged discussion. The meeting was finally brought to a close with a vote of thanks from Mr P. Lynsky; the audience expressed their appreciation in the usual manner.

D.M.W.

Midlands

Trent Valley Branch

North Sea oil—inspection

Mr J. D. Griffiths, who is the deputy managing director of R. J. P. Nicklin & Co Ltd of Sheffield, delivered an informative lecture before twenty members and their guests at the Crest Motel, Derby, on the night of Thursday 7 October 1976 on the role of the "Quality Assurance Corrosion Engineer" in both "offshore" and "onshore" inspection of corrosion hazards.

Mr Griffiths had considerable experience of the devastation caused by un-checked corrosion and he expounded his wealth of knowledge about the painting of oil-rigs, bridges and plant maintenance areas involving the use of structural steelwork.

Mr Griffiths illustrated his talk with slides of structures which exemplified areas of paintwork failure brought about as a result of unsupervised application—defects which quality assurance corrosion engineers had battled against since their introduction ten years ago, in their more primitive role as inspectors of corrosion.

A lively discussion was concluded by a vote of thanks from Mr J. Fowles-Smith.

J.R.K.

Newcastle

Painting of ships and blast cleaning standards

A joint meeting of the Section and the North East Branch of the Institution of Corrosion Science and Technology was held at Newcastle upon Tyne Polytechnic on 7 October 1976. Some 70 Members and visitors assembled to hear two papers given by J. O. Jemitus and A. N. McKelvie who are members of the Admiralty Paint and Preservation Team based at Cammel Lairds' shipyard, Birkenhead. The papers were entitled "The integration of the protection function when building a ship" and "Steel cleaning standards—a case for their reappraisal" and both were well illustrated with slides. A wide ranging and lively discussion followed the presentation before the Chairman finally brought the meeting to a close. Both papers are to be published in a future issue of the *Journal*.

T.H.

Ontario

Optimistic outlook for the future of the coatings industry

The Section held its first technical evening of the new session on Wednesday, 20 October at the Skyline Hotel, Toronto. Over sixty members and guests were the audience for an address by Mr E. Barry, Executive Vice-President of the Canadian Paint Manufacturers' Association.

Following a broad examination of the structure and economics of the paint manufacturing industry in Canada, Mr Barry proceeded to a more detailed analysis.

In the presentation of statistical data, the meeting was particularly fortunate in having Mr Barry as speaker. The critical review of industry data was not only comprehensive but meaningful and amply supported by illustration and example.

It was the general conclusion of the paper that the domestic coatings industry would show a moderate but steady growth in real output over the next two years. The audience was encouraged by the conclusion that, as the title of the lecture suggested, there was good reason for "an optimistic outlook for the Canadian coatings industry".

After the question period, a vote of thanks to the speaker was proposed by Committee member, Mr A. Redmond.

A.M.C.

Scottish

Recent developments in polyurethanes

A lecture was given by Mr R. M. Entwhistle of Bayer UK Ltd at 6.00 pm on Thursday 14 October in the Beacons Hotel, Glasgow. Mr Entwhistle's lecture dealt specifically with the two-pack polyurethane system. After an outline of the basic chemistry of the isocyanates and polyhydroxy compounds used, the energy consideration of spraying and curing were dealt with in detail. The high solids content and low curing temperature (180°C) required for the two-pack polyurethane system gave an energy requirement lower than that for conventional thermosetting acrylics, water-based coatings, powder coatings or high solids polyester.

Mr Entwhistle then described how the long life of the two-pack system had opened up new areas for painting, especially on building structures. Here their anti-graffiti properties were of considerable interest.

Following an interesting discussion, Mr McKendrick proposed a vote of thanks and the audience expressed its appreciation in the usual manner.

G.H.R.

West Riding

Health and Safety at Work Act

A meeting of the Section was held on Tuesday 14 September 1976 at the Griffin Hotel, Leeds. A lecture dealing with the Health and Safety at Work Act was given by Mr P. F. Meal, H.M. Principal Inspector of Factories (Training).

Mr Meal explained the Act had come into being in 1974 following the report of the Robens committee. This had expressed concern about the plateau reached in the incidence of workplace accidents, the diversity of legislation and its enforcement and the number of unprotected employees.

The lecturer pointed out that health and safety was a very large subject, but he would proceed to discuss the major provisions of the Act. The duties of an employer were widespread and not only covered virtually every aspect which had an impact on employee safety but also extended to ensuring the safety of persons not in his employment. Other clauses dealt with the duties of manufacturers and suppliers of substances with respect to ensuring the safe and proper use of their products as far as reasonably practical. There was also a duty on an employee to take reasonable care of his own and others' health and safety and to co-operate with his employers so far as necessary to ensure that the duties of an employer were complied with. Thus the objective of the Act was to involve everybody concerned in the implementation of the Act.

In response to questions, Mr Meal gave his opinion that the use of lead and cadmium based pigments would continue to be allowed. There would be a proviso, however, that they should be handled and used safely. Similar comments applied to many other materials.

A lengthy discussion was brought to a close with a vote of thanks proposed by Mr H. Young.

R.A.C.

Adhesion and the formulation of adhesives

By W. C. Wake

London: Applied Science Publishers, 1976

Pp. xi + 325. Price £15.00

This book is in two parts; part I deals with the physical aspect of adhesion and covers a remarkably wide field. It starts with the types of interaction between various bodies, and this is followed by a chapter on a number of surface interactions with adhesives. The book continues with a chapter on theories of adhesion and adhesive action, which is particularly welcome and is most lucid in its explanations. Part I concludes with an interesting discussion on modes of failure, which goes into the subject of failures more thoroughly than the title would suggest.

The reviewer is sure, however, that part II, although the smaller part of the book, will be referred to much more often. It contains material which will be most useful for day-to-day reference by the adhesive technician. It deals mainly with adhesives, and contains a wealth of information—even though some of it reads like extracts from the makers' pamphlets. The various materials used in adhesive formulations are discussed and, to a limited extent, their use is explained. This chapter, although most useful and helpful, could have been improved by padding out with examples and perhaps some indication of quantity usage. The usual chapter on hot-melt adhesives is included. The chapter on sealants is welcome, informative and well written as far as it goes, but surely this subject warrants a greater coverage than the 11 pages devoted to it?

The title may be said to be slightly ambiguous in that there are only two examples of actual formulation given; and those under Hot-melt Adhesives, which are merely quotes from patents or specifications.

The weak point in this book, unfortunately like so many others, is the index, which is poor and contains numerous mistakes or misdirections.

All criticism apart, this is an excellent book with a sound and well-written text. It can be said to be two books in one and it will appeal in part I to students etc., and in part II to technicians, chemists and those involved with the manufacture of adhesives. There is a growing need for books of this type and the present volume will be a welcome addition to those currently available.

G. ANDERSON

Continuous flow analysis—theory and practice

By W. B. Furman

New York and Basel: Marcel Dekker Inc., 1976

Pp. ix + 334. Price Sw Fr 82.00

Although one third of this book is taken up by references (941), author index and subject index, the remaining 225 pages are an extremely useful source of information. An introduction to continuous flow analysis is followed by chapters on "Continuous flow instrumentation; practical considerations of Autoanalyzer modules", "The use of laboratory instruments in continuous flow analysis", "Design and construction of continuous flow manifolds", "The use of continuous flow manifolds with liquid chromatographic systems", "Automatic data processing in continuous flow analysis" and "Theoretical aspects" (written by W. H. C. Walker).

As the author points out in the Preface, the book is intended for laboratory personnel already familiar with the Autoanalyzer system. However, the author, in his method of presentation, also assumes that the reader is fully aware of the problems involved in using the technique and is able, and has the time, to decide himself which are the best methods of analysis. An effort has possibly been made to incorporate too much information. The book, therefore, tends to become a listing of the work carried out over the years with no attempt made at critical assessment. Frequent reference to original papers is required to obtain adequate information on many of the topics. The chapter on theoretical aspects is easier to read than the others and does not require reference back to original papers so often.

In the reviewer's opinion the usefulness of this book could have been improved. Small line drawings to illustrate the practical Autoanalyzer configurations used for specific analyses would have been easier to follow than some of the descriptions used in the text. Too little information is often given on too many analytical procedures: for example, on page 155 under "Fluoride" in a space of 25 lines the following appears "Mandl *et al* (564) give a photograph . . .", "Marten and Grady (579) show a picture . . .", "Holy (410) described a manifold . . .", "Catanzaro *et al* (171) show a picture . . .", and "Wahl and Auger (881) give a drawing . . .". In each case the reader would have to refer to the original article to obtain the necessary information. Summaries of some recommended analytical procedures may have been more useful for the rapid choice of methods.

Because of its emphasis on applications in the pharmaceutical and related industries this book is unlikely to be of practical use to most readers of the *Journal*. For the Autoanalyzer user who requires easy access to a large proportion of the published literature up to mid-1973, this book would certainly be useful. Similarly, analytical chemists requiring a summary of the many aspects of continuous flow analysis would find this book helpful; although they would need to be prepared to refer frequently to original published work for detailed information.

C. W. FULLER

Characterization of powder surfaces with special reference to pigments and fillers

By G. D. Parfitt and K. S. W. Sing (Eds)

London: Academic Press Inc., 1976

Pp. 464. Price £13.80

The nine chapters of this textbook are contributed by an international team of specialists. In the first two chapters the co-editors review the physical and chemical methods for characterising powder surfaces, with particular attention to gas adsorption techniques and the identification of surface functional groups, which contribute to the agglomeration of pigment particles. The section devoted to chemical methods also examines the role of surface-active agents, a subject of interest to the paint chemist because of the important contribution of surfactants to pigment dispersion. Chapter 3 discusses the flow properties of powders and the reviewer found this to be a concise and informative account of the problems and the methods used to resolve them. There is no doubt, however, that a considerable effort in this field is required before the problems of powder flow are resolved.

Further chapters deal with inorganic white pigments, inorganic coloured pigments, organic pigments and carbon blacks and the book concludes with chapters devoted to silicas and clays.

The book is well printed, has numerous references and the quality of printing and photographic reproduction is excellent. It may prove to be too academic for the paint technologist, but it will be ideal reading for the pigment chemist. A good reference book for the library shelf.

S. T. HARRIS

Encyclopaedia of PVC—Volume I

First Edition (Ed) by L. I. Nass

New York: Marcel Dekker Inc., 1976

Pp. xii + 600. Price Sw Fr 240.00 per volume

Previous decades have supplied comprehensive tomes on Polystyrene and Polyethylene and it is surprising that a similar work on PVC has not appeared until now. The new work is an "Encyclopaedia" in three volumes comprising 32 chapters which attempt to cover the science and technology of the subject, ranging from the genesis of the monomer, through manufacture, compounding, fabrication and, finally, to disposal. The editor, Leonard I. Nass, has brought together many authors, each an expert in his field, to tackle the various chapters. The intention is to provide a text for "the interested student and the serious research worker"; it is not a work written by experts for experts. On the contrary, it can be consulted and read profitably by those who have no previous knowledge of polymers without being overcome, either by complex theory or by a maze of contradictory empirical observations.

Only the first volume is available.for review. It gives a clear and well illustrated account of Vinyl Chloride (monomer) Production followed by a chapter on Polymerisation and Manufacture (Chapter 3). This deals with the various kinetic steps in the polymerisation process and discusses Talamini's two-phase kinetics in some detail. It attempts to describe commercial manufacture without any pictorial illustrations, which would have helped. The following chapter, on Manufacture of Vinyl Chloride Copolymers (Chapter 4), is informative and satisfying.

Chapter 5 deals with test methods. It describes various rheometers, but shows no graphical results. There is a brief chapter on the Elucidation of Structure (Chapter 7) followed by two major chapters on stabilisation and stabilisers. The text gives a logical, lucid account of the functions of stabilisers of all kinds and provides much interesting reading on their chemical action. However, the reader gets no quantitative information to help him appreciate stabiliser effectiveness.

Chapter 10 on Theory of Solvation and Plasticisation gives extensive data on solubility and interaction parameters, deals with the effects of plasticisers on physical properties and their permanence, and leads to the last chapter on plasticisers themselves. This covers the manufacture of the main types of plasticisers and gives extensive charts of their properties and their effects in PVC at various concentrations.

The editor has placed the emphasis in this book on "the fundamentals surrounding formulation and processing philosophies" and has not attempted to provide a "formulary of recipes". This approach is very much in evidence. The two chapters on polymerisation and copolymerisation contain just one formulation for polymerisation; the two extensive chapters on stabilisation contain not one fully quantitative example. The authors have gone so far in withholding practical examples throughout this volume that the reader may have to look elsewhere to obtain a practical feel for the subject. Here, the generally very full reference lists will help.

The volume is well set out and clearly printed, but there are some important mistakes and omissions. For examples, the points of the Talamini plots referred to on page 57 are not shown; the asterisks said to mark the most widely used UV absorbers in a set of tables are not there (page 329); the heading on page 451 is misplaced in the text. The editor might have insisted on the consistent use of units, but mixed units are often quoted even within the same chapter. There is no volume index. Such deficiencies should have been avoided in a work of this magnitude and importance.

The strength of this first volume lies in its presentation of much science and technology in logical essayist's style without deflecting the reader with doubts and difficulties. Its chief weakness lies in some lack of realism and, above all, lack of practical illustration. It is, on balance, a very useful text and technical staff working on PVC will want this book on their shelves—if they can afford it.

M. N. BERGER

Lackrohstoff-Tabellen

By E. Karsten

Sixth Edition revised by O. Lückert

Hannover: Curt R. Vincent Verlag 1976

Pp. 638. Price DM 78.00

After an interval of four years, Vincentz Verlag has published the sixth completely revised and up-dated edition of "Karsten, Lackrohstoff-Tabellen". Because of the death of Dr Karsten, Herr Olaf Lückert has taken over and done a very good job. As expected, the size of the book has increased from 516 to over 600 pages. A total of 8500 different raw materials from 225 producers has been covered. The make-up and divisions are unchanged. Some sections are now much bigger; for example *No. 24 Resins based on unsaturated hydrocarbons, No. 30 Polyamide Resins* and *31 Polyurethane Resins* are now almost twice their former size. Powder coating resins have been added and, where necessary, other completely new sub-sections have been added, for example there is one for radiation-curing polyester resins. Again, subjects such as waxes, plasticisers, solvents and various auxiliary materials are included, whilst synthetic resins naturally take up most of the space. Equivalent tables for pigments and fillers are planned for publication next year.

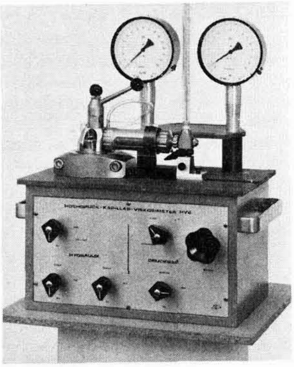
The tables are in order of product groups, and indicate certain characteristics, chemical and physical constants, possible applications and the names of the international suppliers from Europe and America and, where appropriate, their agents in West Germany. The main index is in four languages. Everything is well documented and indexed. Although written in German, these tables can be of very great help to laboratories and buying offices.

M. HESS

Information Received

Viscometer for non-Newtonian fluids

The HV6 High Pressure Capillary Viscometer recently introduced by Contraves Industrial Products Ltd is intended for predicting the flow behaviour of non-Newtonian substances at shear rates up to 10^6 sec^{-1}. It is easy to use, maintenance is minimal and cleaning is made easy by the stainless steel construction.



The principle of operation is as follows. The test fluid is forced, by a controlled pressure from a nitrogen cylinder, through a capillary tube of constant diameter. The pressure is exerted on the sample via a diaphragm so that contamination of the test sample cannot occur. The volume of test substance passing through the capillary per unit time is accurately measured and from this the viscosity is derived.

Extensive use is made of a temperature regulating fluid around the test substance and the capillary to ensure constant temperature throughout the system. Various diameters and lengths of capillary tube are available to enable a large variety of substances to be tested. The large top-mounted pressure gauge makes it a simple matter to take readings over a range of pressures so that a flow curve can be produced. Operating temperatures up to 60°C and pressures up to 15 MPa are possible.

Tenfold increase in Witcothane output

Major replanning at the Droitwich and Dronfield (Nr Sheffield) plants of Witco Chemical Company has facilitated a tenfold increase in production of the company's "Witcothane" output—the polyurethane-based product which is in great demand by the adhesives industry, particularly for footwear.

Witco Chemical—change of address

Witco Chemical Ltd, the UK subsidiary of the Witco Chemical Corporation of the USA, has recently moved its headquarter offices, including administration, sales and accounts departments, from London to Worcester. The new address of the company is: Witco Chemical Limited, Witco House, Barbourne Road, Worcester WR1 1RT.

Schenectady orders resin plant

Asme Vessels Ltd of Gillingham, Kent, is to supply a complete resin plant worth £33 000 and designed to BS 1515 for Schenectady-Midland Ltd.

The reactor is constructed from 316 grade stainless steel and fitted with Asme half-coils for operation at 350°C. All the butt-welds on the half-coils are subjected to 100 per cent X-ray examination by a special procedure developed by the company.

Additional stainless steel items to be supplied include a holding tank, weigh tank, condenser, receiver, vapour ducts and pipework.

G. J. Erlich Ltd—change of address

G. J. Erlich Ltd has recently moved to: Erli House, Tillington Place, Petworth, West Sussex.

Diamond Shamrock defoaming agents

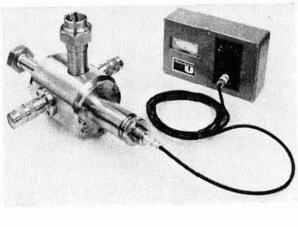
As a service to UK customers, all defoaming agents manufactured and sold by Diamond Shamrock Chemicals (UK) Ltd will in future be designated "Foamaster". This will facilitate recognition of foam control agents and will bring nomenclature in line with that adopted by the Process Chemical Division of Diamond Shamrock Corporation in the USA.

Products such as "Nopco Foamaster NDW" and "Nopco Foamaster NXZ" will be known as "Foamaster NDW" and "Foamaster NXZ".

Formulations will remain the same and will continue to be manufactured in the Leeds plant.

Homogenising head

The "Ultrason" homogenising head, manufactured by Ultrasonics Ltd, is provided with controls to allow the equipment to be tuned during operation to maximum acoustic intensity. It is said to have application in almost all areas where emulsification or dispersion are required.



The principle of operation is that process material is forced at high velocity through a specially formed orifice in a flat stream across a blade. At the point at which the material hits the blade, vibrations are set up in the liquid to produce a high level of cavitation suitable for the manufacture of high quality emulsions and dispersions. Cavitational energy is further increased by mounting the blade on to a block of resonant length, which vibrates longitudinally. Maximum acoustic intensity is achieved by maintaining a constant orifice-to-blade distance and changing the configuration of the liquid stream in relation to the blade.

Ink curing equipment

A new range of units for curing conventional or ultraviolet inks has been introduced by Wallace Knight Ltd of Slough, to provide rapid drying in a wide variety of applications, such as textile printing, printed circuit board production, metal decorating and adhesive curing.

Called "Infracure", the units are designed to house long, medium or short-wave infrared lamps together with ultraviolet lamps in a multi-purpose curing head. They are intended for end-of-line applications and include integral in-feed and delivery conveyors of Teflon-coated, glass fibre mesh with infinitely variable delivery speeds to enable precision curing of all substrates.

Literature

BIP "Beetle" Leaflets

British Industrial Plastics Ltd has published a new series of technical leaflets describing its range of "Beetle" urea and melamine coating resins. There are five leaflets in the set, comprising an introduction to coating resin systems, separate leaflets on urea and melamine resins, a fourth leaflet describing various speciality resins which BIP Chemicals Division has developed (for example melamine/epoxy copolymers for increased chemical resistance) and a final leaflet containing text methods and conversion tables.

Market for paint additives in Europe

The present market for all types of paint additives (excluding extenders) in Western Europe is currently estimated to be around 53 000 tonnes, valued at over £90 million in terms of current prices. This market is expected to increase to more than double this tonnage by 1986. This is one of the conclusions reached in the recent report on the subject issued by Information Research Ltd.

The report is claimed to be the first comprehensive review of this aspect of the paint industry and is based on a large number of in-depth interviews throughout the industry in Europe. It comprised 137 pages with 34 tables and is available at a cost of £135.00 (excluding postage).

Test sieves

The British Standards Institution has announced the availability of BS 410: 1976 "Specification for test sieves". This British Standard is a revision of, and supersedes, BS 410: 1969, which is now withdrawn.

THE INTERNATIONAL FORUM FOR DISPLAY AND DISCUSSION IN THE SURFACE COATINGS INDUSTRIES • OCCA 29

OCCA-29 Exhibition

22-25 March 1977 at Alexandra Palace, London

The continuous dialogue between suppliers and manufacturers

★ Belgium ★ Denmark ★ East Germany ★ Holland ★ Hungary ★ ★ Italy ★ Norway ★ Poland ★ Romania ★ Spain ★ Sweden ★ ★ Switzerland ★ UK ★ USA ★ West Germany ★

Allocation of space

The Exhibition Committee of the Oil & Colour Chemists' Association announces that the allocation of space for OCCA-29 (the twenty-ninth annual technical exhibition of raw materials, plant & equipment for the paint, varnish, printing ink, colour, adhesives and allied industries) has now taken place.

It is particularly pleasing to note the return of many exhibitors from previous years, as well as new exhibitors, thus showing the strength of the support for this annual focal point for the surface coating industries. At present, there will be participation by organisations in the following 15 countries:

Belgium, Denmark, East Germany, Holland, Hungary, Italy, Norway, Poland, Romania, Spain, Sweden, Switzerland, United Kingdom, U.S.A. and West Germany.

Theme of the Exhibition

The Committee emphasises that whilst it naturally encourages the showing of new products it **does not stipulate that new products have to be shown by exhibitors each year and it attaches equal importance to the advantage to personnel at all levels of meeting and discussing their common technical problems.**

Dates and times

The 1977 Exhibition will take place at Alexandra Palace, London, N.22 on the following dates and times:

Tuesday	22 March ..	09.30 – 17.30 hrs.
Wednesday	23 March ..	09.30 – 17.30 hrs.
Thursday	24 March ..	09.30 – 17.30 hrs.
Friday	25 March ..	09.30 – 16.00 hrs.

First List of Exhibitors

The following organisations from the UK and 14 overseas countries will be represented; product classifications are given in parentheses.

AB Metall—Sweden (*Equipment*)
A. B. M. Chemicals Ltd (*Additives, chemical intermediates*)
AMF International Ltd (*Equipment*)
AMK Peter Kupper—W. Germany (*Manufacturing equipment*)
Amoco Chemicals (UK) Ltd (*Additives*)
Anchor Chemical Co. Ltd (*Resins, additives, chemical intermediates*)
Ancomer Ltd (*Additives, chemical intermediates*)
Anchor Chemical Co. Ltd (*Resins, additives, chemical intermediates*)
Applied Color Systems—USA (*Colour control apparatus, computer technology*)
Arcode Ltd—Romania (*Resins, pigments, chemical intermediates*)
Ateliers Sussmeyer—Belgium (*Manufacturing equipment*)
BOC Automation (*Colour control apparatus, computer technology*)
Baird & Tatlock Ltd (*Instruments*)
Barford Chemical Co. (*Resins*)
Berk Ltd (*Pumps and filling machines*)
Berol Kemi AB—Sweden (*Resins, additives*)
Brandhurst Co. Ltd (*Resins*)
Cabot Carbon (*Additives, extenders*)
Chemolimpex—Hungary (*Resins, additives etc*)
Ciech Import & Export—Poland (*Chemicals, etc*)
Colwell (*Colour displays*)
Contraves Industrial Products (*Laboratory and testing apparatus*)
Degussa—W. Germany (*Pigments and additives*)
D. H. Industries Ltd (*Equipment*)
Diaf A/S—Denmark (*Manufacturing equipment*)
Diffusion Systems (*Laboratory apparatus*
Dow Chemical Co. (*Resins, additives*)
Draiswerke GmbH—W. Germany (*Manufacturing equipment*)
Dyno Industrier AS—Norway (*Resins*)
Glen Creston (*Manufacturing equipment, laboratory apparatus*)
Graco (*Dispensing machines*)
Herbert Smith & Co. (Grinding) Ltd (*Manufacturing equipment*)
Hercules Powder Co. Ltd (*Resins, pigments*)
Hilton Davis Chemical Co.—USA (*Pigments*)
Honeywill & Stein Ltd (*Resins, intermediates*)
Hopkin & Williams (*Chemicals*)
Hunterlab—USA (*Colour control apparatus, computer technology*)
ICI Ltd, Mond Division (*Additives, chemical intermediates*)
Institute of Metal Finishing
J. de Vree—Belgium (*Filling, labelling and packaging machinery*)
John Godrich (*Manufacturing equipment, laboratory and artificial weathering apparatus*)
Joseph Crosfield & Sons Ltd (*Additives, extenders etc*)
Jotun A/S—Norway (*Automated paint manufacture*)
K & K Greeff Industrial Chemicals Ltd (*Resins and other chemicals*)
K. W. R. Chemicals Ltd (*Equipment*)
Kirklees Chemical Co. (*Resin emulsions*)
Laporte Industries Ltd (*Pigments, chemical intermediates*)
Macbeth Colour & Photometry Division, Kollmorgen (UK) Ltd (*Colour measuring apparatus, computer technology*)
Marchant Bros. Ltd (*Manufacturing equipment*)
Mastermix Engineering Co. Ltd (*Manufacturing equipment*)
Monsanto Europe SA—Belgium (*Resins*)
Montedison—Italy (*Pigments*)
NL Industries Inc. (*Pigments, additives*)
Netzch—W. Germany (*Machinery*)
Noratom-Norcontrol A/S—Norway (*Automated paint production, computer technology*)
Oliver & Batlle—Spain (*Manufacturing equipment*)
Pamasol Willi Mader—Switzerland (*Aerosol filling plant, quality control apparatus*)
Paul Vollrath—W. Germany (*Equipment*)
Pilamec Ltd (*Equipment*)
Porter Lancastrian Ltd (*Equipment*)
R. K. Chemical Co. Ltd (*Laboratory and testing apparatus*)
R. K. Print-Coat Instruments Ltd (*Laboratory and testing apparatus*)
Research Equipment (London) Ltd (*Laboratory apparatus*)
Rio Beer—Switzerland (*Machinery*)
Roban Engineering Ltd (*Equipment, solvent bulk storage schemes*)
Rohm & Haas (UK) Ltd (*Resins, additives*)
Sachtleben Chemie—W. Germany (*Pigments, extenders*)
Scientific & Educational Aids (ABR) Ltd (*Laboratory equipment*)
Sheen Instruments (Sales) Ltd (*Laboratory and testing apparatus*)
Sherwin-Williams—USA (*Pigments*)
Silberline Ltd (*Pigments*)
Synres International BV—Netherlands (*Resins*)
Synthese BV, Division of Akzo Chemie—Netherlands (*Resins, additives*)
Sun Chemicals Corporation—USA (*Pigments*)
Ten Horn Pigments BV (*Pigments*)
Tenneco Colortrend BV—Netherlands (*Pigments*)
Tenneco Malros Ltd (*Additives*)
Tenneco Organics Ltd (*Solvents and additives*)
Tioxide International Ltd (*Pigments*)
Titanium Intermediates Ltd (*Chemical intermediates*)
UCB SA—Belgium (*Resins*)
Veb Kombinat Nagema—E. Germany (*Machinery*)
Wallace Knight (*UV curing apparatus*)

OCCA-29 *cont'd*

Wheatland Journals Ltd (*Literature*)
Willy A. Bachofen—Switzerland (*Manufacturing equipment, laboratory apparatus*)
Worsdall Chemical Co. Ltd (*Resins, additives etc, chemical intermediates*)

Venue

The twenty-ninth annual Exhibition of raw materials, plant and equipment for the paint, printing ink, colour and allied industries organised by the Association will take place at Alexandra Palace, London N22 from 22 to 25 March 1977. Alexandra Palace was the venue for the exhibition held in March 1976 and for the series of exhibitions from 1965 to 1969.

The exhibition provides an excellent annual opportunity for the technical personnel in the supplying industries to meet their counterparts in the manufacturing industries and to discuss their common technical problems. The advantage both to exhibitors and visitors of meeting in an informal atmosphere needs hardly be stressed, since the cost to exhibitors sending representatives to all the countries from which the visitors are drawn might well be prohibitive, particularly to smaller companies.

Refreshments on stands

This year in pursuance of this theme the Committee has amended the rule which had previously prohibited the serving of alcoholic refreshments on the stand. Exhibitors at previous Association Exhibitions at Alexandra Palace have commented that the provision of exclusive facilities, such as unlimited car parking, free bus shuttle service from the Underground station, two restaurants, a cafeteria and several bars has meant that visitors tend to spend longer time at the Exhibition.

Facilities at Alexandra Palace and travel arrangements

The facilities at Alexandra Palace, which the Association's exhibition will occupy on its own, include 2 licensed Restaurants, 2 bars, a Cafeteria and an Exhibitors' bar. Ample free car parking facilities are available for both exhibitors and visitors and Alexandra Palace is within easy access of the M1 Motorway and the flyover at the junction of the M1 and the North Circular Road was opened earlier this month. The Association organises a free bus service to and from Turnpike Lane Station on the Piccadilly Underground Line. The journey by Underground from Central London takes approximately 18 minutes and in due course the Piccadilly Line will be extended to Heathrow Airport terminal, which will give a direct link for visitors arriving at the Airport. In the meantime, a bus service operates from Heathrow Airport to Hounslow West Station. Visitors who prefer to travel from Heathrow Airport to the West London Air Terminal in order to leave their luggage at hotels, can board the Piccadilly Line trains at Gloucester Road Station.

"Official Guide"

This unique publication will contain descriptions of all exhibits and advertising space is available both to exhibitors and those organisations not able to show at the 1977 Exhibition. The "Official Guide" will be published **at the end of January 1977,** so that intending visitors can obtain copies and plan their itineraries.

Each Member of the Association, at home and abroad, will be sent a copy of the "Official Guide" and free season admission ticket.

Members are asked to ensure that they bring their tickets to the Exhibition **since otherwise the charge for admission will be made and no refund will be applicable in these cases.**

As for the 1976 exhibition, copies of the "Official Guide" and season admission tickets will be available several weeks in advance of the exhibition (prepayment only) from the Association's office and they will also be available for purchase at the entrance to the Exhibition Hall.

For the last two exhibitions, it was decided that a small charge should be made both for the "Official Guide" and for season admission tickets to the exhibition. This policy undoubtedly deterred casual visitors who might otherwise be attracted to exhibitions for which no admission charge was made and who gathered quantities of technical literature from the stands. The innovation was welcomed by many exhibitors and in no way acted as a deterrent to visitors to this exhibition. **The charge for a season admission ticket, including a copy of the "Official Guide", for OCCA-29 will be £2.00 (US $10.00).**

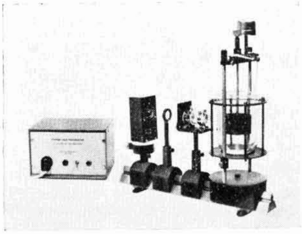
Information in foreign languages

As in previous years, the Association will be circulating information leaflets in six languages, which will contain application forms for those wishing to purchase copies of the "Official Guide" and season admission tickets before the exhibition.

News of Exhibitors

Baird & Tatlock (London) Ltd

Baird & Tatlock will be exhibiting a range of instruments, including photochemical reactors, a range of *Brookfield* viscometers, and a *Neotec* colorimeter.



A quantum yield photoreactor available from Baird & Tatlock

The "Du-Color" colorimeter for measurement of colour difference, opacity and brightness, shade differences, CIE X, Y and Z values, and absolute reflectance and transmittance

Also exhibiting on the *Baird & Tatlock* stand will be *Hopkin & Williams*, suppliers and manufacturers of a range of chemicals for industry and the laboratory.

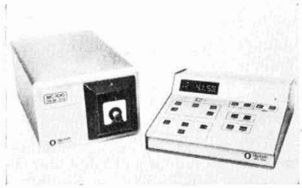
Contraves Industrial Products Ltd

Contraves Industrial Products Ltd is the UK sales and service subsidiary of *Contraves AG*, Switzerland. The company will be exhibiting a range of instruments and testing apparatus for the surface coatings industry. The attention of readers is drawn in particular to the Information Received section of this issue on page 456, which reports a new high pressure capillary viscometer recently introduced by the company.

Kollmorgen Corporation

The *Macbeth Color and Photometry Division* of *Kollmorgen Corporation* will be demonstrating the ability to use colour as a unique form of identification—as a "fingerprint". A highly sophisticated abridged spectrophotometer for industrial quality control applications, the *MS-2000*, will be introduced at the Exhibition. The machine uses a pulsed xenon light source, laser-tuned optical detector system, pre-programmed microprocessor and solid-state modular circuitry.

Macbeth's MS-2000 spectrophotometer



The MC-1010 colorimeter

The new *Macbeth MC-1010* colorimeter will also be shown. This is based on similar technology to the spectrophotometer and can offer high speed calculations from the microprocessor.

Wallace Knight

Demonstrations of some typical UV-curable formulations, based on prepolymers, oligomers and acrylates available from the *Chemicals Division* of *UCB s. a.*, Belgium, will be given on the *UCB* stand using the *Wallace Knight* "Labcure" system. A new range of units for curing both ultraviolet-sensitive and conventional inks is now available from *Wallace Knight Ltd* and described on page 456 of this issue.

Optional Professional Grade for Ordinary Members

Routes to the three Grades

Anyone who had allowed his membership of the Association to lapse and now desires to rejoin the Association is reminded that previous service as an Ordinary member (or Registered Student) can be counted towards the qualifying period of membership set out in the regulations.

The attention of senior members of the Association is particularly drawn to the Licentiate Grade and they are asked to encourage younger technical personnel to take advantage of this important Association activity. Several Colleges are now willing to help suitable candidates with the preparation of dissertations, and a list of Colleges was given on page 349 of the September issue of the *Journal*.

Reprints of the regulations covering the Professional Grade are obtainable from the Association's offices, together with application forms.

Admission

The following Member has been admitted to the Associateship category:

David Thomas Catchpole (*Scottish Section*)

List of successful candidates

As laid down in the report of the Working Party on Education, Training and Qualifications which was adopted in the institution of the Professional Grade, a list of all those Members who have entered the Grade will be published in the December issue of the *Journal* each year. The fifth such list appears below.

The Section to which the Member is attached is given in italics.

The certification fees at present are: Fellows £10.00 + VAT, Associates £6.00 + VAT, and Licentiates £3.00 + VAT. The amended regulations for admission to every grade last appeared in full in the July 1976 issue of the *Journal*.

Fellows

Anderson, George (*Scottish*)
Apperley, Thomas William James (*West Riding*)
Archer, Harold (*Manchester*)
Arnold, Michael Henry Miller (*London*)
Ashworth, Norman (*Manchester*)
Atherton, Donald (*Scottish*)
Austin, Denis Leonard (*Bristol*)
Balbi, Giorgio (*General Overseas—Italy*)
Banfield, Thomas Arthur (*London*)
Beere, Andre Jaimie (*Thames Valley*)
Bell, Sydney Hector (*London*)
Bennett, Norman Arthur (*General Overseas—Malta*)
Bester, Lawrence Percy (*Transvaal*)
Bews, Ian Charles Randall (*London*)
Bhumkar, Chidanand Jayram (*General Overseas—India*)
Birrell, Peter (*Ontario*)
Bishop, Eric Harold Abbott (*Thames Valley*)
Bohringer, Eberhard (*London*)
Boroky, Joseph Stephen (*General Overseas—Australia*)
Bourne, John Robert (*Midlands—Trent Valley Branch*)
Brooks, Leo James (*London*)
Brown, Arthur Ernest Girdlestone (*London*)
Butcher, George Alfred (*Midlands*)
Butcher, Kenneth William George (*Manchester*)
Butler, Cecil (*West Riding*)
Caldwell, David George (*Wellington*)
Campbell, George Alexander (*Manchester*)
Carr, William (*Manchester*)
Carter, Eric Victor (*Midlands*)
Ceresa, Raymond John (*London*)
Chatfield, Herbert Walter (*London*)
Chessman, Clifford Reginald (*Transvaal*)
Clarke, Harry James (*Midlands*)
Colborn, Douglas Charles (*Thames Valley*)
Cole, Derek (*General Overseas—Australia*)
Cole, Reginald Joseph (*London*)
Collier, Claude William (*Midlands—Trent Valley Branch*)
Collings, Arthur Geoffrey (*London*)
Cook, Harold Gilbert (*Manchester*)
Coupe, Raymond Richard (*London*)
Coverdale, Peter Frederic Muir (*Midlands*)
Cutter, John Outram (*London*)
Day, Keith Julyan (*London*)
Duckworth, Samuel (*Manchester*)
Dunkley, Frederick George (*Midlands—Trent Valley Branch*)
Durrant, George Geoffrey (*Hull*)
Easton, James Douglas (*Ontario*)
Ellinger, Marianne Livia (*London*)
Entwistle, Thurston (*Newcastle*)
Fillingham, Thomas Alan (*Hull*)
Finn, Stanley Russell (*Hull*)
Fullard, John Edward (*Transvaal*)
Gate, Peter Atholl Jackson (*Transvaal*)
Gay, Philip James (*Hull*)
Gellay, Victor Peter (*London*)
Gellman, Alexander (*London*)
Gillan, James Graham (*Manchester*)
Gollop, Percy Lionel (*London*)
Gosling, Harry (*Manchester*)
Graham, Thomas (*Manchester*)
Grainger, William Alan (*Irish*)
Gray, Denis Roy (*West Riding*)
Grover, Donald Henry (*London*)
Hampton, Horace Arthur (*Manchester*)
Hawkey, John Albert Lawrence (*London*)
Hess, Manfred (*London*)
Hill, Lawrence Albert (*General Overseas—Australia*)
Hill, Roger Frederick (*Midlands*)
Hipwood, Hubert Allan (*London*)
Hodgson, Kenneth Vickerson (*Newcastle*)
Holbrow, Gordon Leonard (*London*)
Holt, Alfred Gordon (*Thames Valley*)
Hutchinson, Geoffrey Herbert (*Scottish—Eastern Branch*)
Inshaw, John Leslie (*Thames Valley*)
Jacob, Basil (*Thames Valley*)
Jolly, Anthony Charles (*Manchester*)
Kane, Joseph Richard (*London*)
Keenan, Henry Wilfred (*London*)
Kinsman, Roy Granville (*Transvaal*)
Kotwal, Hoshidar Peshotan (*General Overseas—Pakistan*)
Kut, Siegmund (*London*)
Landmann, Axel Wolfgang (*London*)
Lasser, Howard Gilbert (*General Overseas—USA*)
Lewin, John Buckingham Grey (*London*)
Lewis, Fred (*Manchester*)
Ley, John Barry (*London*)
Lomas, Harold (*Ontario*)
Long, Denis Terence (*Irish*)
Lunt, Walter Richard (*West Riding*)
McKelvie, Archibald Neil (*London*)
McLean, Angus (*Scottish*)
McWilliam, Anthony (*Manchester*)
Mell, Cedric Charles (*Hull*)
Mitchell, John Edmund (*Manchester*)
Mole, Seymour Lloyd (*Ontario*)
Moll, Ivor Stuart D'anvers (*Manchester*)
Monk, Cyril James Henry (*Bristol*)
Moon, William Robert (*Manchester*)
Morgans, Wilfred Morley (*London*)
Munn, Raymond Henry Edward (*London*)
Newnham, Herbert Alan (*London*)
Newton, Dennis Sydney (*London*)
Newton, Donald Stringer (*Bristol*)
Nutt, William Owen (*London*)
Oostens, Emile Elie Eugene (*General Overseas—Belgium*)
Parfitt, Geoffrey Derek (*Newcastle*)
Penfold, Arthur de Ramon (*General Overseas—Australia*)
Piggott, Kenneth Elliot (*Natal*)
Polaine, Sydney Alan (*London*)
Ray, Stanley Arthur (*Midlands*)
Rechmann, Heinz (*General Overseas—Germany*)
Robinson, Ralph Sidney (*Natal*)
Roe, David Edwin (*London*)
Rose, Charles (*Manchester*)
Rouse, Robert Earnshaw (*Transvaal*)
Rubin, Wallace (*London*)
Rudram, Arthur Thomas Stephen (*London*)
Saunders, Laurence Frederick (*Natal*)
Seymour, Norman Henry (*Manchester*)
Slade, Harold Aitken (*Midlands*)
Slinn, Thomas Walter (*Wellington*)
Smethurst, Jack (*Manchester*)
Smith, Francis Mark (*Manchester*)
Smith, Harry (*General Overseas—Tanzania*)
Sowerbutts, Frank (*London*)
Stoyle, Francis Wilbert (*Irish*)
Talbot, Ernest Alexander (*Thames Valley*)
Tatton, William Henry (*Thames Valley*)
Tawn, Alec Richard Hornsey (*London*)

Optional Professional Grade Successful candidates—*cont'd*

Taylor, Cyril James Allan (*Midlands*)
Taylor, John Roberts (*Bristol*)
Taylor, Maurice David (*Wellington*)
Thorpe, William Frederick Albert (*Midlands*)
Tickle, Trevor Cyril Kenneth (*Manchester*)
Tooke-Kirby, John Theodore (*London*)
Tooth, John Henry Collins (*London*)
Touchin, Herbert Roy (*Manchester*)
Tozer, Edwin John (*General Overseas—Argentina*)
Unsworth, Alfred Kenneth (*London*)
Valentine, Leslie (*London*)
Walker, Alan Gordon (*Thames Valley*)
Wall, Dennis Charles (*Manchester*)
Warner, Eric Albert André (*Wellington*)
Watkinson, Leonard James (*West Riding*)
Westwood, George Ernest (*London*)
Whiteley, Peter (*London*)
Whitfield, Thomas (*Auckland*)
Wilkinson, Thomas William (*Hull*)
Willis, Gervase Hewitson (*Manchester*)
Woodbridge, Richard John (*Bristol*)
Worsdall, Herbert Charles (*London*)
Yorath, Robert Stanley (*Wellington*)

Associates

Acey, John Arthur (*London*)
Adams, John Charles (*Midlands*)
Adams, Terry Ernest (*London*)
Addenbrooke, Brian John (*Midlands*)
Aitken-Smith, Frank Joseph (*Auckland*)
Allavena, Antonio (*General Overseas—Switzerland*)
Anthony, Alan Sydney (*London*)
Armstrong, Edward (*Hull*)
Arnold, Frank (*Manchester*)
Assink, Jo (*Auckland*)
Baker, John (*London*)
Baldwin, George William (*Manchester*)
Bannington, Donald Bertram (*London*)
Bargrove, Kenneth Laurence (*London*)
Barnes, Peter James (*London*)
Barton, James Francis (*London*)
Batch, Alan James Edward (*London*)
Beachen, John Frederick (*Auckland*)
Bell, Brian Robert (*Midlands*)
Belsham, Barry Michael (*General Overseas—Cyprus*)
Bentley, Major Gordon (*West Riding*)
Bird, George Donald Chaplyn (*Midlands*)
Blackledge, Amos (*Manchester*)
Bloomfield, Kenneth Vincent (*London*)
Bluck, Ross Steele (*Wellington*)
Bolam, Ion Barrow (*Newcastle*)
Bowerman, David Francis (*Manchester*)
Bowler, Kenneth Ernest (*Midlands*)
Boxall, John (*Thames Valley*)
Brockman, Andrew Leonard Sloane (*General Overseas—Australia*)
Brooke, Leslie John (*Bristol*)
Brown, Peter Thomas (*London*)
Caffery, George Francis (*London*)
Calder, Robert Malcolm (*Auckland*)
Campey, Leslie John Randall (*Ontario*)
Cartwright, Jeffrey (*London*)
Catchpole, David Thomas (*Scottish*)
Catherall, Kenneth David (*Midlands*)
Chebsey, Maurice (*Manchester*)
Chellingsworth, Horace Thomas (*Midlands*)
Chippington, Kenneth Alan (*Bristol*)
Clark, Laurence Norman (*London*)
Clark, Michael Denis Thomas (*Wellington*)
Clement, Donovan Harry (*Midlands*)
Coates, John Allen (*Manchester*)
Cole, Francis William (*Midlands*)
Constantinides, Erricos (*London*)
Cordwell, Terrence Allan (*Midlands—Trent Valley Branch*)
Cox, Garth Anthony (*West Riding*)
Cunnington, Robin Roy Carol (*London*)
Daggett, Wilfred Francis (*London*)
Dalton, Frank (*General Overseas—Denmark*)
Dando, Vivian Charles Owen (*London*)
Davies, Frank Watkin (*Manchester*)
Davis, Reginald Albert (*Bristol*)
de Waal, Tielmann Johannes (*Natal*)
Delorette, Gustav Otto Hans Jurgen (*Transvaal*)
Donkersley, Brian (*Newcastle*)
Dowsing, George Frederick (*London*)
Drew, Harold Henry Lennox (*Midlands*)
Dunn, Paul Alan (*London*)
Durdey, Alan James (*Newcastle*)
Dury, Ian Clifford James (*Thames Valley*)
Eaton, Michael George (*Thames Valley*)
Ebdon, James William (*General Overseas—Rhodesia*)
Eltringham, James Norman (*Auckland*)
Ernst, Joel (*London*)
Evans, Carey Pearce (*Auckland*)
Fairless, Joseph (*London*)
Fell, Alan William (*London*)
Field, Lawrence Edward (*Natal*)
Finlay, Cecil Newton (*Newcastle*)
Fisher, Leslie Alexander *Natal*)
Flood, Geoffrey Terence (*Manchester*)
Ford, Keith Sydney (*Manchester*)
Formanek, Leopold (*General Overseas—Czechoslovakia*)
Frazee, Jerry Daniel (*General Overseas—USA*)
Fry, Jack Ian (*Wellington*)
Garratt, Peter Garth (*General Overseas—Switzerland*)
Gay, Alan Stanley (*Midlands*)
Geddes, Kenneth Raymond (*Manchester*)
Ghosh, Sunil Kumar (*General Overseas—India*)
Gibson, Frank (*Manchester*)
Gibson, John Carrington (*Hull*)
Goodman, Robert John (*General Overseas—Spain*)
Green, Basil Ray (*General Overseas—Trinidad*)
Green, Brian James (*London*)
Greenall, Brian John (*Wellington*)
Greenfield, Eric (*Midlands*)
Griffiths, Henry James (*Midlands*)
Grime, David (*London*)
Groom, John Robert (*London*)
Gunn, Reginald (*Thames Valley*)
Hamilton, Alexander (*Scottish*)
Harrison, Cyril Geoffrey (*Hull*)
Harty, David Basil (*General Overseas—Australia*)
Hasnip, John Anthony (*Hull*)
Heald, Desmond (*Manchester*)
Heffer, Victor George (*Manchester*)
Herriott, Charles Edward (*London*)
Hickman, Edwin Peter (*Midlands*)
Hill, Gilbert Victor Geoffrey (*Thames Valley*)
Hill, Raymond Forsyth (*Scottish*)
Hirst, John William Arthur (*Auckland*)
Hodge, Robert Alexander Paul (*Auckland*)
Holden, William Desmond (*Manchester*)
Holmes, David James (*Midlands—Trent Valley Branch*)
Holt, Clifford (*West Riding*)
Homden, Kenneth James Arthur (*London*)
Honiball, Alan Edward (*Manchester*)
Hopper, Derek Edgar (*Midlands*)
Hossack, James (*Scottish*)
Howard, Eric (*Manchester*)
Howells, Barry John (*Hull*)
Howes, Edward John (*London*)
Hughes, Gilbert William (*Manchester*)
Humphrey, Thomas Lawson Myles (*Scottish*)
Jangbahadur, Shyam Sharan (*General Overseas—Iran*)
Johnsen, Svend (*General Overseas—Denmark*)
Johnstone, James William (*Manchester*)
Jones, Derek Frederick Arthur (*Thames Valley*)
Jones, Geoffrey Peter (*Wellington*)
Judah, Jack Everard (*Hull*)
Kelly, Peter Graeme (*General Overseas—Australia*)
Kenna, Frank William (*Manchester*)
Kerr, Michael Anthony (*Manchester*)
Khan, John Mohammed (*London*)
Khidher, Abdul Monum (*General Overseas—Iraq*)
King, Charles William Henry (*Midlands*)
King, Raymond John (*Midlands*)
Kirakoz, Yousif Diran (*Manchester*)
Kirlew, Charles Wesley (*General Overseas—Jamaica*)
Kitchen, John Robert (*Midlands—Trent Valley Branch*)
Knight, Richard Charles (*London*)
Laker, Bernard George (*London*)
Lakshmanan, P. R. (*General Overseas—USA*)
Lander, Wilfred Terence (*West Riding*)
Lang, Robert (*Scottish*)
Langford, Henry (*London*)
Langley, Robert (*Scottish*)
Lawton, Cyril Victor (*Midlands*)
Lewis, John David (*Thames Valley*)
Lipscombe, Charles George (*Auckland*)
Low, Charles (*Transvaal*)
Macdonald, Alan (*Auckland*)
Macdonald, Arthur Gillings (*Newcastle*)
Mandelson, Jack (*Scottish*)
Maple, Donald Peter (*London*)
Marsden, Chris Eyre (*Manchester*)

Optional Professional Grade Successful candidates—*cont'd*

Martin, Christian Pierre (*General Overseas—France*)
Maynard, Albert William David (*Overseas*)
McCapra, Ronald (*Auckland*)
McDonald, Kenneth Roy (*Natal*)
McDonnell, Christopher Robin Stack (*West Riding*)
McKay, Alan Gordon (*London*)
McKean, James Newlands (*Wellington*)
McMillan, James (*Manchester*)
McQuirk, Peter John (*London*)
Mepham, Brian Edwin (*London*)
Mikucki, Wiktor (*London*)
Mills, Thomas Nelson (*Natal*)
Mitchell, Seward John (*Midlands*)
Moore, Frank Roden (*West Riding*)
Moore, James (*Manchester*)
Moore, Ronald Henry (*West Riding*)
Moore, William Alexander (*Auckland*)
Moreham, Frank Joseph (*Newcastle*)
Morpeth, Frederick Johnson (*Manchester*)
Morris, David (*London*)
Munro, Hugh Anderson (*Scottish*)
Murray, David John (*Manchester*)
Murray, Robert Frederick (*London*)
Myers, Gordon (*Transvaal*)
Naess, Erik (*General Overseas—Norway*)
Ness, Robert Alexander (*Auckland*)
Nisbet, Peter Samuel (*Scottish—Eastern Branch*)
Nolan, Michael Melvyn (*Irish*)
Norton, Douglas Kent (*Midlands*)
Oakley, Ernest (*Newcastle*)
O'Connor, Eugene Daniel (*Manchester*)
Oldring, Peter Kenneth Thomas (*London*)
Orpwood, John Leonard (*London*)
Oswitch, Stanley (*General Overseas—Israel*)
Pace, Graham (*Midlands*)
Parry, Martin Gerald (*London*)
Patrick, Alan Clive (*Irish*)
Pemberton, Joseph James (*London*)
Perry, Leonard C. (*Bristol*)
Pessall, Robert George (*Midlands*)
Piper, Norman William (*Manchester*)
Pobjoy, Reginald Claude (*General Overseas—Zambia*)
Poborca, Stefan (*Midlands*)
Proudley, Philip Miles (*London*)
Quorn, Peter James (*Cape*)
Rackham, John Michael (*Newcastle*)
Rampley, Dennis Neil (*London*)
Redman, Frank Benson (*Manchester*)
Reeve, Frank Nicholson (*Transvaal*)
Robinson, Arthur Graham (*Manchester*)
Robinson, Francis Derrik (*Hull*)
Rothwell, Gerald William (*London*)
Rout, Peter George (*West Riding*)
Routley, Alan Francis (*London*)
Sharp, Peter Frank (*Auckland*)
Sharpe, David (*London*)
Sheikh, Saeed (*General Overseas—Pakistan*)
Shoham, Joseph (*General Overseas—Israel*)
Silsby, Denys John (*Midlands*)
Silverwood, David (*Manchester*)
Smith, David Dorman (*Scottish*)
Smith, Harry Bertram (*London*)
Soman, Chettiparambil (*General Overseas—Spain*)
Sowerby, Alan Hope (*Auckland*)
Spargo, Robert (*Auckland*)
Speding, George (*London*)
Springett, Robert Arthur Edward (*London*)
Sreeves, John Ernest (*Midlands*)
Staples, Peter Graham (*London*)
Stephenson, Robert Perry (*Auckland*)
Stewart, Donald (*Manchester*)
Stone, Francis Edward (*Midlands*)
Stone, James Bryan (*London*)
Stott, Raymond (*Manchester*)
Stretton, Elizabeth (*Manchester*)
Stubbings, Alec Walter George (*London*)
Surinphong, Julian Suriya (*General Overseas—Thailand*)
Sutton, Peter Michael (*London*)
Talwalkar, Vinayak Sakharam (*London*)
Tasker, Leonard (*General Overseas—Iran*)
Taylor, Terence (*Manchester*)
Thomas, Anthony (*General Overseas—Brazil*)
Thoms, Hugh Sydney (*Manchester*)
Tillyer, Richard Brian (*London*)
Topping, George David (*London*)
Trevitt, Edwin William (*London*)
Triggs, Francis Cyril (*London*)
Troparevsky, Alejandro (*General Overseas—Argentina*)
Tye, Terence Thomas (*Thames Valley*)
Unni, Madhavan T. N. (*General Overseas—Malaysia*)
Venus, Norman (*Transvaal*)
Walker, Peter (*Thames Valley*)
Weineck, Terrence Graham (*Natal*)
Westbrook, Ernest Louis Edward (*London*)
Whalley, James (*Irish*)
Whatling, Allan (*Manchester*)
Wheatley, Kenneth Valentine (*Irish*)
Whetstone, Peter John (*London*)
White, Robert Arthur (*Wellington*)
Whiteside, Alexander Edward (*Ontario*)
Williams, Adrian Arthur Owen (*London*)
Williams, Cyril (*Manchester*)
Wood, George (*London*)
Woof, John Clifford (*London*)
Wooll, Frederick James (*London*)
Wu, Andrew Chi Kit (*General Overseas—Hong Kong*)
Zissell, Martin John (*London*)

Licentiates

Canterford, Barry Albert (*London*)
Chambers, Anthony (*London*)
Churchman, Anthony Edward (*London*)
Downham, Stephen Airey (*Manchester*)
Elliott, Peter (*London*)
Fernandes, Larry Raphael Francis Joseph (*London*)
Hemmens, Anthony John (*Bristol*)
Lodge, David William (*London*)
Moss, Noel Sydney (*London*)
Ohene-Kwadade, Kofi (*General Overseas—Ghana*)
Rogers, Michael Ambrose (*General Overseas—Trinidad*)
Sawyerr, Olatunji Pekun (*General Overseas—Nigeria*)
Schierbaum, James Helmut (*Midlands*)

* * *

News of Members

Mr D. K. Naylor, an Ordinary Member attached to the Manchester Section, has been promoted to Director of European Sales Administration for Cabot Carbon Ltd, and took up his duties at Neuilly, France in the autumn. Mr Naylor was formerly Field Sales Manager for the company.

Professor G. D. Parfitt, an Ordinary Member attached to the Newcastle Section and a Fellow in the Professional Grade, has recently been appointed head of Research and Development with Tioxide International Ltd.

Mr E. B. Cowie, an Ordinary Member attached to the General Overseas Section, has been appointed Regional Technical Manager of Robbialac Paints Kenya Ltd, a member of the Berger Group, in which capacity he is responsible for the application of all available technical resources from the Berger Group and elsewhere to the surface coatings market in East Africa.

Mr Cowie was Technical Manager of the Robbialac Paints Company in Dar es Salaam, Tanzania for a year before moving to Kenya as technical advisor on industrial marine and vehicle refinishing paints.

Mr R. N. Faulkner, an Ordinary Member attached to the London Section, was earlier this year appointed Deputy Head of the Paint Research Association's Chemistry Division. He joined the PRA in September 1948 and his work included studies in thermal and oxidative polymerisation of drying oils, alkyds, metallo-organic compounds, photopolymerisation, and sucrochemistry.

Dr S. H. Bell, OBE, was presented with his scroll of Honorary Membership at the Council Reunion Dinner in October. (See page 462.)

Dr H. R. Hamburg, an Ordinary Member attached to the London Section and the Association's Honorary Treasurer, retired at the end of October after 21 years as Chief Chemist with Atlas Products and Services Ltd. Dr Hamburg will continue to provide his many years' experience in the surface coatings industry, practising now as an independent consultant.

Report of Council Meeting

A meeting of Council took place at the Great Northern Hotel, London N1 on 13 October 1976 with the President, Mr A. T. S. Rudram, in the chair. There were 26 members of Council present.

It was noted that during the summer recess the addition of a Scottish thistle in gold and semi-precious stones had been made to the Presidential insignia, being the gift of the company employing the late Jimmy Miller (Chairman of the Scottish Section 1968-1970) in commemoration of his services to the Association (see page 191 of the May issue of the *Journal*). The formal presentation of the addition to the insignia would be made at the Scottish Section's Dinner Dance in January 1977.

Since the last Council meeting, Mr D. A. Bayliss had been elected Vice-Chairman of the London Section and its representative on Council and notification had been received that Mr M. J. Cochrane had been appointed representative on Council for the West Riding Section.

It was reported that Dr J. Toole did not wish to continue his representation of the Association on the Society of Dyers & Colourists Terms and Definitions Committee and the Council nominated Mr J. T. Tooke-Kirby as his replacement.

The President reported that as a result of the ballot conducted since the last Council meeting, Mr Angus Maclean (the Immediate Past Chairman of the Scottish Section and currently a Vice-President) would be the Council's appointment as President Designate for the session 1976-77 and that this would be reported to the adjourned AGM, which would take place later that day.

Details of the programme for the 1977 Conference, including the technical sessions, registration fees and social activities were reported to Council and these details were given in the November issue of the *Journal*: brochures and registration forms will be circulated to Members at the beginning of 1977.

Reports were submitted to Council on the Reunion Dinner, which would take place that evening, and of the preliminary arrangements for the 60th Anniversary celebrations, which would take place on 11 and 12 May 1978 (see page 349 of the September issue and page 386 of the October issue of the *Journal*).

The Honorary Treasurer reported on the half-yearly accounts which had been considered by the Finance Committee and the estimates for the second half of the year.

Discussion took place on means whereby a greater number of applicants for the Jordan Award could be encouraged and it was felt that those in the Licentiate Grade and tutors at colleges preparing candidates for the Licentiateship should be reminded of the provisions of the Award, details of which appeared on page 386 of the October issue of the *Journal.*

The Honorary Treasurer reported that the number of removals from the register for non-payment of subscriptions had been slightly less than in 1975, and that applications from organisations in 14 countries had been received for the 1977 Exhibition.

The Honorary Editor reported that he had already received papers from the South African Division's Convention, which had taken place on 8 and 9 October 1976, and that he had accepted some of these for publication in the *Journal.* Council were particularly pleased to see that the Ontario Section had sent in details of meetings sufficiently in advance for them to be included in the Forthcoming Events feature of the *Journal.* It was reported that there was a steady sale of the bound copies of the book "Ultraviolet Polymerisation" and that the 4th edition of the "Introduction of Paint Technology" had just been received.

The proposed dates for various Section symposia were noted by Council; details of these when finalised would be published in the *Journal.*

A meeting of the Professional Grade Committee would be taking place later on the same day and it was noted that further colleges were now prepared to help students in the preparation of dissertations for the Licentiate Grade.

The President reported on his visit to the Convention for the Federation of Scandinavian Paint and Varnish Technologists at Helsinki and on the Liaison Committee which had been held at that time. Full consideration was given to reports from the various Sections and the Chairmen or Section Representatives commented on various aspects of their activities.

There being no other business, the President thanked members for their attendance and declared the meeting closed at 3.30 pm.

At 4.00 pm the adjourned AGM of the Association was held and a report of this appeared in the November issue of the *Journal* on page 418.

Report of 1976 Council Reunion Dinner

A Reunion Dinner of past and present members of Council was held on Wednesday 13 October at the Piccadilly Hotel, London W1. There were 38 members present, including four Past-Presidents. The Dinner followed a Council meeting held earlier in the afternoon.

After the loyal toast, the President, Mr A. T. S. Rudram, gave the Address of Welcome stating that on this occasion he was particularly pleased to welcome two lady members of Council, Miss P. Magee, Chairman of the Irish Section and Mrs E. Harper, Representative of the Bristol Section.

Mr Rudram then briefly reviewed the year since the last Reunion Dinner in October 1975. The twenty-eighth Technical Exhibition of the Association had been held at Alexandra Palace from 23 to 26 March. Visitors from 37 overseas countries had signed the visitors' book at the Association's Information Centre. Exhibitors had been very pleased with the response and a number had written specially to thank the Association, so that the event had to be counted a success. A full report of the Exhibition had been published in the May issue of the *Journal.*

As part of its 50th anniversary celebrations, the Manchester Section of the Association had held a symposium in April and some of the papers from this were to be published in the *Journal.*

One tragic event had been the sudden death of Mr A. A. Duell less than one week before he was due to be installed as President Designate at the 1976 Annual General Meeting.

At the adjourned AGM held earlier in the day it had been reported that Mr A. McLean was appointed by the Council to be President Designate; this announcement was received with acclamation.

During the year, Mr Rudram had been pleased to visit the FSCT Paint Convention in Los Angeles, the FATIPEC Convention at Cannes and the SLF Conference in Helsinki. He had also attended the 50th anniversary dinner at the Paint Research Association, when he had presented a congratulatory scroll from the Association to the PRA.

Another notable anniversary was that of the Director & Secretary, Mr R. H. Hamblin, because 1976 marked his 25th year with the Association. Mr Rudram expressed the gratitude of all Members for the excellent work Mr Hamblin had done throughout this time, and these sentiments were very warmly applauded.

Earlier in the year, Council had conferred Honorary Membership—the highest award of the Association—upon Dr S. H. Bell, OBE, President 1965-67. Dr Bell had not been able to be present at the AGM earlier in the year and Mr Rudram was, therefore, to present the scroll on this occasion; he was particularly pleased to do so because they had both worked together for a number of years at the Paint Research Station. Mr Rudram added that in his view there was none more deserving of this award. Dr Bell thanked Mr Rudram for his scroll and explained how much it meant to him to receive it. There were brief speeches also from the senior Past-President present, Dr H. W. Keenan, and the Immediate Past-President, Mr L. H. Silver.

Dr Bell with his Hon. Membership scroll

After the Dinner, the assembled company were able to retire to a private room to meet old friends and renew acquaintances.

Forthcoming Events

Details are given of Association meetings in the United Kingdom and Ireland up to the end of the month following publication and in other parts of the world up to the end of the second month following publication.

December

Wednesday 1 December

Scottish Section—Eastern Branch: "Put a sparkle into your industrial finishes" by Dr D. R. King, Silberline Ltd, to be held at the Carlton Hotel, North Bridge, Edinburgh, commencing at 7.30 pm.

Thursday 2 December

Newcastle Section: "Ion beam etching for the study of paint film structure" by Mr J. L. Prosser, Paint Research Association. To be held at the Royal Turks Head Hotel, Grey Street, Newcastle upon Tyne, at 6.30 pm.

Thames Valley Section: "Colour and gold decoration on pottery and glass" by Mr O. N. Collier, Johnson Matthey Ltd (Ladies invited). To be held at the Beaconsfield Crest Motel (White Hart), Aylesbury End, Beaconsfield, Bucks, at 6.30 for 7.00 pm.

Monday 6 December

Hull Section: "High solid coating systems" by Dr D. Faulkner, Rohm & Haas (UK) Ltd. To be held at the "George Hotel", Land of Green Ginger, Hull, commencing at 6.30 pm.

Manchester Section: "Decoration of ceramics" by Mr K. Hopkins, Ben Capper Ltd. To be held at The Woodcourt Hotel, Sale, Cheshire, commencing at 6.30 pm.

Thursday 9 December

Scottish Section: "Laughter in the Law" by Mr A. Carswell, BL. To be held at the Beacon's Hotel, 7 Park Terrace, Glasgow G3, commencing at 6.00 pm.

Friday 10 December

Irish Section: "UV curing-principles and practice" by Dr B. E. Hulme, BTP Tioxide Ltd. To be held at the Clarence Hotel, Dublin, commencing at 8.00 pm.

Tuesday 14 December

West Riding Section: Chairman's Lecture, "Home-made wines, and the effect of alcohol on the body system". Ladies' Evening to be held at the Mansion House Hotel, Roundhay Park, Leeds, commencing at 7.30 pm.

Wednesday 15 December

Ontario Section: Informal Ladies' Evening with a talk, "Cosmetics" by Mrs H. Hamley, Yardley of London (Canada) Ltd. To be held at the Skyline Hotel, Toronto.

January

Thursday 6 January

Newcastle Section: "New coatings based on aromatic acids" by a speaker from Amoco Chemicals, to be held at the Royal Turks Head Hotel, Grey Street, Newcastle upon Tyne commencing at 6.30 p.m.

Monday 10 January

Hull Section: "The optimum use of organic pigments" by Mr D. M. Varley, CIBA-GEIGY (UK) Ltd. To be held at the George Hotel, Land of Green Ginger, Hull, commencing at 6.30 p.m.

Tuesday 11 January

West Riding Section: "Extenders in emulsion paints" by Mr D. J. Huxtable, English Clays Lovering Pochin & Co Ltd, to be held at the Griffin Hotel, Bear Lane, Leeds, commencing at 7.30 p.m.

Wednesday 12 January

Manchester Section: "Micro-emulsions" by Mr G. H. Falkin, Perstorp AB, to be held at the Manchester Literary and Philosophical Society, George Street, Manchester, commencing at 4.30 p.m.

Thursday 13 January

London Section: "Micro-emulsions" by Mr K. H. Falklin, Perstorp AB, Sweden. Evening meetings at the Princess Alice, Romford Road, London E7, commencing at 7.00 p.m.

Midlands Section—Trent Valley Branch: "Bulk handling of powders and pigments' by Dr N. Harnby, University of Bradford, to be held at the Crest Hotel, Pastures Hill, Littleover, Derby, commencing at 7.00 p.m.

Friday 14 January

Manchester Section: "The use of microvoids as pigments" by Mr J. Clark, BTP Tioxide Ltd, to be held at the Manchester Literary and Philosophical Society, George Street, Manchester, commencing at 6.30 p.m.

Scottish Section: Annual Dinner Dance at the Albany Hotel, Glasgow.

Wednesday 19 January

Ontario Section: "De-inking of paper" by Dr O. Sepal of Reed Ltd. To be held at the Skyline Hotel, Toronto.

Thursday 20 January

Scottish Section: "Pigment dispersions" by Mr R. S. Monk, Kenroy Dispersions Ltd, to be held at the Beacon's Hotel-7 Park Terrace, Glasgow G3, commencing at 6.00 p.m.

Friday 21 January

Irish Section: Ladies' Evening with "Antiques" lecture by Mrs A. Dalton, RIDpl, AIDP, Andrian Interiors, to be held at the Clarence Hotel, Dublin commencing at 8.00 p.m.

Midlands Section: Dinner Lecture: "High solids systems" by Dr Uerdingen, Bayer AG, to be held at Birmingham Chamber of Commerce and Industry, Harbourne Road, Edgbaston B16, at 6.30 for 7.00 p.m.

Thursday 27 January

Thames Valley: "Pigments for the printing industry" by Mr A. J. Green, Horace Cory & Co. Ltd, to be held at the Beaconsfield Crest Motel (White Hart), Aylesbury End, Beaconsfield, Bucks, at 6.30 for 7.00 p.m.

Friday 28 January

Bristol Section: "Smoke emission from polymer and paint films" by Mr K. A. Safe, Vinyl Products Ltd, to be held at the Royal Hotel, Bristol, commencing at 7.15 p.m.

Friday 28 January

Ontario Section: 1st Annual Dinner Dance of the Section, to be held at "The Old Mill", 21 Old Mill Road, Toronto at 6.00 for 7.00 pm.

Sixtieth Anniversary celebrations

In May 1978 the Association will celebrate the sixtieth anniversary of its foundation and it is felt that Members (and others who wish to take part in the celebrations) would like to have as much notice as possible of the dates. Following the pattern successfully used at the Association's Fiftieth Anniversary in 1968, the main events will be on two consecutive days. On the evening of Thursday 11 May it is planned to hold at a City Livery Hall a Commemorative Lecture, followed by a Dinner to which Past Presidents, Past Honorary Officers of the Association, Honorary Members and the surviving Founder Member will be invited as guests. On Friday 12 May the Association's Dinner and Dance will be held at the Savoy Hotel, London WC2 and Presidents of other societies, together with their ladies, will be invited to attend. Full details will be published in the *Journal* from time to time and forms of application for the celebrations will be sent to all Members (and others who have made application to the Director & Secretary) at the beginning of 1978.

New OCCA publications

In July this year the Association published "Ultraviolet polymerisation and the surface coatings industries", a volume comprising papers presented at a symposium of the Newcastle Section of the Association in 1975 and subsequently published in the *Journal*. The twelve papers form a comprehensive 'state of the art' review of this new and exciting field, with particular reference to the surface coatings industries.

The Association's extremely popular book "Introduction to Paint Technology", which forms an excellent introduction to the whole field of surface coatings and related technologies and which has already sold over 16 000 copies, has now been completely revised and updated in a new fourth edition. An important addition in this latest printing is a glossary of most of the chemical and technical terms used in the text: this has been included for the benefit of those readers who require a less superficial knowledge of paint formulation. A brief account of the history and development of chemistry and chemical symbols, formulae and equations is included as an introduction to the glossary itself.

Copies of the new fourth edition of "Introduction to Paint Technology" are now available from the Association's offices. Further information is given in advertisement on the back inside cover of this issue.

OCCA Conference 1977

The next Biennial Conference of the Association will be held at Eastbourne, England in June 1977 with the theme "Conservation of energy, materials and other resources in the surface coatings industry" and full details, including the titles and summaries of papers and authors' biographies and photographs, appeared in the November issue of the *Journal* (pages 419–425).

Registration forms for the Conference will soon be despatched to Members of the Association and all organisations at home and abroad which subscribe to the *Journal*. Non-members wishing to receive application forms should write to the Director & Secretary at the address on the Contents page of this issue.

The papers by Mr J. A. Seiner "Microvoid coatings—material and energy savers?" and Mr M. A. Glaser "Conserving human resources through innovation" have now been designated as papers to be presented on behalf of the Federation of Societies for Coatings Technology.

Jordan Award

This award was instituted by the late Mrs M. R. Jordan in memory of her husband Dr L. A. Jordan, who was President of the Association 1947-49 and an Honorary Member, and who died in December 1964. The Committee invites applications for the fourth award of £100.

The rules of the Award are:

1. The Award will be made for the best contribution to the science or technology of surface coating by a Member of any nationality working in either the academic or industrial field who is under the age of 35 at the date of application.

2. The final date for submission of applications will on this occasion be 31 December 1976 and it is hoped to present the award at the 1977 Association Conference.

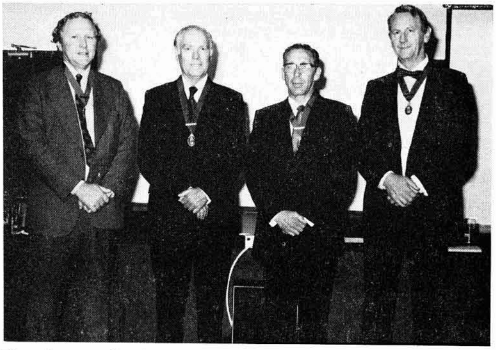
3. The selection of the recipient of the Award will be made by a Committee under the chairmanship of the Association's Hon. Research and Development Officer.

4. There will be two methods of application. First, by the submission of a paper describing original work by the candidate which is offered for publication in the *Journal* or has been so published during application. The alternative method will be by recommendation by a superior for work which for reasons of commercial secrecy cannot be published; in this case the candidate will be expected to submit a dissertation on a topic relating to his work and demonstrating his superior knowledge fo the principles thereof. The Award is for individual merit and clear evidence of the candidate's own contribution will be required if a paper is offered under joint authorship.

5. Applications should be addressed to the Director & Secretary at the Association's offices.

South African Division

South African Symposium 1976



The photograph above was taken on the occasion of the 1976 Symposium of the South African Division and shows, from left to right: Mr D. J. House, Chairman of the Natal Section, Mr D. Piennaar, Vice-President of the South African Division, Mr T. Wright, Chairman of the Transvaal Section and Mr G. Warman, Chairman of the Cape Section. The Symposium was a most successful one, with a record attendance of 170 delegates. A number of the papers presented will be published in due course in the *Journal*.

Register of Members

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

Ordinary Members

Adegoke, John Akinyele, BSc, Berger Paints Nigeria Ltd, PMB 1052, Ikeja, Lagos State, Nigeria. *(General Overseas)*

Aderibigbe, Rashid Olaniyi, International Paints (WA) Ltd, PO Box 67, Ikeja, Nigeria. *(General Overseas)*

Agmen-smith, Piers Toby, BSc, Mintech, Private Bag, Papakura, New Zealand. *(Auckland)*

Ajayi-Obe, Oyebode Abayomi, BSc, Berger Paints Nigeria Ltd, PMB 1052, Ikeja, Lagos State, Nigeria *(General Overseas)*

Ajiboye, Olusegun Adisa, BSc, Berger Paints Nigeria Ltd, PMB 1052, Ikeja, Lagos State, Nigeria *(General Overseas)*

Amusa, Moshood Akanni, Berger Paints Nigeria Ltd, PMB 1052, Ikeja, Lagos State, Nigeria. *(General Overseas)*

Apatira, Nojem Kola, Berger Paints Nigeria Ltd, PMB 1052, Ikeja, Lagos State, Nigeria. *(General Overseas)*

Bettison, Robert Ames, Berger Paints NZ Ltd, PO Box 14346, Panmure, Auckland, New Zealand. *(Auckland)*

Cochrane, Michael Charles, BSc, AC Hatrick (NZ) Ltd, PO Box 2359, Auckland, New Zealand. *(Auckland)*

Demmer, Christopher George, PhD, BSc, Ciba-Geigy Plastics & Additives Co, Plastics Division, Duxford, Cambridge CB2 4QA. *(London)*

Famuyiwa, Olusegun Israel, Berger Paints Nigeria Ltd, PMB 1052, Ikeja, Lagos State, Nigeria. *(General Overseas)*

Hassan, Mustafa Ayinla, BSc, Berger Paints Nigeria Ltd, PMB 1052, Ikeja, Lagos State, Nigeria. *(General Overseas)*

Hiejnis, Adriaan Alexander Jan, PO Box 35, Eppindust 7475 Cape Town, South Africa. *(Cape)*

Ikeri, Promise, Berger Paints Nigeria Ltd, PMB 1052, Ikeja, Lagos State, Nigeria. *(General Overseas)*

Iyinnbo, Omosuyi Omogbeyinwa, c/o Mr J. O. Olatunji, 199 Ijesha Road, Ijesha-Tedo, S/Lane, Nigeria. *(General Overseas)*

Karimjee, Shabbir, PO Box 11910, Nairobi, Kenya. *(General Overseas)*

Kidger, Alan, 11 Uit 'n Tuis, Redruth Street, Alberton, Transvaal, South Africa. *(Transvaal)*

Macauley, Akinola, International Paints (WA) Ltd, PO Box 67, Ikeja, Nigeria. *(General Overseas)*

Nwogu, Sebastian Ukiwe, PhD, International Paints (WA) Ltd, PO Box 67, Ikeja, Nigeria. *(General Overseas)*

Parrott, Ivan, 61 The Avenue, Surbiton, Surrey. *(London)*

Snow, Errol Rutherford, BSc, Hoechst SA (Pty) Ltd, PO Box 1785, Port Elizabeth, South Africa. *(Cape)*

Thompson, Adebowale, BSc, Berger Paints Nigeria Ltd, PMB 1052, Ikeja, Nigeria. *(General Overseas)*

Associate Member

Sangster, Eric Garden, 78 Berrylands, Surbiton, Surrey KT5 8JY. *(London)*

Registered Students

Omoluwabi, Pius Ojo, Berger Paints Nigeria Ltd, PMB 1052, Ikeja, Lagos State, Nigeria. *(General Overseas)*

Sanu, Isaiah Akande Adekunte, Berger Paints Nigeria Ltd, PMB 1052, Ikeja, Lagos State, Nigeria. *(General Overseas)*

Index to Volume 59—1976

Key:
(C)—Correspondence
(D)—Discussion
(E)—Editorial and Comment
(N)—News
(R)—Reviews
(S)—Section Proceedings
(SC)—Short Communications
(SR)—Student Review
(T)—Transactions and Communications

Authors

Keywords

Reference list of papers

The number given opposite each keyword in the index below is the key number allocated to the paper to which the keyword refers as shown in the reference list above. It is not a page number: this can be obtained from the reference list.

Index

Subjects

Association Notices

Applications for membership

It is felt that the Members would like to be reminded of the standard of competence for the election of candidates to Ordinary Membership of the Association, as laid down by the Council, when they are sponsoring candidates for election. The qualifications for the granting of Ordinary Membership at the present time are:

1. A degree in a scientific subject or any generally accepted equivalent qualification; or an approved technological qualification in a subject covered by the Association.

2. Or where there is adequate evidence of the technical competence of the candidate other than the obtaining of the qualifications mentioned above, the qualifying period of practice in the industries covered by the Association shall be normally not less than seven years.

Associate Membership is open to those employed in the industries who do not qualify for Ordinary Membership.

The Council has further resolved that Student Registration should be open without restriction to the age of 21 years and may be extended to 25 years of age, where candidates are following courses of technical study to the satisfaction of their employers or technical college lectures.

Retired members

Council also wishes it to be known widely that in 1962 it introduced a reduced Membership subscription rate for Members who have retired from business. This applies to a Member who has completed 20 years as an Ordinary or Associate Member and has retired from business, and normally has reached the age of 60; he may apply for his name to be retained on the Register of Members at an annual subscription rate of £1.50 and he will retain the same rights of Membership as the class of Membership to which he was attached upon retirement.

Members wishing to avail themselves of this concession should write, in confidence, to the Director & Secretary at the address shown on the front cover of this *Journal*, giving the relevant information under the four headings: (*a*) name, address and Section, (*b*) date of election, (*c*) date of retirement, (*d*) age.

Change of address

Members changing their address are urged to inform the Association's office immediately so as to avoid any misdirection of mail. This is particularly important as far as the *Journal* is concerned.

Will Members please note that since Membership of the Association is entirely on an individual basis, if notification of the change of an address for a company is sent to the Association's office this will not necessarily guarantee the change of address in the Association's records of the Member concerned unless the name of the Member is stated on the communication.

Binding of Journal

Members will be pleased to know that J. S. Wilson & Son, 14a Union Road, Cambridge CB2 1HE, will undertake the binding of back volumes of the Association's *Journal* sent in by individual Members at a cost of £4.60 (including postage and packing) per volume.

Members wishing to avail themselves of this facility should send the parts, securely wrapped, direct to J. S. Wilson & Son, enclosing a remittance of £4.60 (including postage and packing) per volume, and ensuring that notes bearing their names and addresses are enclosed with the parcels. It is particularly important that packets are sufficiently wrapped to negate the possibility of damage in the post.

1977 Members' subscriptions

Members are reminded that 1977 Membership subscriptions to the Association are payable on 1 January 1977. Forms were despatched to all Members in October or November, depending upon address.

The Commissioners of Inland Revenue have approved of the Association for the purpose of the Income and Corporation Taxes Act Section 192, so that a Member subject to United Kingdom income tax is entitled to a deduction from the amount of his emoluments assessable to income tax under Schedule E for the whole of the annual subscription to the Association, provided the subscription is defrayed out of the emoluments of his office or employment and that the interests covered by the objects of the Association are relevant to such office or employment.

Members resident in the United Kingdom are reminded that if there is any change in the standard rate of Value Added Tax announced before they send in their 1977 subscription, the VAT payable on membership subscriptions is the amount which applies on the date of payment.

1977 library subscriptions

The *Journal* subscription rate to non-Members, including libraries, for 1977 will be £20.00 ($50) post free by surface mail, home and abroad. Individual copies can be purchased for £2.00. Remittance should be sent with order to the Association's offices.

Some important dates for your diary

Tuesday 22 to Friday 25 March 1977—OCCA-29 Technical Exhibition, Alexandra Palace, London.

Thursday 16 to Sunday 19 June 1977—Association Biennial Conference, Eastbourne, Sussex. "Conservation of energy, materials and other resources in the surface coatings industry".

Thursday 11 and Friday 12 May 1978—Sixtieth Anniversary of the Association. *Programme of events to be announced.*

AT YOUR SERVICE to develop finer, more durable products

The fast, economical weather tests of

SUB-TROPICAL TESTING SERVICE, INC.

established 1929

Sub-Tropical Testing Service is known and utilised world wide

Our 48th year

Send for free
Sub-Tropical colour
brochure

Sub-Tropical Testing gives fastest Natural Weather tests available for ★ paints ★ chemical coatings ★ plastics ★ textiles ★ fabrics ★ related products ★

(List of representative clients given upon request)

Wir waren die ersten, welche einen Prüfdienst dieser Art für Lacke, Kunststoffe, chemische Beschichtungen, Stoffe und Gewebe aller Art, Farbstoffe und verwandte Erzeugnisse in den U.S. möglich machten.

Mr. C. Hubbard Davis, President, Sub-Tropical Testing Service, Inc.
P. O. Box 560876, 8290 S.W. 120th Street, Miami, Florida, U.S.A. 33156

Phones: (305) 233-5341
Cable: SUBTROPIK, Miami

J.O.C.C.A.

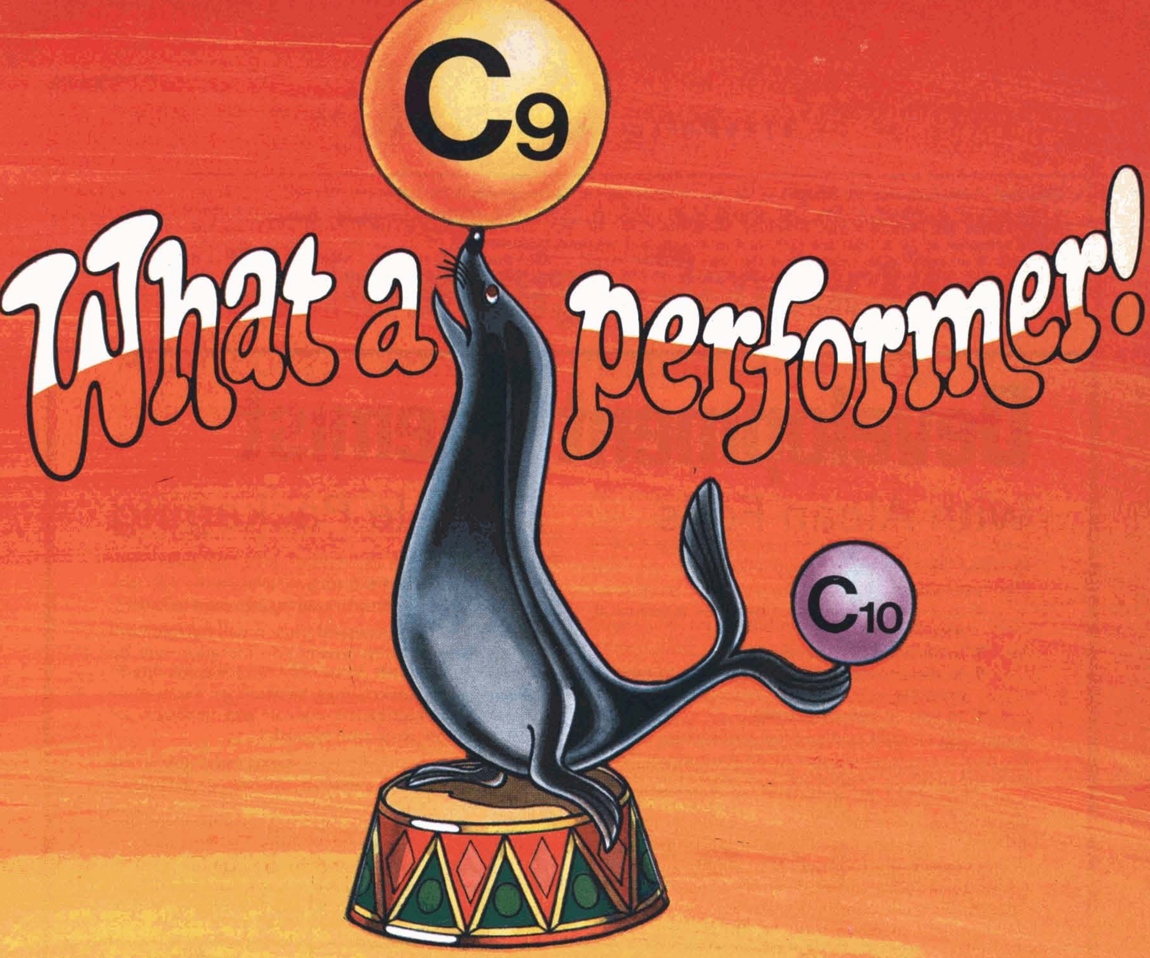
is our advertisement

Similar Publications, Weekly, Monthly or Quarterly are our speciality. Reports and accounts, internal stationery and advertising literature in colour are all produced speedily and efficiently at our North London plant which has over one hundred experienced staff working in two shifts at your service.

Richard Madley Ltd

P.O. Box 151, Elthorne Road, London N19 4AH

Tel 01-263 0256



'Aromasol' H - the balanced C_9 solvent with a vital C_{10} tail

What counts with a product is what it actually does, and that's where ICI's 'Aromasol' H scores every way.

It's the solvent that makes the paint you manufacture perform so well when it's being applied. That's because it's the C_9 aromatic hydrocarbon solvent that evaporates out at a precisely calculated rate... thanks to its C_{10} tail which gives the paint a longer wet edge and allows just the right amount of after-flow to eliminate brush and spray marks.

A separate advantage

You've also got a very useful solvent in 'Aromasol' H as far as the current fire regulations are concerned. Its own flashpoint is 117°F, well above the line. That means you can offer paints with a real advantage in handling and storage requirements.

For further information, contact at any time:
ICI Petrochemicals Division,
Wilton, Middlesbrough, Cleveland, TS6 8JE

ICI 'AROMASOL' H

CLASSIFIED ADVERTISEMENTS

Classified Advertisements are charged at the rate of £3.00 per cm. Advertisements for Situations Wanted are charged at 80p per line. A box number is charged at 50p. They should be sent to C. A. Tayler, BSc, Assistant Editor, Oil & Colour Chemists' Association, Priory House, 967 Harrow Road, Wembley, Middlesex HA0 2SF. JOCCA is published EVERY month and Classified Advertisements can be accepted up to at least the 12th, and in exceptional circumstances the 20th of the month preceding publication. Advertisers who wish to arrange for an extension of the copy deadline should contact the Assistant Editor, Mr C. A. Tayler, at the address given above (telephone 01-908 1086, telex 922670 OCCA Wembley).

SITUATIONS VACANT

Development Chemist

with Alcan Foils Flexible Packaging

IS THIS FOR YOU?
The opportunity

- ✳ to join a Company that believes in technical excellence
- ✳ to work on new developments
- ✳ to make a significant contribution to our progress
- ✳ to join an energetic team

Alcan Foils Limited at Wembley could be for you. We are part of the International Alcan Aluminium Group. Our speciality is producing and marketing flexible packaging materials to the Food, Dairy, Pharmaceutical and Tobacco Markets, using a range of printing, laminating and film extrusion processes.

Recent investments of over £1 million give us the ability to produce the most sophisticated products. The Development Chemist will play a key role in the development of new products and process innovations, by working on liquid inks, lacquers and adhesives. As part of the technical team the successful person will need to work on his/her own initiative.

We anticipate the successful person will be qualified to HNC level, or alternatively consideration will be given to those with ONC/City and Guilds qualifications in surface coatings technology. Experience with the manufacture or use of inks, lacquers or industrial paints would be essential.

Salary will be dependent on experience and likely contribution. Fringe benefits including assistance with removal expenses (where appropriate) are of a Big Company standard. If this sounds like the opportunity you have been waiting for, then write or ring for further details and an application form to **Tony Watts, Manpower Services Supt., Alcan Foils Ltd., First Way, Exhibition Grounds, Wembley, Middx. Tel: 01-902 6011.**

ALCAN
... everything from aluminium
ALCAN

OCCAA 1977 PACIFIC PAINT CONVENTION

The Oil and Colour Chemists' Association Australia will be organising its first international Paint Convention at Canberra 25—28 September 1977.

The lecture programme, under the heading "Technical & Management Efficiency in the coatings business" will have two concurrent themes—Paint Technology, and Management as it relates to paint manufacture.

The initial circular has been printed and copies are available from N.M. MacLeod, OCCA Australia, Pacific Paint Convention '77, P.O. Box 93 Punchbowl, 2196, Australia.

AT ANY TIME
DAY OR NIGHT

**TELEX
YOUR CLASSIFIED**

FOR

JOCCA

Telex 922670 (OCCA Wembley)

See above for details of rates for Classified Advertisements.

CLASSIFIED ADVERTISEMENTS

SITUATIONS VACANT

Ink Technologist–Production

Alcan Foils – Wembley – Printing/Laminating

DO YOU ENJOY:-

- ✳ the dynamism of production
- ✳ solving technical problems
- ✳ working on new developments

Alcan Foils at Wembley could be for you! We are a leading producer of flexible packaging materials for the food, dairy, pharmaceutical and tobacco industries using a variety of printing and laminating processes.

We have some of the most modern printing and laminating equipment in the country and require an Ink Technologist to take a vital role in the effective provision of inks, lacquers and adhesives. Working in the conversion department the successful candidate will provide an immediate technical service covering formulations, colour standards and problem solving, together with developing improvements. There will be considerable contact with suppliers.

We anticipate that candidates will hold HNC or ONC in surface coatings or related field, although people with extensive practical experience, particularly in the ink/lacquer industry, will also be considered. Age around 25/40.

Salary will be according to experience and likely contribution. Fringe benefits including removal expenses (where appropriate) are of a Big Company standard. If this seems like the chance for you to join a progressive company, then write or ring for further details and an application form to:- **Tony Watts, Manpower Services Supt., Alcan Foils Ltd., First Way, Exhibition Grounds, Wembley. Tel: 01-902 6011.**

ALCAN

. . . everything from aluminium

ALCAN

CANADA

MAJOR PRINTING INK MANUFACTURER

Requires:

LABORATORY MANAGER

To be responsible for quality control, technical service and product development

Apply in writing to:

GENERAL MANAGER
BORDEN CHEMICAL CANADA
1811 HYMUS BLVD.,
DORVAL, QUEBEC,
CANADA

Technical Manager

London **c. £7000**

A British subsidiary of a major US firm is growing fast. Our clients seek a Technical Manager with first class qualifications and experience in speciality paints and finishes for metal and plastics. As part of a young management team he/she will be responsible for introduction of new products, development and quality control. It will be an advantage to have commercial and international experience.

Telephone today or write briefly to:—

D. Bryan Andrews,
Kearney Management Consultants,
6 Arlington Street,
St. James's, London SW1A 1RE
Telephone No. 01-493 6423

SECOND-HAND PLANT AND EQUIPMENT

For sale

One ICI Rotothinner 5, measuring range 0-5 poise - - - - £150

One REL power operated scratch tester £140

Both as new. Box No. 432.

Paint Technology Manuals Part Seven:

Works Practice

available at **£3.00** each

Contents include:

Chapter 1—The factory. Siting and layout

Chapter 2—Raw materials. Storage and handling

Chapter 3—Varnish and media manufacture

Chapter 4—Paint manufacture

Chapter 5—Factory organisation and personnel

Chapter 6—Legal requirements and regulations

Chapter 7—Factory hazards and safety precautions

To keep the price of this book at its present low level, it is essential to reduce book keeping to a minimum. Copies of this book will only be supplied if remittance is sent with the order. Accredited Bookseller's discount: 25%

To: Oil and Colour Chemists' Association, Priory House, 967 Harrow Road, Wembley, Middlesex, England HA0 2SF.

Please send ...... copies of Paint Technology Manual, Part Seven, "Works Practice", @ £3.00 per copy, post free in UK. I enclose a cheque/P.O. for £......

Name ....

....

Address ....

....

....

....

NAN PAO RESINS CHEMICAL CO., LTD.

THE APPLICATION OF NAN PAO RESINS

ADHESIVES FOR INDUSTRY
For adhesion of assembled wood, architectural material, musical instrument, mosaic plywood, melamine plywood, cork, furniture, rigid plastic, soft plastic, rigid glue, polyrone, nylon cloth, chemical fibre, polyurethane foam, metal, iron, brass, bronze, aluminium, vehicle, vessel electrical machinery, grinding machine, tape recorder, etc.

ADHESIVES FOR INDUSTRIAL PACKING
For adhesion of wooden trunk, paper case, plastic case, paper product, and sack making, glaze paper, P.V.C. sheet, waving carton, aluminium box, container packing, metal foil, printed label, PVC to paper.

FOR ARCHITECTURAL WATER-PROOF
For water-proof of cement concrete roof, outside wall, storehouse wall, water-tower, asbestos tile, chemical plant, etc.

FOR PAINT MAKING INDUSTRY
Raw material for water, soluble paint, inner and out printing, glossing the water soluble paint, prevent metal from staining etc.

FOR CASTING MOLD AND ELECTRICAL BULB INDUSTRY
Sand casting mold, sand grinder, insulating board, oilless gear, core of melamine board, electric bulb, electric products etc.

FOR SHOE MAKING INDUSTRY
PVC shoes, leather shoes, cotton shoes, gentleman boots, chemical leather boots etc.

FOR LEATHER INDUSTRY
For dyeing of leather surface, treatment of leather grain side.

FOR RESIN TREATMENT OF TEXTILES
For treatment of cotton, man-made fibre, wool, nylon, synthetic fibre tetoron, rayon etc.

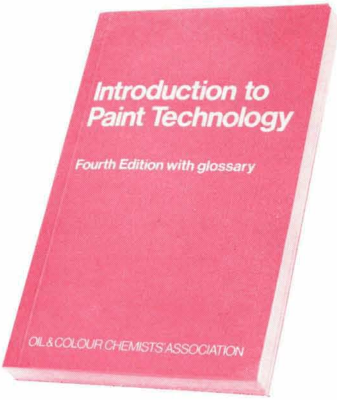
Please send your enquiry to:

南寶 NAN PAO

235-1, SEC. 3, CHUNG CHING N. RD.,
TAIPEI, TAIWAN, R.O.C. TEL: (02) 5618191-5
CABLE: "NANPAO" TAIPEI
TELEX: 23719 NANPAO

INDEX TO ADVERTISERS

INTRODUCTION TO PAINT TECHNOLOGY



New fourth edition now available

Contents include:

1. Origins and Development of Paint Technology

Science and empiricism. What is paint technology? Paint origins. Pigment, Vehicle, Paint. Synthetic Resins—early history. Film formers. Molecular structure and size. Polymerisation. Mechanical bonding. Thinners. Types of drying mechanism. Physic of paint technology. Paint formulation. Paint systems. Nomenclature.

2. Oils

Drying oils. Semi-drying oils. Non-drying oils. Chemical structure of fatty acids Drying rate. *Drying oils:* **Linseed oil. Stand oils. Tung oil. Soya bean oil.** *Semi-drying oils:* **Dehydrated castor oil. Tall oil. Tobacco seed oil. Safflower seed oil. Sunflower seed oil. Poppy seed oil.** *Non-drying oils:* **Castor oil. Coconut oil.**

3. Natural and Synthetic Resins

Natural resins: **Run gum. Damar resin. Rosin.** *Synthetic resins:* **Alkyd resins. Manufacture of alkyd vehicles. Phenolic resins. Vinyl resins. Vinyl polymers and copolymers. Solvent soluble vinyl resins. Vinyl chloride dispersions. Styrene containing resins. Polyester resins. Urea resins. Melamine resins. Epoxy resins. Epoxy/pitch media. Polyurethane resins. Acrylic resins. Silicone resins. Coumarone resins Petroleum resins. Chlorinated rubber. Non-aqueous dispersions.**

4. Resins as Media for Paints

Oleoresinous media: **Alkyd resins as media. Cellulose lacquers and media. Solvents for cellulose lacquers. Manufacture of lacquers. Other solvent-soluble, film-forming high polymers.** *Spirit varnishes. Solvent and driers:* **solvents, driers.** *Some uses of clear finishes:* **insulating varnishes, wood finishing by cellulose lacquer. Water-based paints for industrial use.**

5. Pigments and Extenders

Dispersion and wetting: **wetting, wetting agents.** *Inorganic Pigments:* **white pigments: titanium dioxide, antimony oxide, zinc oxide, lithopone, white lead, zinc phosphate. Extenders: barytes, blanc fixe, whiting, precipitated chalk, silica, china clay bentonite, slate powder, mica, asbestine, talc. Black pigments: carbon blacks, vegetable (lamp) black, bone and drop blacks. Metallic pigments: aluminium, bronze powders, zinc. Oxides of lead: red lead. Natural oxides of iron: red oxides, ochres, siennas, umbers, micaceous oxide of iron. Chemically prepared oxides of iron: yellow hydrated oxides, reds and browns, black oxide. Chrome pigments: lead chromes, zinc chromes, zinc tetroxychromate, stronium chromate. Blue pigments: prussian blue, ultramarine blue, Green pigments: chrome (Brunswick) green. Flooding and floating. Cadmium pigments. Nickel titanate.** *Organic pigments:* **classification of organic pigments: pigment dyestuffs, toners, lakes. Chemical classification: azo pigments, alkali blue or reflex blue, phthalocyanine pigments, phthalocyanine blues, phthalocyanine greens, vat colours, idanthrone blue, quinacridone pigments, dioxazine pigments.** *Luminescent pigments. Testing of pigments:* **staining power or tinting strength. Opacity or hiding power. Oil absorption Water-soluble matter. Lightfastness. Chemical constitution. Purity. Conditions of exposure, measurement of lightfastness.** *Pigment hazards:* **toxicity, dust.**

6. Decorative and Structural Paints

Types of decorative and structural paints. Sealers. Primers: **primers for wood, primers for alkaline and porous surfaces, primers for iron and steel, the mechanism of corrosion, protective mechanism of paint coatings, metal cleaning and pretreatment, blast primers, etch (or wash) primers, zinc-rich primers, zinc silicate primers, zinc phosphate primers, zinc chrome primers, red oxide/zinc chrome primers, red lead/linseed oil primers, calcium plumbate primers, primers for galvanised surfaces.** *Undercoats, fillers and stoppers:* **stoppers, fillers, undercoats.** *Finishes:* **alkyd-based finishes. 'Non-drip' or thixotropic finishes, semi-gloss and eggshell finishes, oleoresinous finishes, finishes for structural work, chlorinated rubber finishes, epoxy-resin finishes, epoxy ester finishes, vinyl resin finishes, masonry paints.** *Emulsion paints:* **nature of emulsions, preparation of polymer emulsions, homopolymers and copolymers, manufacture of emulsion paints, additives, properties and uses of vinyl emulsion paints, acrylic emulsions.**

7. Industrial Stoving and Cold-curing Finishes, including Marine Finishes

Industrial finishes. **Table of media used for various purposes, alkyds, alkyd/amino combinations, epoxy and epoxy ester resins, epoxy/pitch combinations epoxy/acrylamide acrylic resins, hydroxylated acrylic/amino resins, hydroxylated acrylic, isocyanate resins, thermoplastic acrylic resins, cellulose finishes, polyurethane finishes, vinyl resin finishes, plastisols and organosol finishes, chlorinated rubber finishes, polyester finishes, non-aqueous dispersion finishes, phenolic resin finishes, water-thinnable finishes, solicone resins, zinc silicate finishes, oil-free polyester finishes.** *Stoving Equipment:* **convection, infrared radiation, induction, dielectric heating. U.V. curing, electron beam curing.** *Paint application:* **padding, spraying, airless spraying, electrostatic spraying, hot spray technique, dipping, 'roto-dip' process, flow coating, curtain coating, roller coating, silk screen method, vacuum and pressure impregnation, electro-deposition, powder coatings, strip coating, aerosol spraying.**

8. Paint Manufacture and Hazards

Paint milling: **function of paint mills. General principles of paint mills.** *Types of mill:* **premixers, mixers for pastes, mixers for slurries, paddle mixers, high speed mixers. Dispersing mills. Dispersing mills requiring premixers. Triple roll mills, single roll mills, colloid mills, the sand mill, sealed sand mill, the 'Dyno' mill. Dispersing mills, direct charge: the ball mill, the attritor mill, high speed dispersers, the kady mill. Thinning mixers. Straining. Filling.** *Health and fire hazards:* **toxicity, pigments, resins, solvents, fire, other fire risks.**

9. Common Defects of Varnishes and Paints

Varnishes: **bloom, blushing, pinholing and cissing, silking.** *Paints:* **blistering, checking, cissing, crawling, dirt collection during drying, flotation, livering, pinholing, pigment sedimentation, rivelling, sagging, curtaining and tears, silking, skinning.**

10. Paint Testing

Liquid paint: **viscosity, brushability, colour measurement, colour matching, lightfastness, opacity, drying time.** *The dried film:* **adhesion and elasticity, hardness, gloss, film thickness, wet and dry, fineness of grind, water resistance, humidity resistance, salt spray resistance, durability, weatherometers.**

Glossary—Appendices—Index

Copies of this book are available at £5.00 each (prepayment only), post free by surface mail, from:

OIL AND COLOUR CHEMISTS' ASSOCIATION, Priory House, 967 Harrow Road, Wembley, Middlesex HA0 2SF.

Printed in England by Richard Madley Ltd., 6a Elthorne Road, N19 4AG

OIL & COLOUR CHEMISTS' ASSOCIATION

TECHNICAL EXHIBITION

22-25 MARCH 1977

The motif, designed by Robert Hamblin, uses red arrows to symbolise how exhibitors and visitors are drawn from all points of the compass to the Exhibition. The heads of the red arrows form white arrows in the opposite direction showing the subsequent spreading of knowledge of technical advancements from this unique annual focal point for the surface coatings industries.

TRAVEL ARRANGEMENTS FOR VISITORS TO OCCA-29

In recent years, travel arrangements have been improved by the addition of the Victoria Line to the Underground system, which now links Victoria Station to the Piccadilly Line at Finsbury Park. The building of the extension of the Piccadilly Line from Hounslow to the Airport terminal at Heathrow is now well advanced and when this is completed it will give a direct link with Turnpike Lane Station on the Piccadilly Line. In the meantime, a bus service operates from Heathrow Airport to Hounslow West Station. Those travelling by the Piccadilly Line should alight at Turnpike Lane Station and the Association will be running a bus shuttle service from this station to and from Alexandra Palace. The journey from central London to Turnpike Lane takes approximately 18 minutes.