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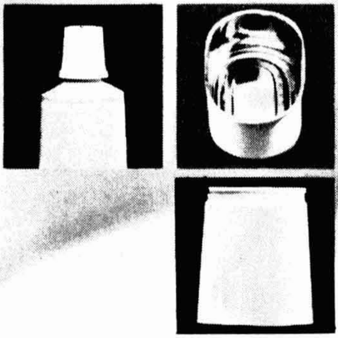

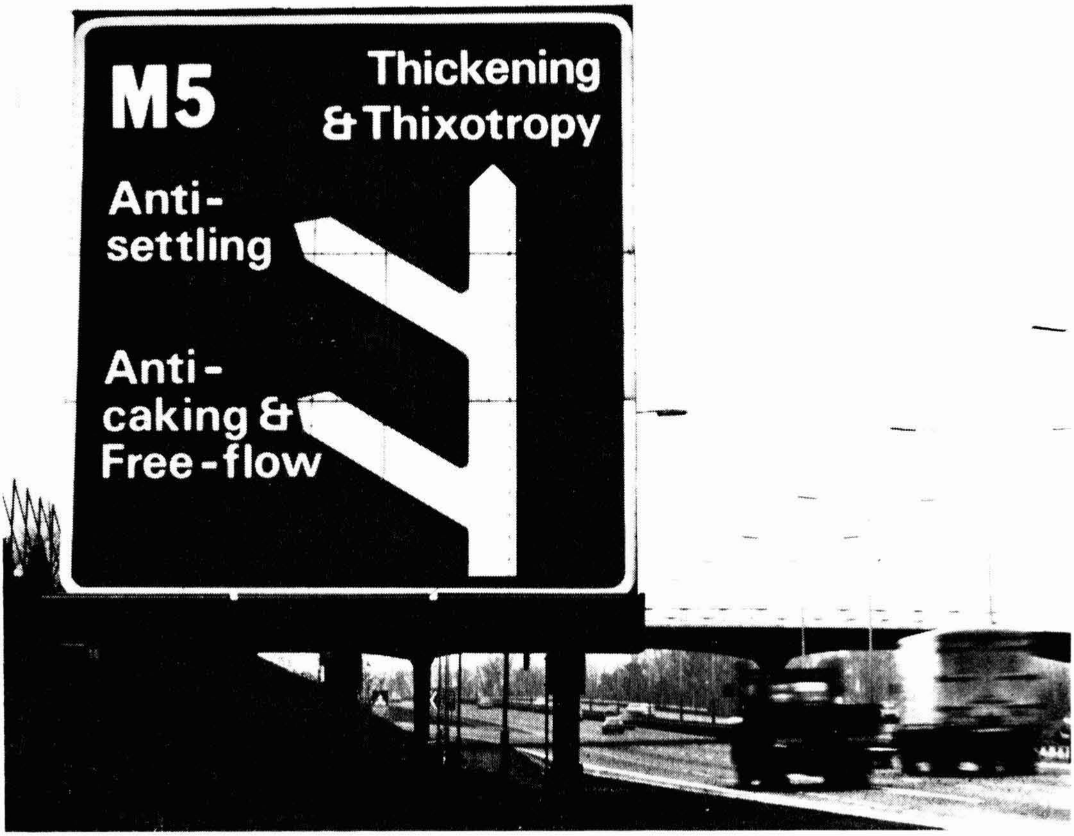
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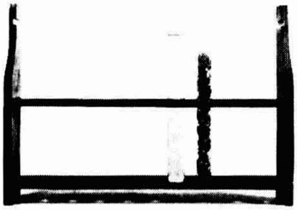

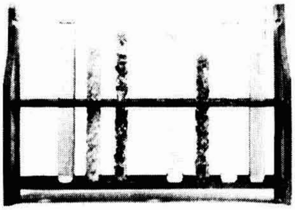

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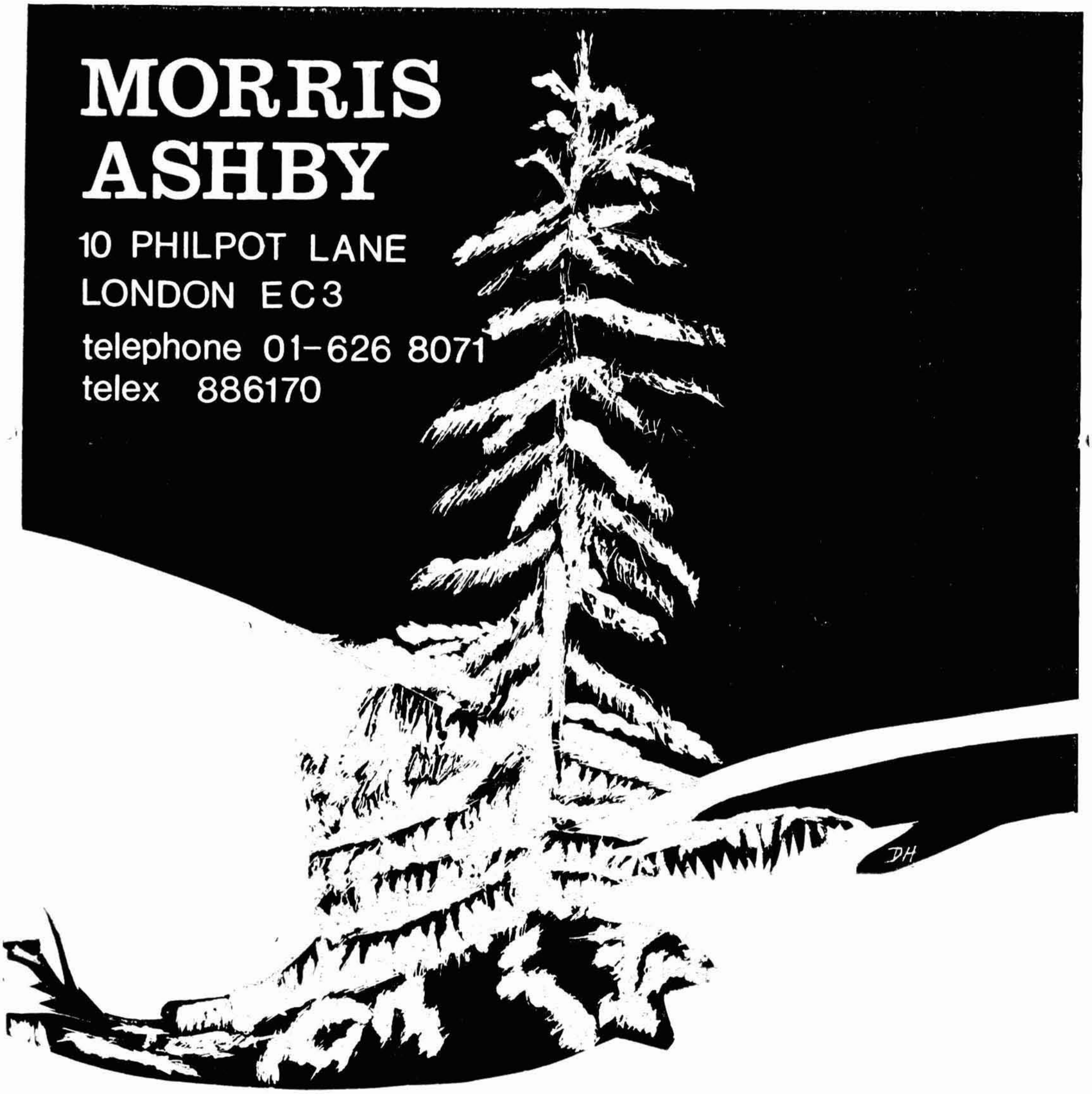

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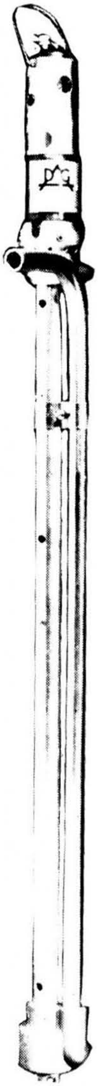

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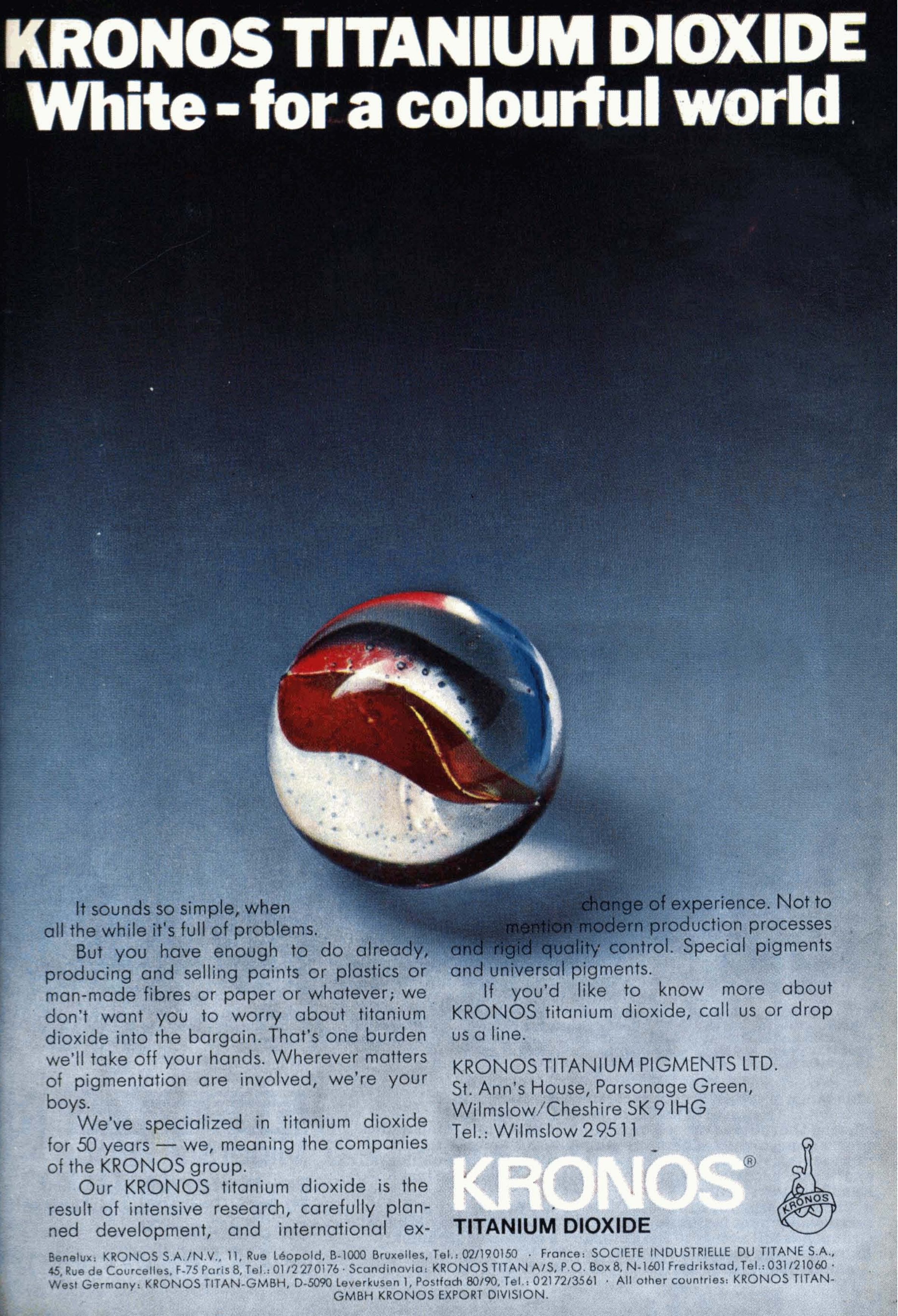

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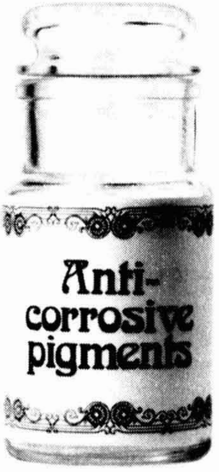

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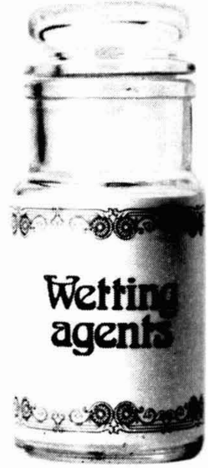

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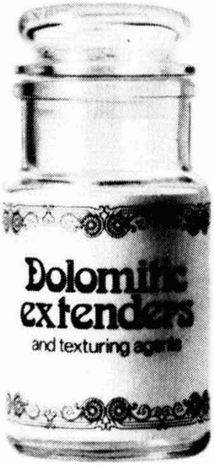

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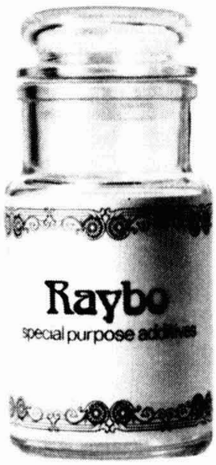

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Editorial correspondence should be addressed to the Hon. Editor, *JOCCA*, 49 Elms Drive, Kirk Ella, Hull HU10 7QH.

General correspondence should be addressed to:

R. H. Hamblin, M.A., F.C.I.S.,
Director & Secretary,

Oil & Colour Chemists' Association,
Wax Chandlers' Hall, Gresham Street,
London EC2V 7AB. (Tel.: 01-606 1439)
Telex: 883711 Grams: Oil Colour London

Assistant Secretary: N. S. Pearce, A.C.I.S.
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Transactions and Communications

The brushing characteristics of latex paints

By P. J. Cooke, O. Delatycki, R. W. Kershaw and Wong Sang
Dulux Australia Ltd., Central Research Laboratories, McNaughtons Road, Clayton (3160)
Victoria, Australia

Summary

A series of model latex paints has been prepared containing varying amounts of propylene glycol; the lapping and drying characteristics of the systems are reported. Rheological measurements made on the drying films are used to explain the lapping phenomenon, and from the measured evaporation rates an explanation of the effect of propylene glycol on the lapping, or wet edge, times is proposed.

Keywords

Types and classes of coating
latex coating

Properties, characteristics and conditions primarily associated with coatings during application
lapping
wet edge time

La brossabilité de peintures-émulsions

Résumé

On a préparé une série de peintures-émulsions contenant de diveres quantités de propylène glycol, et on rend compte des caractéristiques de reprise et de séchage. On se sert des mesures rhéologiques effectuées sur les feuils lors de leur séchage pour expliquer ce qui arrive pendant que l'on fait la reprise de la peinture. On propose, à partir des taux d'évaporation déterminés, une explication de l'effet qu'exerce le propylène glycol sur les temps de reprise.

Die Streichfähigkeitscharakteristika von Latexfarben

Zusammenfassung

Eine Reihe von Modell-Latexfarben, welche verschieden hohe Zusätze von Propylenglycol enthielten, wurden angefertigt; über die Offenzeit und die Trocknungscharakteristika der Systeme wird berichtet. Rheologische Messungen am trocknenden Filn werden benutzt, um die Wirkungen während des Anschlussvorganges zu erklären. Es wird ausserdem vorgeschlagen, mit Hilfe der gemessenen Verdampfungszahlen, die Auswirkung des Propylenglykols auf die Offenzeit zu erklären.

Характеристики кистевой окраски латексоподобных красок

Резюме

Приготовлен ряд модельных латексоподобных красок содержащих различные количества пропилен-гликола и даются сведения о характеристиках перекрывания и сушки этих систем. Реологические измерения высыхающих пленок применяются для объяснения эффектов во время перекрывания, и из измеренных скоростей испарения выводится объяснение влияния пропилен-гликола на продолжительность перекрывания или мокрой грани.

Introduction

The advantages of latex paints, including rapid drying and ease of handling, are partly offset by the difficulty in obtaining a smooth uniform film by brush application. Commonly recognised defects in this respect include poor levelling of the brush marks and difficulty in lapping into partly dried films. This paper is concerned with the latter problem and constitutes the first part of an investigation into the application and drying characteristics of latex paints.

When applying latex paints to large areas by brushing, it is common practice to complete areas of several square feet at a time. Thus, when starting such an area it is usually necessary to overlap a previously applied area. If the time of drying of this previously applied area exceeds a critical value, usually called the lapping, or wet-edge, time, excessive brush drag is experienced in lapping and permanent brush marks may be produced that spoil the appearance of the dry film.

It is characteristic of latex paints that the lapping time is generally too short under many ambient conditions. The use of about 13 per cent by weight of propylene glycol on the total weight of the paint has been proposed[1, 2], to extend this lapping time. It has recently been confirmed that lower concentrations of propylene glycol have an insignificant effect on lapping time.

The work reported here investigates the effect of high glycol levels on the lapping characteristics of model latex systems, by measurement of the rheological properties of the drying films.

In most rheological studies of paints[4-10], the experimental emphasis is on the initial composition of the applied film, that is, prior to any loss of volatile components. These studies have provided insight into such phenomena as brush drag, levelling and sagging, but do not assist in the problem of lapping. On the other hand, Befferman and Bergren[11] studied the change in high shear viscosity with drying time in paint films applied to both sealed and porous substrates. They found that the lapping time corresponds to the time taken for the film viscosity, measured at 14,400 sec^{-1}, to reach 4 poise.

The hypothesis that lapping time corresponds to the time taken for the drying film to reach a critical viscosity will now be further examined, and the causes of the viscosity increase investigated.

Experimental

Model systems

The systems chosen are listed in Table 1.

Table 1
Model systems

	System No.					
	1	2	3	4	5	6
Latex solids*	27.4	27.4	27.4	27.4	27.4	27.4
Thickener solids† ..	1.9	1.9	1.9	1.9	1.9	1.9
Propylene glycol ..	2.0	17.0	20.0	23.0	26.0	29.0
Water	70.7	55.7	52.7	49.7	46.7	43.7
Total	100.0	100.0	100.0	100.0	100.0	100.0
% glycol (W/W) in aqueous phase ..	2.8	23.4	27.5	31.6	35.8	39.9

Film preparation

Films were prepared at three thicknesses: 0.004in, 0.006in and 0.008in (wet) by drawing down on a glass plate. The plate was placed in a wind tunnel and maintained at 25°C at a constant air velocity.

Brushing characteristics

At regular time intervals the films were overcoated, using a small paint brush wetted with fresh paint from the batch used to produce the film.

Qualitative assessments of the ease of brushing were made by two operators up to the time when recoating of the drawn film by brushing became no longer practicable.

Tack-free times were determined on the drawn films by touching the film lightly.

Evaporation rates

The applied films were sampled at regular time intervals avoiding edges, weighed immediately and the samples dried to constant weight at 105°C.

Rheology

At regular intervals, as above, samples of the applied films were taken and immediately transferred to a Drage Rheomat (RM15) fitted with a cone and plate attachment (KP10-8) using either of systems 1 or 3 to afford the maximum shear rate range. In some cases, the effect of restoration to the original composition by water addition to a sample of the partly dried film on its rheological properties was also determined.

Measurements were carried out at 25°C under an atmosphere saturated with water vapour at shear rates between 20 and 1,400 sec^{-1}. The viscometer had previously been calibrated against Newtonian oils of standard viscosities.

Results

Brushing characteristics

Initially all the paints had acceptable brushing properties but there was a significant increase in drag with an increase in the glycol level.

The brush marks left in the films on initial brushing disappeared. After some time, and consequently loss of water, the drag on the brush increased to a point where the brushing into the drying film was distinctly difficult. This occurred quite sharply and was readily detectable by a panel of experienced painters.

Results of lapping time vs. glycol level are shown in Fig. 1, together with the tack-free times.

---

*The latex is primarily a copolymer of methyl methacrylate and butyl acrylate. The particle diameter is about 0.1 micron and the latex is anionically stabilised.

†The thickener is a stable polyvinyl alcohol copolymer and was used as a 13 per cent solution in water.

The main difference between the above formulations and a conventional latex paint is the absence of a pigment.

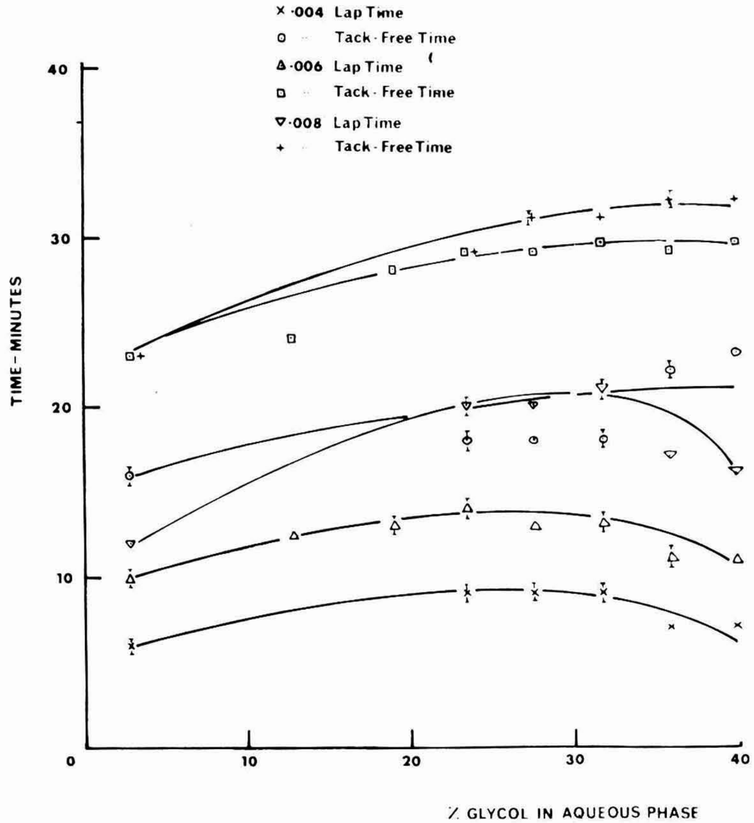

Fig. 1. Lap and tack-free times vs. glycol content in drying films

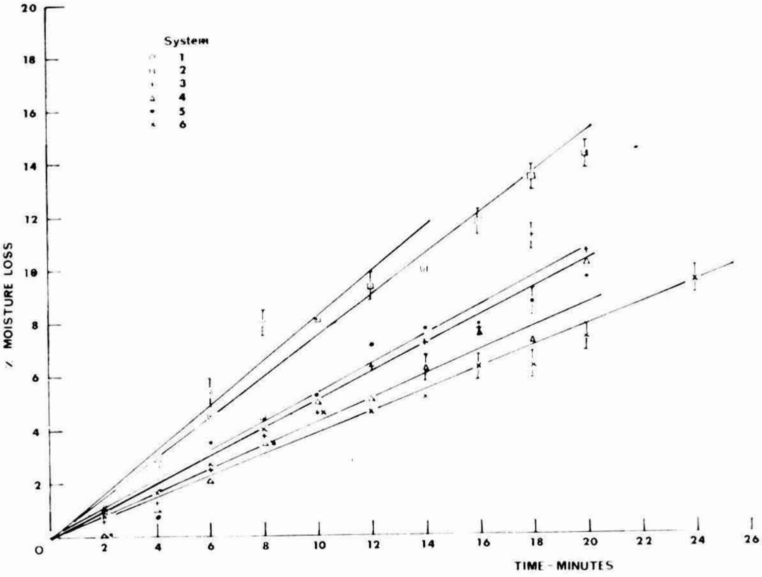

Fig. 2. Percentage moisture loss vs. time

Evaporation rates

The percentage moisture loss from the drying film vs. time is shown in Fig. 2.

Rheology

Fig. 3 shows the rheograms for the paints as produced. The shear rate/shear stress relations are linear on the log/log plot within the experimental error and consequently can be characterised by two parameters k and n in the power equation.

$$\tau = k\,\dot{\gamma}^{n}$$

The values of k and n for all systems at various drying times are given in Table 2, where τ is the shear stress in dyne cm^{-2} and γ is the shear rate in sec^{-1}.

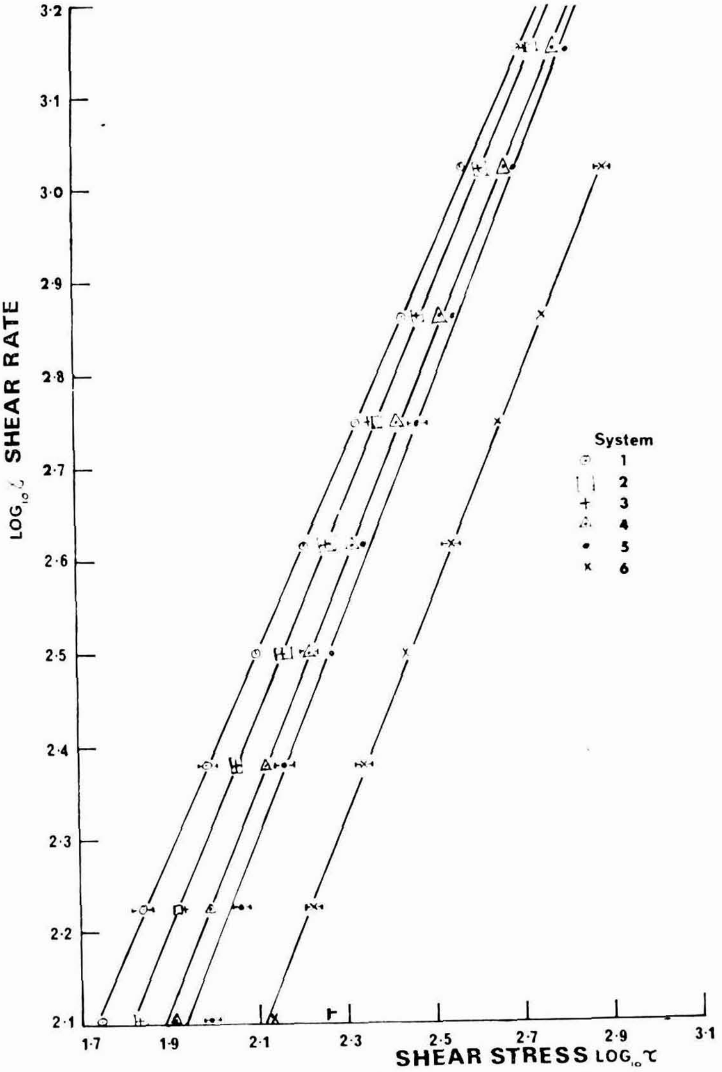

Fig. 3. Rheograms of systems as prepared

Table 2
Summary of rheological data at various drying times

System	1		2		3		4		5		6	
Drying time (minutes)	*k*	*n*	*k*	*n*	*k*	*n*	*k*	*n*	*k*	*n*	*k*	*n*
0	0.7	0.90	1.0	0.86	1.1	0.85	1.6	0.81	1.8	0.81	2.8	0.80
2	3.3	0.74	1.5	0.85	1.8	0.84	1.6	0.84	2.9	0.78	5.6	0.65
4	6.2	0.74	2.3	0.81	2.2	0.83	2.2	0.82	3.8	0.75	8.3	0.62
6	10.8	0.70	2.4	0.84	3.2	0.81	2.7	0.80	10.0	0.63	6.1	0.70
8	14.1	0.66	4.4	0.76	4.4	0.80	4.7	0.76	12.0	0.64	11.0	0.64
10	32.0	0.60	4.8	0.78	4.6	0.79	7.0	0.72	14.0	0.62	15.0	0.60
12	47.0	0.60	5.4	0.80	5.6	0.77	7.3	0.71	24.0	0.59	11.0	0.64
14	90.0	0.64	7.6	0.75	9.3	0.75	15.0	0.64	27.0	0.58	18.0	0.61
16	—		10.0	0.76	14.0	0.69	12.0	0.68	24.0	0.68	15.0	0.70
18	—		—		26.0	0.70	21.0	0.64	24.0	0.69	15.0	0.70
20	—		37.0	0.64	26.0	0.70	30.0	0.67	43.0	0.64	18.0	0.67
22	—		—		—		—		—		—	
24	—		—		—		—		—		20.0	0.76

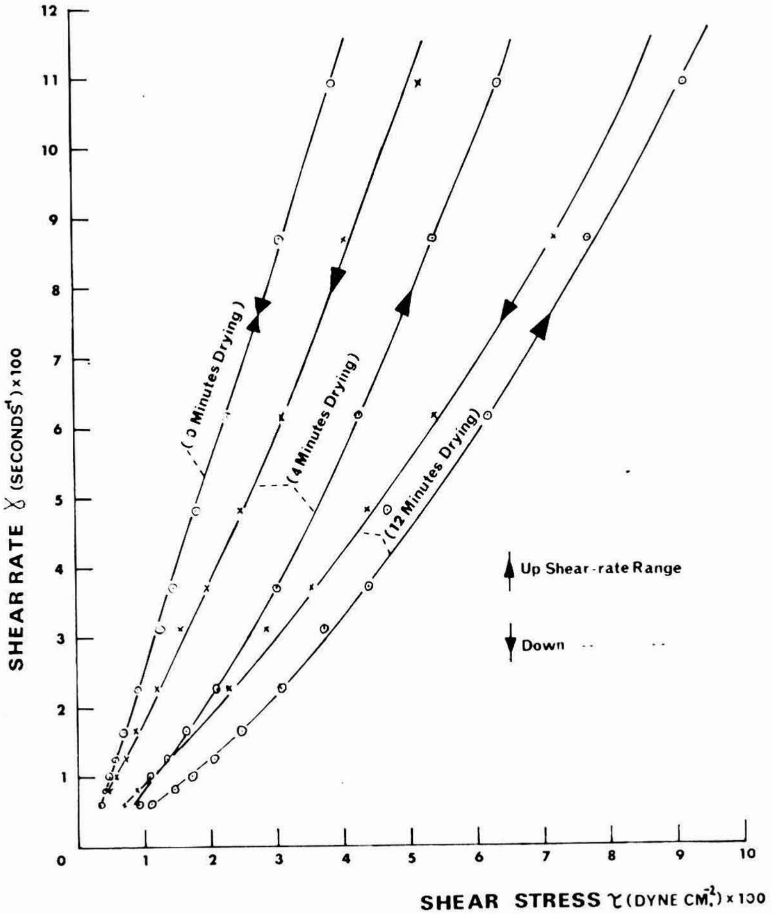

Fig. 4. Reconstitution to original composition

The rheological properties of system 1 after partial drying for 4 and 12 minutes respectively, followed by additions of water to reconstitute the original compositions, are shown in Fig. 4.

Discussion

The results shown in Fig. 1 confirm that, under the ambient conditions used, the model latex system containing least glycol has insufficient lapping time[12] when the wet film thickness is 0.004in. This is confirmed by the presence of excessive brush marks in the overlapped areas of a dry film obtained in a practical assessment of the brushing characteristics of this system. The effect of propylene glycol at concentrations of up to approximately 30 per cent of the aqueous phase is to increase the lapping time, although it is doubtful whether the increase is sufficient to give totally satisfactory application properties. Further increase in the propylene glycol level actually reduces the lapping time, as well as retarding the complete drying to an extent that completely negates the important fast drying properties of latex paints.

Thicker films (0.006in and 0.008in, wet film thickness) give longer lapping times, but are difficult to produce in practice.

From the rheological properties of the drying films, summarised in Table 2, it is possible to estimate the apparent viscosity at a shear rate corresponding to the lapping process. Brushing shear rates of between 5,000 sec^{-1} and 20,000 sec^{-1} have been proposed in earlier work[5], and the authors consider that, for the lapping of latex paints, the lower end of this shear rate range is appropriate. On this basis, Fig. 5 gives the apparent viscosity at a shear rate of 5,000 sec^{-1} for the six model systems during the drying process.

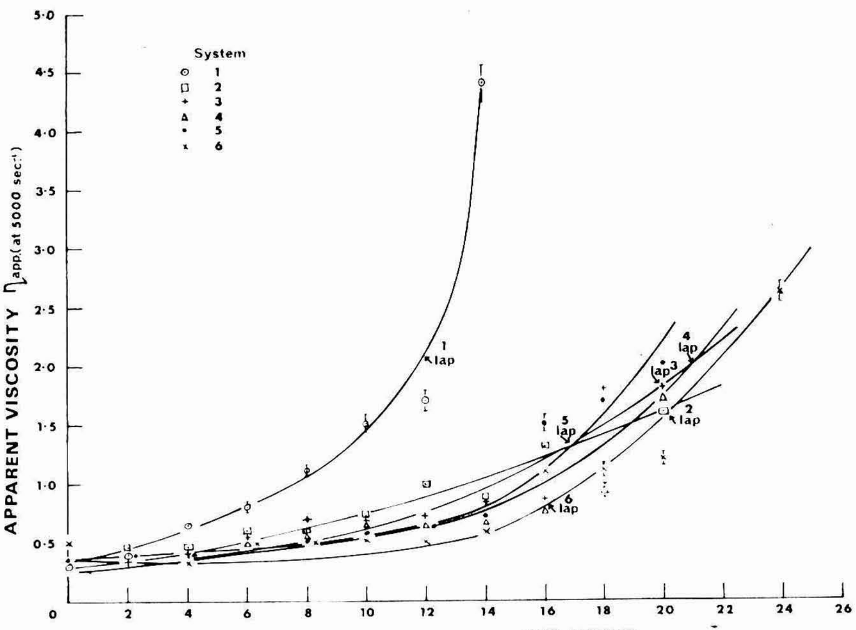

Fig. 5. High shear viscosity vs. drying time

In this figure the points at which lapping becomes difficult are also indicated, and it can be seen that these correspond to a viscosity of about 1.5 poise. Furthermore, the lapping times seem to correspond to a steepening of the viscosity/time curves, and it is possible that this correlation is even more significant than the absolute value of the viscosity attained at the lapping time. That is, subjective assessment of lapping time may be based on the observation of the onset of a rapid viscosity increase.

The mechanism by which propylene glycol affects the rheology of the drying films, and hence the lapping times, can now be considered.

Vapour pressure data[13] indicate that evaporation rates of the aqueous phases should not be greatly affected by propylene glycol at the concentrations of up to about 25 per cent by weight. The total vapour pressure of such a composition is only about 5 per cent lower than that of water. Yet the experimental results given in Fig. 2 indicate a significant reduction in the initial evaporation rates between system 1 (2.8 per cent glycol) and systems 2–6 (23.4 to 39.9 per cent glycol). It is possible that the observed lowering of evaporation rates is due to a rapid build-up of glycol concentration in the surfaces of the films due to the preferential evaporation of water. That is, the evaporation of water is limited by diffusion rates within the films.

It would seem possible that the glycol increases the time elapsing before the rapid viscosity increase occurs, merely by slowing the evaporation rate of the aqueous phase.

There is, however, a second effect of the glycol. Fig. 6 shows that propylene glycol has an influence on the amount of aqueous phase left in the film at the time of the rapid viscosity increase. Intermediate levels of glycol (around 25 per cent) allow the evaporation of more aqueous phase before this viscosity increase occurs than do the lower glycol levels.

Comparison of system 2 with system 1 shows that not only is the aqueous phase evaporating more slowly, but more of it must evaporate before difficulty in lapping is experienced.

In an attempt to explain this effect, partly dried films were mixed with water to reconstitute the original compositions and the rheological properties were measured. The results given in Fig. 4 show that, for system 1, there was an irreversible increase in viscosity on partial drying. The results for systems containing higher glycol levels, on the other hand, showed complete reversibility. The irreversibility in the system containing little glycol may be caused by premature coalescence of the latex particles in the surface of the film as the water evaporates and concentrates this layer. Glycol, in sufficient quantities, would prevent this by spacing the particles in the surface. The irreversible increase in viscosity of system 1 partly explains the rapid viscosity increase and poor lapping characteristics as films of this system dry.

Fig. 6 also shows that, at glycol levels greater than 28 per cent, lapping times are reached whilst relatively high levels of aqueous phase still remain in the film. This explains the unexpectedly poor lapping characteristics of systems 5 and 6—whilst the evaporation rate of the aqueous phase has been reduced by the glycol present, considerably less evaporation is needed to reach the point at which lapping becomes difficult.

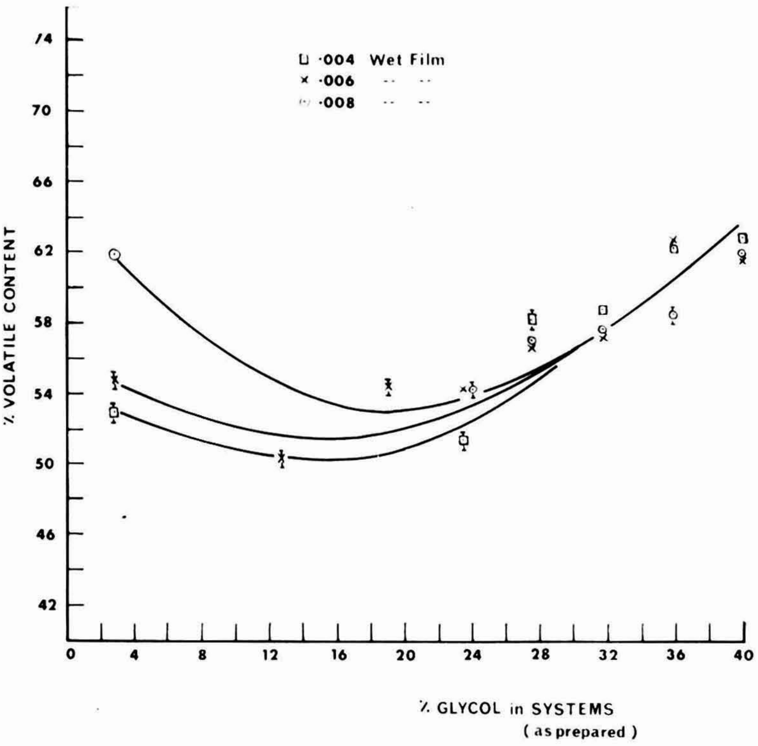

Fig. 6. Volatile content in drying films at lapping time vs. glycol level

Conclusions

At concentrations of around 25 per cent (W/W on the aqueous phase) propylene glycol causes a significant increase in the lapping times of the model latex systems. Higher concentrations of propylene glycol actually reduce lapping times, and cause undesirable increases in the drying time.

The lapping times of the latex systems correspond to the time at which a rapid increase in viscosity at a shear rate of 5,000 sec^{-1} occurs, and are determined by the evaporation rate of the aqueous phase and the rate at which the viscosity increases with loss of the volatile constituents. In the case of low glycol concentrations, this viscosity increase is particularly rapid and irreversible and it is suggested that this may be caused by early partial coalescence of the latex particles in the drying film. At higher levels of glycol, the evaporation rate of the aqueous phase is reduced, and the irreversible viscosity increase is prevented; both these effects tend to increase the lapping time. However, these effects are opposed at high glycol concentrations by an inherently greater rate of viscosity increase with loss of volatile components.

Acknowledgment

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The application of magnetic resonance in the field of surface coatings

By P. S. Nisbet

A. B. Fleming & Co., Ltd., 170 Glasgow Road, Edinburgh 12

Summary

Magnetic resonance techniques are finding increasing application in the surface coatings industry. A brief indication of the source of such spectra is a useful introduction to a review of the use of nuclear magnetic and electron spin resonance as applied to surface coatings.

Keywords

Processes and methods primarily associated with analysis, measurement and testing

electron spin resonance
nuclear magnetic resonance

L'utilisation du phénomène de résonance magnétique dans le domaine de peintures et de préparations assimilées

Résumé

Dans l'industrie de peintures et de préparations assimilées les techniques de résonance magnétique connaissent l'utilisation croissante. Une indication briève de l'origine de tels spectres sert d'une introduction utile aux phénomènes de la résonance magnétique nucléaire et de la résonance électronspin, et à leur utilisation dans le domaine de peintures et de préparations assimilées.

Die anwendung magnetischer Resonanz auf dem Gebiet der Oberflächenbeschichtung

Zusammenfassung

Die Techniken der magnetischen Resonanz finden immer mehr Anwendungsmöglichkeiten in der Industrie der Oberflächenbeschichtung. Kurze Angaben über die Quelle solcher Spektra dienen als nützliche Einführung zu einer Übersicht über die für Beschichtungsmittel anwendbare kernmagnetische und Elektronenspinn- Resonanz.

Применение магнитного резонанса в области поверхностных покрытий

Резюме

Технология магнитного резонанса находит все более широкое применение в промышленности поверхностных покрытий. Краткое указание на источник таких спектров является полезным введением к обзору применения ядерного магнитного и электронного спинового резонансов по отношению к поверхностным покрытиям.

The phenomenon of magnetic resonance

A fundamental property of charged spinning bodies is that they possess a magnetic moment. In the presence of an applied magnetic field, the magnetic moment vector can take up only specific orientations in the field, each corresponding to a different energy level. In addition, the spinning body precesses about the field, and if radiation is applied at a frequency equal to the rate of precession, energy will be absorbed, and the orientation will change to one of higher energy.

In the case of the nucleus, the allowed orientations are given by the nuclear magnetic quantum number, M_I, where

$$M_I = I, I - 1, I - 2 \ldots\ldots\ldots\ldots\ldots - I + 1,$$

and I is the spin quantum number. Only nuclei with $I = \frac{1}{2}$, such as ^{1}H, ^{13}C, ^{27}Si, ^{19}F and ^{33}P will be considered here. In particular, reference will be made to the proton, i.e. ^{1}H. Since $I = \frac{1}{2}$, then to maintain symmetry M_I can have only the values $+\frac{1}{2}$ or $-\frac{1}{2}$, corresponding to two orientations of the magnetic moment vector in the field; i.e. either with the field or against it, the latter being of slightly higher energy.

For hydrogen nuclei in an applied field of 0.94 Tesla (Tesla, T, is the derived SI Unit of magnetic flux density), the transition frequency is about 40MHz.

The effect of the applied field on the electrons induces a diamagnetism which partially shields the nucleus. The field actually "felt" by the nucleus thus depends on its electronic, and therefore on its chemical, environment. Hence, since the frequency of precession is proportional to the magnetic field experienced by the nucleus, the frequency of absorption will give an indication of the chemical environment of the proton under examination. The effect of diamagnetic shielding in shifting the expected absorption frequency is termed "chemical shift" and is measured relative to the absorption frequency of an internal standard such as tetramethylsilane. The chemical shift parameter is defined as:

$$\delta = \frac{H\ (\text{sample}) - H\ (\text{ref}) \times 10^{6}}{H\ (\text{ref})}$$

where H is the magnetic field strength. The *tau* value is defined as $\tau = 10 - \delta$.

The above phenomenon is termed "nuclear magnetic resonance" (NMR) or, in the case of the proton, "proton magnetic resonance". Unpaired electrons produce a similar effect termed "electron spin resonance" (ESR) or "electron paramagnetic resonance". In this case the frequency required is in the microwave region, and the effect is displayed by paramagnetic substances or free radicals.

Both NMR and ESR spectral bands can display hyperfine structure under high resolution. In the high-resolution NMR spectrum of ethanol (Fig. 1), the signals appear as a quartet for CH_2, a triplet for CH_3 and a singlet for OH.

This is termed spin-spin coupling and arises from interaction of the magnetic moments of one set of protons with those of an adjacent set carried via the bonding electrons. In general, if there are n equivalent protons on a carbon adjacent to the proton set under consideration, the signal of the latter will be split into $n + 1$ components of relative intensity given by the coefficients of the expansion of $(1 + x)^n$. The separation of components is termed the coupling constant J, and is valuable in structural and bonding analysis. This explains

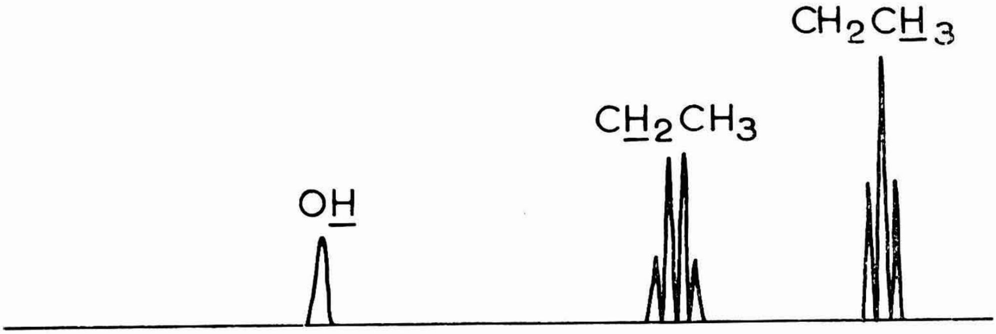


Fig. 1. NMR spectrum of ethanol

the appearance of the ethanol spectrum. Splitting in ESR arises from interference of the nucleus in the electron orbital with the applied field. For *n* nuclei of spin quantum number *I* the signal will be split into $2nI + 1$ components.

Application

Nuclear magnetic resonance

Information is obtainable from the chemical shift, the extent of splitting, the coupling constant, and the peak area, which is often available on the spectrum as an integral of the signal. The integral is useful in quantitative work, since the signal area is a measure of the number of protons it represents. Its application is best considered by example.

The high resolution NMR spectrum of the compound $C_6H_{14}O_3$ is shown in Fig. 2. The signal from the internal standard, tetramethysilane, is given a value of 10τ. The signals at 8.6 and 9.1τ display the characteristic pattern of the ethyl group as found in the ethanol spectrum (Fig. 1). The doublet at 6.4τ must be coupled with a single proton, and since the adjoining signal at 6.1τ is a triplet, will probably be due to a methylene group.

Thus CH_3CH_2 $-CH_2-$ and XH are present, where X is either C or O. The The integrals show that there is only one ethyl group in the molecule (integral value $3 + 2 = 5$), three other methylene groups (integral value 6) and three

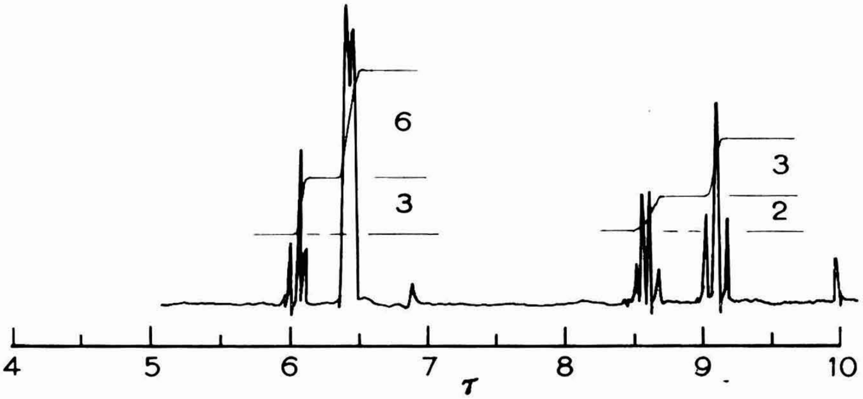
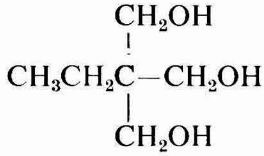


Fig. 2. NMR spectrum of $C_6H_{14}O_3$ (trimethylol propane)

XH groups (integral value 3). Since we have three oxygen atoms present XH must be hydroxyl, and the only possible structure is



$$\begin{array}{c} CH_2OH \\ | \\ CH_3CH_2C-CH_2OH \\ | \\ CH_2OH \end{array}$$

i.e. trimethylol propane.

This is the first application of NMR; i.e. structural analysis and the identification of unknowns. More complex spectra often present difficulties in interpretation, but the general procedure is much the same as in the example above[1,2,3]. The use of computer programmes in interpreting complex spectra has been described[4]. A major part of the use of the technique in the surface coatings industry is in the determination of structure[5,6,7], composition and mode of formation of polymeric materials. Accurate quantitative measurements can be obtained directly from a signal without the use of standardisation or absorptivity values such as are required with infra-red or ultra-violet spectroscopy. A quantitative application to the structure and constitution of polyesters has been described by Afremow[8] and Yeagle[9], and similar work has been carried out on a variety of polymers such as alkyds[10] and acrylics[11,12].

The technique has been widely used for tacticity and sequence distribution studies. Thus, differences in backbone structure have been found in copolymers of vinyl acetate with acrylic esters, maleic diesters and fumaric diesters[12] owing to a greater tendency for the formation of fumaric than maleic sequences. It was pointed out that these copolymers cannot be distinguished by IR spectroscopy.

Tacticity studies have been carried out on polymethacrylonitriles[13] and it has been shown that the chain configuration of acrylonitrile/methyl methacrylate copolymers may not adhere to Bernouillian or first order Markoffian statistics[14]. This conclusion, however, will need verification. The monomer sequence distribution in styrene/methyl methacrylate has been determined[15] and the styrene content evaluated.[16] Copolymerisation reactivity ratios can be rapidly and accurately determined by NMR.[17] Values of $r_{ma} = 6.3 \pm 0.4$ and $r_{va} = 0.031 \pm 0.006$ have been found for vinyl acetate/methyl acrylate copolymerisation in bulk at 60°C[18]. Goldberg[19] has shown that in the anionic polymerisation of alkylene oxides and anhydrides to polyesters, the molecular weight distribution and polyether content can be controlled by the use of active hydrogen containing compounds such as water or phthalic acid.

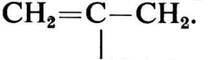
The technique provides a rapid non-destructive method for the identification and structural analysis of fatty acids[20,21]. Thus, NMR provided the first direct proof of the structure of sterculic acid as 2-*n*-octyl-1-cyclopropenecaprylic acid[22] and has been widely used in the examination of conjugation and isomerism[23]. Chemical shift data is available for the sixteen isomers of C-18 monoenic acids. It was shown that eight of these can be positively identified by NMR; i.e. the four with double bonds nearest the methyl group, and the four with double bonds nearest the carboxyl[21]. A method for determining the iodine value of acids and oils has been developed[24,25] though this seems of academic rather than of practical interest owing to the expense involved. However, the technique is useful where extensive conjugation leads to inaccuracies in the Wijs value[24]. The calculation of molecular weights of triglycerides[24] is more easily carried out by NMR than by saponification and should give more accurate results. Molecular weights of other compounds can also be obtained[26], but the technique cannot yet be applied to polymers. Hopkins[27] has carried out an extensive survey of the fatty acid field.

Although the preceding fields have provided most of the more interesting applications of NMR, there are numerous possibilities which have not been fully explored. For example, the technique provides the easiest and most rapid means of characterising long-chain surface active agents. The chain lengths in polyethoxy compounds, for example, can be accurately and rapidly determined.[28] Miscellaneous applications include the determination of the water content of cellulose[29] and montmorillonite[30], and examination of the O-H-O hydrogen bond in boehmite which was found to be asymmetric[31]. Paints and related products have been analysed for toxic solvents such as benzene, acetone, methylated spirits, dichloromethane[32], etc. Attention should also be drawn to the use of the ^{13}C spectrum in determining the water content of acetone[33] down to 0.03 per cent, and the work by Bovey[34] on polymethyl methacrylate configurations in which the ^{13}C spectrum gives more detailed information than the ^{1}H spectrum. Future work will probably make more use of ^{13}C spectra.

NMR has still not reached its full potential in the surface coating industry, probably due both to ignorance of the method and the cost of the equipment required. The cost can be cut somewhat by use of the services offered by the Paint Research Association to members. Used in conjunction with IR spectroscopy, NMR provides the most powerful analytical tool available to date.

Electron spin resonance

Since ESR is used for the study of free radicals its potential applications in the study of polymerisation mechanisms are limitless. Concentrations as low as 10^{-7} mol m^{-3} and lifetimes of less than 10^{-7}s can be detected. Specific radical structures may be determined, such as the species



$CH_2{=}\underset{\displaystyle COOCH_3}{\underset{|}{C}}{-}\dot{C}H_2$.

which has been found in the radiation-induced polymerisation of methyl methacrylate.

Study of the copolymerisation of vinyl monomers[35] showed that the rate of formation of HO-vinyl acetate-M_2 increases in the order M_2 = maleic acid, acrylic acid, acrylonitrile, fumaric acid. New information on monomer reactivity and copolymer conformation was obtained. The gamma-ray induced polymerisation of methacrylates in the solid state has been shown to proceed via radical mechanisms, and the kinetics of such reactions have been studied[36]. Work done on curing unsaturated polyesters indicates that radicals may contribute to yellowing[37]. The presence of radicals over a long period of time indicates that an aftercure may be possible. The technique can also be used to detect degradation in polymeric materials, for example in oxymethylene polymers[38] in both the solid state and solution. Work has been carried out by

Campbell[39] on a variety of polymers, such as polyolefins, polystyrene, polyamides and polyvinyl acetate.

Amongst the applications not directly related to the polymer field are studies on precipitated titanium dioxide. ESR spectra of ammonia precipitated TiO_2 powders show that radicals are formed, owing to oxidation of traces of ammonia held by the material[40]. The formation of atomic oxygen on the surface of zinc oxide exposed to hydrocarbons at 25°C has been postulated as a result of ESR studies[41]. In the dyestuffs field, it has been found that certain triphenylmethanes and xanthenes form radicals on irradiation with light. For example, dyes such as Rhodamines B, 5G and 6G initiate the photopolymerisation of acrylonitrile[42] when irradiated at wavelengths above 500nm.

There has been very little work published on the use of ESR in the surface coatings industry. However, the technique should find increasing applications, especially in the study of polymerisation and drying behaviour. NMR and ESR provide two tools which are invaluable to the surface coatings chemist, and essential for the study of complex macromolecules and the kinetics of their formation.

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Corrigendum

In the paper "Composition of dehydrated castor oil alkyds prepared by different routes" by N. A. Ghanem, M. A. El-Azmirly and Z. H. Abd El-Latif, which appeared in the March issue, the equation at the foot of page 229 should read:

$$\Upsilon = \frac{V}{V_0 + V}$$

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Measurement of the hiding power of paints

By E. Hoffmann, C. J. Lancucki and J. W. Spencer

Division of Building Research, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia

Summary

It is shown that the values calculated from the Kubelka and Munk equations for the scattering and absorption coefficients depend on the thickness of the paint film on which the reflectance measurements are carried out. Similar behaviour is found for the equations derived by one of the authors.

Both types of equations can be used for calculating the reflectivity of a paint from the reflectance of the film over two surfaces of different reflectance. Alternatively, by measuring the reflectance of a paint film over a black surface and determining the reflectivity separately, the reflectance over a white surface can be calculated. In order to determine the hiding power of a paint, it is proposed that the reflectance measurements should be carried out on thick films for which the contrast ratio is greater than 0.96, or on films of nearly the same thickness.

Keywords

Properties, characteristics and conditions primarily associated with:
Raw materials for coatings and allied products
hiding power

Equipment primarily associated with analysis, measurement and testing
computer

Materials in general
contrast ratio

Détermination du pouvoir couvrant de peintures

Résumé

On démontre que les valeurs des coéfficients de diffusion et d'absorption, calculés selon les équations de Kubelka et Munk, se dépendent de l'épaisseur des feuils de peinture qui font l'objet des études sur la réflectance. On trouve un comportement semblable dans le cas des équations derivées par un des auteurs de cet exposé.

On peut utiliser chaque type d'équation pour calculer la réflectance spécifique d'une peinture à partir de la réflectance du feuil qui a été déterminée au dessus de deux surfaces de différentes réflectances. Autrement, par la détermination de la réflectance d'un feuil de peinture sur une surface noire et la détermination indépendante de la réflectance spécifique, on peut calculer la réflectance sur une surface blanche. Afin de determiner le pouvoir couvrant d'une peinture, on propose que les mesures de réflectance devraient être effectuées sur les feuils épais où le rapport contraste dépasse 0.96, où leur épaisseur est largement pareille.

Deckkraftmessungen von Anstrichfarben

Zusammenfassung

Es wird aufgezeigt, dass die aus den Kubelka und Munk Gleichungen für die Streuungs- und Absorptionskoeffizienten berechneten Werte von der Dicke der Anstrichfilme, an denen die Rückstrahlungsmessungen vorgenommen werden, abhängen. Für die von einem der Autoren entwickelten Gleichungen wurde ein gleiches Verhalten festgesteklt.

Beide Arten von Gleichungen können zur Berechnung der Rückstrahlung einer Anstrichfarbe aus der Rückstrahlung des Films über zwei Oberflächen mit verschiedenen Rückstrahlungswerten benutzt werden. Wahlweise kann durch Messung der Rückstrahlung eines über einem schwarzem Substrat befindlichen Anstrichfilms und separate Bestimmung der Reflexion die Rückstrahlung über einem weissen Substrat berechnet werden. Es wird vorgeschlagen, dass zur Bestimmung der Deckkraft eines Anstrichmittels die Rückstrahlungsmessungen an dicken Filmen, deren Kontrastverhältnis höher als 0,96 ist, oder an Filmen von beinahe gleicher Dicke ausgeführt werden.

Измерение кроющей способности красок

Резюме

Показано что значения коэффициентов рассеяния и поглощения вычисленные из уравнений Кубельки и Мунка, зависят от толщины красочной пленки для которой производятся измерения отражения. Подобное же поведение наблюдается также в уравнениях полученных одним из авторов.

Оба типа уравнений могут быть использованы для вычисления отражательной способности краски из отражаемости пленки, на двух поверхностях различной отражаемости. Альтернативно, путем измерения отражения красочной пленки на черной поверхности и определив отражательную способность отдельно, можно вычислить отражаемость на белой поверхности. Для определения кроющей способности краски, предлагается проводить измерения отражения на толстых пленках, коэффициент контрастности которых превышает 0.96, или на пленках почти такой же толщины.

Introduction

The hiding power of a paint is defined as the number of units of surface area that can be obliterated by a given weight or volume unit of paint; this is clearly of great economic interest to the user. The hiding power can be found by determining the contrast ratio (CR) of paint films of various thicknesses.* The CR is the ratio of the reflectance of a paint film over two substrates of different reflectance, usually black and white surfaces. The hiding power can then be determined from the weight of the paint film and the solid content of the paint. A film which has a CR of 0.98 is considered thick enough to hide the background under average conditions. Fig. 1 shows a typical curve of CR versus film thickness expressed as the weight of paint solids in g m^{-2}. The value of the

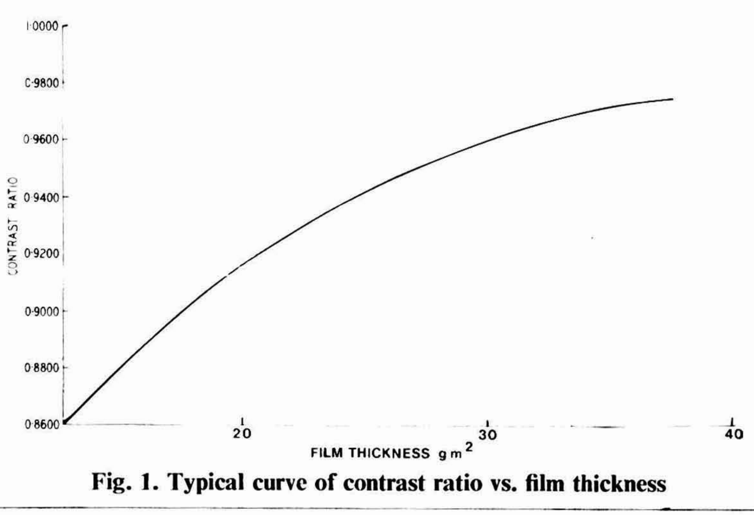

Fig. 1. Typical curve of contrast ratio vs. film thickness

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*Film thickness is proportional to the weight of the paint film unit area. In this paper the thickness will be expressed as the weight of paint solids (in g) per m^2.

CR approaches one asymptotically, and it is therefore impossible to extrapolate from measurements less than 0.98 to find values for CR = 0.98 with a reasonable degree of accuracy.

Dunn[1] maintains that if the CR is plotted against the reciprocal of the thickness, a straight line is obtained, and an extrapolation to the value of 0.98 is therefore possible. Determination of at least three points is necessary to make sure that a particular paint actually follows the straight-line rule. The paint for which the CR is given in Fig. 1 does not follow this rule.

Both procedures are very time consuming, and for this reason they have been replaced by a method based on the Kubelka and Munk (K and M) theory[2, 3]. Starting from the two simultaneous differential equations:

$$dj = -(S + K)\,j\,dx + Si\,dx \text{ and } -di = -(S + K)\,i\,dx + Sj\,dx$$

these authors derived a number of equations of which (1) is the most important

$$R = \frac{1 - R_g\,(a - b \coth\,(bSX))}{a - R_g + b \coth\,(bSX)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

(The symbols have the meanings set out in the section on Notation.)

A useful collection of the equations derived from the K and M theory has been published by Judd and Wyszeski[4].

By measuring the reflectance of a film of known thickness over two different backgrounds, usually black and white respectively, it is possible to calculate the scattering and absorption coefficients. Once these are known the thickness of any paint film can be calculated for any desired reflectance over any background.

The procedure assumes that the scattering and absorption coefficients will be the same at whatever film thickness the reflectance measurements are made. Only very scanty work seems to have been done on this very important point. Judd *et al*[5] investigated this assumption and found considerable variation in the scattering coefficient, but as this did not show a regular trend they concluded that the discrepancies were due to experimental errors. They considered that the chief cause of these was the experimental difficulty in preparing a paint film of uniform thickness.

Craker and Robinson[6] found a variation of approximately 20 per cent in the scattering coefficient as the film thickness varied between 10 and 50μm. They give no detail regarding the preparation of the paint films, and worked with only one type of paint, a white gloss enamel of 15 per cent PVC. Mitton and Madi[7] also found variations in the scattering coefficient with film thickness, but they did not vary the film thickness over a wide range.

Vial[8] also found a decrease in the scattering coefficient with increasing film thickness, but his experiments were limited to white stoved finishes. None of these workers paid any attention to the behaviour of the values of the absorption coefficient.

The investigation reported here seeks answers to the following questions.

Is there any variation of the values of the absorption and scattering coefficients determined on the basis of the K and M equation from different film thicknesses of the paint under investigation? No attention has been given so far to the constancy or otherwise of the absorption coefficient.

To what degree of accuracy can other experimental values be derived with the help of the K and M equations? It is possible to deduce the reflectance at infinite thickness from reflectance measurements of a paint film of a given thickness over two different backgrounds. This value is also called the "reflectivity." Alternatively, it is possible to find the contrast ratio by determining the reflectivity and the reflectance over a black background.

The same questions were asked for the equations derived by Hoffmann[9], here referred to as H equations. They were originally derived in order to estimate the reflectance of light from a paint film in which the colour is unevenly distributed; a simplified derivation is given in Appendix 1.

Experimental

Preparation of the paint film

In the procedures based on the K and M or H equations it is necessary either to measure the reflectance of a paint film of uniform thickness over two surfaces of different reflectances, or to determine the reflectivity of the paint and the reflectance over one background, usually a black one. The methods developed for the preparation of such paint films can be divided into three main groups.

1. The paint is applied by brush or film applicator over a Morest chart, which is a specially prepared paper with black and white squares. An area over which the film thickness does not vary too much is selected from the middle of the paper. This can be established by measuring the reflectance values over the white and over the black squares, which should not differ appreciably amongst themselves, and the average values over each background are used in the calculation. The amount of paint solids is then determined, usually from the difference in weight between the painted and the unpainted areas.

The averaging procedure is somewhat doubtful. It could be correct only if the reflectance were linearly dependent on the film thickness in the range in which the latter varied. Apart from this, the reflectance of the substrate is often varied by the paint applied to it, and for this reason this method is unsuitable for the present purposes.

2. The paint is applied as a suitable film drawn over black and white glass or ceramic tiles. The reflectances of the dried paint film are then measured over different areas, and the calculation is carried out with average values. The above comment regarding the validity of averaged results also applies here. The amount of paint solids on the tile can then be determined either by the difference in weight between the painted and unpainted tiles, or by removing and weighing the film, the latter procedure being recommended by Mitton[10] and others. A ceramic tile has the advantage that there is no danger of changing its reflectance by application of the paint.

Instead of carrying out reflectance measurements over two backgrounds of different reflectance, it is possible to ascertain the reflectivity of the paint and to determine the reflectance over only one background, usually a black one. This procedure is feasible, as according to the K and M theory

$$R_\infty = a - (a^2 - 1)^{\frac{1}{2}}, b = a - R_\infty \text{ (See equation 1)}$$

and is favoured by Mitton[10].

The paint is applied with a film applicator to a transparent plastic film. Melinex, a polyester film, is widely used for this purpose. The painted Melinex film is then pressed, painted side upward, to the white ceramic test plate, using white spirit to obtain good optical contact, and the reflectance is measured. The film is then transferred to the black surface and the procedure is repeated. A description of this method is given in reference[11].

3. The third method was adopted with one important modification. To meet the objection that the variable values of the absorption and scattering coefficients could be due to a non-uniform paint film, the reflectance was measured over the same area of film. (See Appendix 2.) To overcome the difficulty of identifying the same spot on the film when it was over white and black surfaces, the plastic sheet (Melinex) was laid over the port of the reflectometer and the black or white tile was placed over it and weighted down with a 5kg weight. The reflectance was then measured over different spots of this combined surface. The reflectance of the white surface was 0.7536 ± 0.0004 and of the combined surface 0.6400 ± 0.006. The reflectance of the black surface was 0.0070 ± 0.0005 and of the black surface with the plastic sheet over it 0.0200 ± 0.0008. The values 0.6400 and 0.0200 were used in the calculations for the reflectance over the white and black backgrounds respectively.

The technique used was as follows: The paint film was laid over the port with the painted side down and the black tile was laid over it and weighted down. After completing the measurement, the tile was carefully removed so as not to disturb the film in any way, and the white tile was laid down and the reflectance measured. The procedure was repeated over different areas of the paint film.

For the preparation of the paint films a K Hand Coater was used. After allowing 48 hours for drying, a given area was cut out with a template and weighed. The quantity of paint was determined either by subtracting the weight of an equal area of Melinex from this or by ashing. Both methods gave the same results within 1 or 2 per cent.

Measurement of reflectance

A Colour Master Model V was used, since this type of instrument is very widely used for reflectance measurements on paint films. Model V has two ports, one of 1,500mm^2 and one of 75mm^2 area. In some cases determinations were carried out over both openings. With the smaller opening the reflectance was measured over ten different areas and with the larger opening the measurements were made over five areas. The area of the paint film was 5,750mm^2.

Calculations

The reflectance measurements were evaluated with the help of the K and M or H equations, and the solutions of these were programmed. (See Table 1.)

Types of paint used

Paint 1: White gloss enamel, $R_\infty = 0.9030$

Paint 2: Off-white gloss enamel, $R_\infty = 0.8025$

Paint 3: White matt enamel, $R_\infty = 0.8786$

Paint 4: Off-white matt enamel, $R_\infty = 0.8000$

The results are summarised in Tables 2 to 13.

Table 1

Measurements performed, equations used, and the values calculated

Programme	Appendix	Equations used	Measurements	Values Calculated
1	2	K and M	Reflectance measurements over a black and white surface	R_∞ K, S
2	3	K and M	Reflectance measurements over a black surface together with R_∞	$K, S, R_0/R$
3	4	H	Reflectance measurements over a black and a white surface	R_∞ K, S
4	5	H	Reflectance measurements over a black surface together with R_∞	$K, S, R_0/R$

Discussion

Programme 1 (see Table 2)

A minimum film thickness, depending on the type of paint, must be exceeded before a result can be obtained from the equations. For thicknesses less than the minimum, the value of a as calculated from equation (5) (Appendix 2) is smaller than 1.

A reasonable value is obtained for the corresponding film thicknesses, as characterised by the contrast ratio:

White gloss enamel	C.R. > 0.9800
Off-white gloss enamel	C.R. > 0.8100
White matt enamel	C.R. > 0.9400
Off-white matt enamel	C.R. > 0.6500

An estimate of R_∞ showing less than 2 per cent deviation from the observed value can be obtained from films with the following thicknesses, as characterised by the contrast ratio:

White gloss enamel	C.R. > 0.9800
Off-white gloss enamel	C.R. > 0.9800
White matt enamel	C.R. > 0.9800
Off-white matt enamel	C.R. > 0.9400

For all paints, the value of S_{100} decreases with increasing film thickness, whereas the values of K_{100} follow the opposite trend. The weight of paint film (G) necessary to give the prescribed C.R. value does not change as much as would be expected, because the decrease in S_{100} is partly compensated by the increase in K_{100}.

Table 2

Programme 1, K and M equations

Calculation of derived values from reflectance measurements over black and white surfaces

Type of paint	U	R_0/R	S_{100}	K_{100}	G	$(R_\infty)_{\mathrm{cal}}$	% difference between observed and calculated values of R	S/K
White gloss enamel $R_\infty = 0.9030$	47.83	0.9844	17.1	0.0634	73.5	0.9178	1.6	—
Off-white gloss enamel $R_\infty = 0.8025$	7.72	0.8159	21.9	0.0945	54.6	0.9113	13.5	231.7
	14.65	0.8996	18.0	0.285	42.8	0.8369	7.0	63.1
	23.89	0.9492	15.7	0.303	45.2	0.8222	2.5	51.8
	39.42	0.9829	14.8	0.346	45.0	0.8059	0.4	42.7
	43.16	0.9860	14.3	0.350	43.2	0.8022	0	40.8
White matt enamel $R_\infty = 0.8786$	38.02	0.9485	11.05	0.058	101.0	0.9025	2.6	190.5
	61.44	0.9757	10.4	0.048	112.0	0.9086	3.3	216.7
	75.52	0.9876	10.7	0.094	89.0	0.8759	0.0	113.8
Off-white enamel $R_\infty = 0.8000$	14.99	0.8773	15.35	0.153	59.1	0.8685	7.9	100.3
	23.43	0.9169	12.35	0.202	61.4	0.8348	4.2	61.1
	30.28	0.9482	12.2	0.265	56.3	0.8114	1.4	46.0
	47.59	0.9679	9.5	0.247	69.2	0.8027	0.3	38.4

Programme 2 (*see Table 3*)

The equations give an answer for all film thicknesses. S_{100} and K_{100} decrease with increasing film thickness. The ratio S/K is constant because R_∞ is given, and this from the K and M equation is equal to:

$$1 + \frac{K}{S} - \left[\left(1 + \frac{K}{S}\right)^2 - 1\right]^{\frac{1}{2}}$$

Estimates of $(R_0/R)_{\mathrm{cal}}$ showing less than 2 per cent deviation from the observed value can be obtained from films which have the following thickness as characterised by the contrast ratio:

White gloss enamel	C.R. > 0.9300
Off-white gloss enamel	C.R. > 0.9000
White matt enamel	C.R. > 0.9200
Off-white matt enamel	C.R. > 0.9200

Table 3

Programme 2, K and M equations

Calculations of derived values from reflectance measurements over black surface

Type of paint	U	R_0/R	S_{100}	K_{100}	G	$(R_0/R)_{\text{cal}}$	% difference between observed and calculated values of R_0/R	S/K
White gloss enamel $R_\infty = 0.9030$	3.44	0.6933	34.7	0.180	32.4	0.7357	6.0	193.0
	6.49	0.7861	27.2	0.142	41.1	0.8253	4.7	192.0
	10.22	0.8400	22.3	0.116	50.4	0.8729	3.9	192.0
	14.27	0.8827	20.7	0.108	55.4	0.9108	3.2	192.0
	23.73	0.9308	18.5	0.0961	61.0	0.9200	1.2	193.0
	37.34	0.9618	18.2	0.0948	60.8	0.9787	1.7	192.0
	44.15	0.9844	18.2	0.0948	60.2	0.9876	0.3	192.0
Off-white gloss enamel $R_\infty = 0.8025$	2.64	0.6344	32.7	0.795	20.0	0.6550	3.0	41.1
	4.93	0.7559	29.6	0.720	22.1	0.7950	5.0	41.1
	7.73	0.8159	23.7	0.577	27.6	0.8450	3.6	41.1
	14.61	0.8996	19.3	0.469	33.9	0.9190	2.1	41.1
	24.64	0.9492	16.7	0.405	39.2	0.9610	1.2	41.2
	40.57	0.9829	15.0	0.365	43.7	0.9850	0.2	41.1
	48.70	0.9860	12.7	0.308	51.7	0.9860	0	41.2
White matt enamel $R_\infty = 0.8786$	3.19	0.6565	32.7	0.276	29.3	0.7017	6.9	118.4
	8.26	0.7648	19.5	0.163	49.3	0.8079	1.1	119.6
	14.71	0.8513	14.7	0.123	65.6	0.8652	1.6	119.5
	17.63	0.8507	13.6	0.114	70.4	0.8836	3.9	119.2
	27.37	0.9193	12.3	0.103	77.9	0.9295	1.1	119.4
	38.90	0.9485	11.4	0.959	84.1	0.9557	0.8	119.5
	59.57	0.9757	10.8	0.905	89.1	0.9633	1.3	119.3
	82.82	0.9876	9.5	0.079	101.5	0.9759	1.2	120.2
Off-white matt enamel $R_\infty = 0.8000$	3.84	0.6888	31.6	0.792	20.5	0.7489	8.7	39.9
	6.77	0.7631	23.3	0.585	27.7	0.8135	6.6	39.9
	15.14	0.8773	16.8	0.421	38.5	0.9043	3.0	39.9
	23.01	0.9169	13.8	0.345	46.9	0.9343	1.8	40.0
	30.95	0.9482	12.4	0.311	52.1	0.9550	1.0	39.9
	64.22	0.9854	10.2	0.256	63.3	0.9885	0.3	39.8

Programme 3 (*see Table 4*)

A reasonable answer is obtained for all film thicknesses. S_{100} and K_{100} both decrease with increasing film thickness and this makes the ratio S/K less variable than in programme 1.

An estimate of R_∞ showing less than 2 per cent deviation from the observed value can be obtained from films which have the following thickness as characterised by the contrast ratio:

White gloss enamel	C.R. > 0.9600
Off-white gloss enamel	C.R. > 0.8100
White matt enamel	C.R. > 0.9700
Off-white matt enamel	C.R. > 0.8700

That is, with the H equations a good estimate of R_∞ can be obtained from thinner films than with the K and M equation.

Table 4

Programme 3, H equations

Calculations of derived values from reflectance measurements over black and white surfaces with R_∞ given

Type of paint	U	R_0/R	S_{100}	K_{100}	G	$(R_\infty)_{\text{cal}}$	% difference between observed and calculated values of R_∞	S/K
White gloss enamel $R_\infty = 0.9030$	3.41	0.6933	24.4	1.64	12.9	0.8813	2.5	14.9
	6.42	0.7861	17.4	1.23	17.9	0.8752	3.2	14.1
	9.92	0.8400	13.6	1.00	22.9	0.8637	4.6	13.6
	14.28	0.8827	11.3	0,804	27.7	0.8738	3.4	14.0
	22.83	0.9308	9.07	0.591	34.6	0.8774	2.9	15.3
	33.49	0.9618	7.81	0.438	40.8	0.8861	1.9	17.8
	47.04	0.9844	7.22	0.433	43.8	0.8893	1.5	16.7
Off-white gloss enamel $R_\infty = 0.8025$	2.65	0.6344	25.3	3.35	11.4	0.7904	1.5	7.6
	4,80	0.7559	20.5	2.21	14.5	0.8229	2.5	9.3
	7.29	0.8159	16.3	1.95	18.0	0.8005	0.2	8.3
	14.61	0.8996	11.5	1.45	25.3	0.7987	0.4	7.9
	23.54	0.9492	9.4	1.14	31.4	0.8023	0.0	8.2
	39.69	0.9829	7.7	0.963	38.0	0.7997	0.3	8.0
	42.31	0.9860	7.6	1.01	38.5	0.7973	0.6	7.5
White matt enamel $R_\infty = 0.8786$	3.09	0.6565	24.1	1.56	13.1	0.8853	0.8	15.4
	8.12	0.7648	12.8	0.933	24.4	0.8725	0.6	13.7
	14.35	0.8513	9.6	0.984	31.3	0.8279	6.0	9.8
	17.36	0.8507	8.1	0.636	38.4	0.8638	1.7	12.7
	27.68	0.9193	6.8	0.625	44.6	0.8449	4.0	10.9
	35.99	0.9485	6.3	0.541	48.5	0.8537	2.5	11.6
	55.54	0.9757	5.3	0.419	58.6	0.8629	1.8	12.5
	73.60	0.9876	4.8	0.374	65.1	0.8642	1.6	12.8
Off-white matt enamel $R_\infty = 0.8000$	3.78	0.6888	22.6	1.56	14.4	0.8741	8.5	14.5
	6.75	0.7631	15.9	1.42	20.1	0.8422	5.0	11.2
	14.46	0.8773	10.4	1.24	28.3	0.8085	1.1	8.4
	23.76	0.9169	7.6	0.950	38.6	0.8014	0.2	8.0
	31.14	0.9482	7.0	0.910	41.8	0.7937	0.8	7.7
	58.45	0.9854	5.4	0.690	53.4	0.7992	0.1	7.8

Programme 4 (see Table 5)

A reasonable answer is obtained for all film thicknesses. Both S_{100} and K_{100} decrease with increasing film thickness. The ratio S/K is constant because R_∞ is given, and from this the H equation is equal to $1/(1 + 2K/S)$.

Estimates of $(R_0/R)_{\text{cal}}$ showing less than 2 per cent deviation from the observed value can be obtained from films which have the following thicknesses as characterised by the contrast ratio:

White gloss enamel	C.R. > 0.8400
Off-white gloss enamel	C.R. > 0.6300
White matt enamel	C.R. > 0.9400
Off-white matt enamel	C.R. > 0.8700

The H equations, therefore, provide a better estimate of $(R_0/R)_{\text{cal}}$ from thinner films than the K and M equations.

Table 5

Programme 4, H equations

Calculation of derived values from reflectance measurements over black surface with R_∞ given

Type of paint	U	R_0/R	S_{100}	K_{100}	G	$(R_0/R)_{\text{cal}}$	% difference between observed and calculated values of R_0/R	S/K
White gloss enamel $R_\infty = 0.9030$	3.39	0.6933	24.1	1.29	17.6	0.6852	1.2	18.7
	6.42	0.7861	16.8	0.903	20.8	0.7727	1.7	18.6
	10.12	0.8400	12.7	0.684	27.6	0.8228	2.0	18.6
	14.36	0.8827	10.6	0.570	33.1	0.8658	1.9	18.6
	23.65	0.9308	8.2	0.443	42.5	0.9184	1.7	18.5
	36.76	0.9618	7.0	0.374	50.4	0.9590	0.3	18.7
	44.04	0.9844	7.0	0.372	50.2	0.9800	0.4	18.8
Off-white gloss enamel $R_\infty = 0.8025$	2.65	0.6344	25.1	3.08	12.4	0.6297	0.7	8.1
	4.89	0.7559	20.6	2.54	15.1	0.7671	1.5	8.1
	7.76	0.8159	15.5	1.90	20.1	0.8191	0.3	8.2
	14.50	0.8996	11.4	1.41	27.2	0.8996	0.0	8.1
	24.35	0.9492	9.0	1.11	34.6	0.9491	0.0	8.1
	40.73	0.9829	7.2	0.890	43.1	0.9803	0.0	8.1
	46.85	0.9860	6.4	0.782	49.0	0.9810	0.3	8.2
White matt enamel $R_\infty = 0.8786$	3.16	0.6565	23.6	1.63	14.4	0.6589	0.3	14.5
	8.20	0.7648	12.5	0.857	27.3	0.7619	0.4	14.6
	14.27	0.8513	8.9	0.616	38.6	0.8217	3.5	14.4
	17.67	0.8507	7.7	0.534	44.2	0.8418	1.1	14.4
	28.88	0.9193	5.9	0.411	57.5	0.8957	2.6	14.4
	38.07	0.9485	5.4	0.373	63.2	0.9299	2.0	14.5
	58.83	0.9757	4.4	0.306	77.0	0.9633	1.3	14.4
	80.14	0.9876	3.7	0.257	91.4	0.9759	1.2	14.4
Off-white matt enamel $R_\infty = 0.8000$	3.78	0.6888	23.2	2.89	13.4	0.7219	4.8	8.0
	6.77	0.7631	15.9	1.99	19.6	0.7868	3.0	8.0
	14.90	0.8773	10.3	1.29	32.0	0.8838	1.4	8.0
	23.17	0.9169	7.8	0.979	39.7	0.9181	0.1	8.0
	31.00	0.9482	6.7	0.845	45.9	0.9426	0.6	7.9
	63.09	0.9854	4.9	0.623	62.3	0.9847	0.1	7.9

Reproducibility of measurements of S_{100} and K_{100}

As the values obtained for the scattering and absorption coefficients from reflectance measurements depend on the thickness of the film on which the measurements are carried out, it is first necessary to prepare films having a uniform thickness. This was possible only with the white gloss enamel paint, and in this case the values for S_{100}, K_{100}, and G (Table 6) showed little variability.

It was not possible to prepare films of reasonably uniform thickness for all the paints used, but of the many films that were obtained, there were some which came very near to being of the same thickness, and in such cases the values for S_{100}, K_{100} and G differed only within the range shown in Table 6.

Table 6

Programme 3, H equations. White gloss enamel, $R_\infty = 0.9030$

Reproducibility of S_{100}, K_{100}, and G

U	R_0/R	S_{100}	K_{100}	G	S/K	$(R_\infty)_{cal}$	% difference between observed and calculated values of R_∞
22.16	0.9220	8.8	0.650	35.3	33.55	0.8722	4.0
21.92	0.9220	9.0	0.595	35.0	15.07	0.8830	2.3
22.34	0.9188	8.7	0.571	36.3	15.14	0.8833	2.2
22.70	0.9259	8.9	0.567	35.5	15.66	0.8868	1.8

Calculation of S_{100} and K_{100}

The method of calculation of S_{100} and K_{100} is explained in Appendix 2. The calculation can be made either by taking into account the non-uniformity of the paint film in the manner explained in the Appendix, or by using the averages of the reflectances for the calculations. The values for the scattering and absorption coefficients and the quantity of paint necessary to give a predetermined C.R. (Table 7) differ only little.

Table 7

Programme 1, K and M equations. Off-white gloss enamel. Reflectance measurements over black and white surfaces

Calculations carried out as detailed in Appendix 2

U	R_0/R	S_{100}	K_{100}	G	U_1	$(R_0/R)_{av}$	S_{av100}	K_{av100}	G_1
7.72	0.8159	21.9	0.095	54.6	7.88	0.8207	21.8	0.120	51.6
14.65	0.8996	18.0	0.285	42.8	14.20	0.8972	18.0	0.262	43.6
23.89	0.9492	15.7	0.303	45.2	23.49	0.9485	15.7	0.327	44.1
39.42	0.9892	14.8	0.346	45.0	41.23	0.9850	14.7	0.353	44.7
43.16	0.9860	14.3	0.350	43.2	41.33	0.9852	14.3	0.392	43.8

Change of sequence of measurements in calculations

As mentioned in the introduction, ten values of reflectance were measured over the black and white surfaces and the scattering coefficient was determined by assuming that $X = 1$ for one of the measurements. Then S_{100}, K_{100}, G and the relative thicknesses of the various areas of the paint films were calculated as explained in Appendix 2.

Some consideration might be given to the effect of starting the calculation with a different pair of measurements, and the result of one such calculation is given in Table 8. In column c the film thicknesses are given on the assumption that this is unity over the area of the first measurement. In column d the film thicknesses shown are relative to a thickness of 1.0000 over the area of the fifth measurement. If S_{100} is independent of the film thicknesses in the range encountered in this film (the greatest difference is about 12 per cent between the areas measured), the values in column d should be obtained by dividing

Table 8

Programme 1, K and M equations. Off-white gloss enamel, $R_\infty = 0.8025$

Change of sequence of measurements in calculation

a	b	c	d	e	f	g	h	j
Measurements	R_0/R	X	X	X	U	S_{100}	K_{100}	G
1	0.8593	1.0000	1.0616	1.0616	11.93	17.2	0.1920	50.39
2	0.8645	1.0218	1.0848	1.0847				
3	0.8670	1.0343	1.0980	1.0980				
4	0.8656	1.0286	1.0920	1.0990				
5	0.8471	0.9420	1.0000	1.0000	11.24	17.3	0.1681	52.78
6	0.8494	0.9350	1.0117	0.9926				
7	0.8551	0.9743	1.0343	1.0343				
8	0.8705	1.0510	1.1158	1.1157				
9	0.8542	0.9735	1.0335	1.0334				
10	0.8650	1.0269	1.0902	1.0901				

the values of X in column c by 0.9420, the relative film thickness (fifth measurement) in column c. These data are given in column e and it can be seen that there is scarcely any difference between the two columns. The values obtained for S_{100} are practically the same, but those for K_{100} differ by 13 per cent, leading to values in G which differ by 4 per cent. The difference in the value of K_{100} is probably due to a slightly different dispersion of the coloured pigment in various areas of the paint film.

Measurements with the large aperture of the Colour Master

The values of S_{100}, K_{100}, G, R_∞, R_0/R obtained by measurements over the larger aperture in the Colour Master are slightly different from those obtained over the smaller opening. A comparison of some values obtained by Programme 3 with a white gloss enamel is given in Table 9.

Table 9

Comparison of measurements over large and small apertures

Programme 3, White gloss enamel, R_∞ over small aperture 0.9030, R_∞ over large aperture 0.9073

U	R_0/R	S_{100}	K_{100}	G	R_∞ cal	% difference between observed and calculated values
			Small aperture			
22.16	0.9220	8.81	0.650	35.34	0.8722	3.5
21.92	0.9220	8.97	0.595	35.01	0.8830	2.2
22.34	0.9188	8.65	0.571	36.32	0.8833	2.2
22.70	0.9259	8.88	0.567	35.48	0.8868	1.7
			Large aperture			
—	—	—	—	—	—	—
21.87	0.8969	8.35	0.486	39.14	0.8957	1.3
22.59	0.8951	8.03	0.468	40.75	0.8955	1.3
22.02	0.8907	8.41	0.475	38.99	0.8968	1.2

Proposals for the determination of the scattering and absorption coefficients

From the results obtained on four different types of paint, it is evident that the values for S_{100}, K_{100} and G depend on the thickness of the film upon which the measurements are made. Constant values can be expected only when the thickness is great so that the C.R. exceeds 0.9600. Paints must therefore be compared at nearly the same, or at very high, film thicknesses. If the scattering and absorption coefficients of pigments are to be found, e.g. various grades of titanium dioxide, they should be compared in paints prepared to have the same film thickness. With a K Hand Coater, it is possible to prepare white gloss enamel films which are sufficiently uniform in thickness, and the values for S_{100}, K_{100} and G can then be calculated from the K and M or H equations. The measurements may be made over either aperture of the Colour Master. To obtain more accurate results, it is desirable to repeat the calculations by starting successively with the first, second, third, and so on measurements and take the average value. Results of a calculation for an off-white gloss enamel paint are given in Table 10.

Table 10

Programme 1, K and M equations. Off-white gloss enamel

Values of U, S_{100}, etc. if the calculation is started with the 1st, 2nd, 3rd to 10th reflectance measurements

Measurement	R_0/R	U	S_{100}	K_{100}	G
1	0.8593	11.93	17.29	0.192	50.39
2	0.8645	12.19	17.28	0.226	47.64
3	0.8670	12.34	17.29	0.235	46.84
4	0.8656	12.27	17.29	0.224	47.73
5	0.8471	11.23	17.29	0.168	52.78
6	0.8494	11.37	17.28	0.169	52.75
7	0.8551	11.62	17.29	0.209	48.01
8	0.8705	12.54	17.29	0.250	45.90
9	0.8542	11.61	17.29	0.189	50.61
10	0.8550	12.25	17.29	0.216	48.39
Average		11.93	17.29	0.208	49.20

The biggest variation in film thickness is 11 per cent. The values for S_{100} are constant, but the percentage variation of K_{100} is considerable over the different areas, probably due to flocculation of the absorbing coloured pigment.

If the hiding power of a paint of unknown composition is to be found it is best to work at such a film thickness that the C.R. > 0.9600. The thickness of paint films which will give a C.R. of 0.9800 may then be extrapolated by using the K and M equations. The H equations do not seem to be as suitable for this purpose. The measurements can again be made over either size aperture, and the results may be evaluated by the procedure outlined previously. The results of calculations for a thick paint film for which $R_0/R > 0.9800$ are given in Table 11; the average value $G = 44.53$ characterises the hiding power of the paint. For a thicker film for which $R_0/R > 0.9900$ the value for G was 43.67.

Table 11

Programme 1, K and M equations. Off-white gloss enamel

Values of U_1, S_{100}, K_{100}, and G for a thick paint film C R. > 0.9800 if the calculation is started with the 1st, 2nd, 3rd to 10th reflectance measurements

Measurement	R_0/R	U	S_{100}	K_{100}	G
1	0.9829	39.42	14.80	0.346	44.89
2	0.9879	43.67	14.80	0.366	43.67
3	0.9877	43.61	14.80	0.363	44.09
4	0.9858	41.56	14.80	0.363	41.60
5	0.9802	37.76	14.80	0.329	45.76
6	0.9816	39.45	14.80	0.305	47.05
7	0.9844	40.36	14.80	0.359	44.27
8	0.9848	40.08	14.80	0.383	43.19
9	0.9848	—	—	—	—
10	0.9898	46.09	14.80	0.370	46.32
Average		41.33	14.80	0.354	44.53

It is stressed that the proposals outlined here must be checked by different laboratories before they can be generally accepted. The proposed procedure is probably too time-consuming to be used for routine testing, but it could provide a valuable research tool.

Conclusions

The value of the scattering and absorption coefficients obtained with the K and M or H equations depends on the thickness of the paint film upon which the reflectance measurements are carried out. The scattering coefficient always decreases with increasing thickness of the paint film, but the behaviour of the absorption coefficient is more complex, since it increases or decreases depending on the set of equations and the programme used. The calculated values for the scattering and absorption coefficients approach a constant value only at high film thicknesses.

Both the K and M and the H equations allow calculation of the reflectivity from reflectance measurements over white and black surfaces within 2 per cent of the value found experimentally. The film thickness at which the calculation can be made depends on the paint and the set of equations used. The H equations are better than the K and M equations in obtaining an estimate from thinner films.

The value R_0/R can be found from measurements of the reflectance over a black surface and a knowledge of the reflectivity. By using the H equations, it is usually possible to make estimates from thinner films than by the use of the K and M equations.

A method has been proposed for calculating the scattering and absorption coefficients from measurements of scattering on thin and thick films.

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Notation

a	$1 + K/S$
b	$(a^2 - 1)^{\frac{1}{2}}$
coth	Hyperbolic cotangent
$\coth^{-1} y$	Arc whose hyperbolic cotangent is y
D	K/S
G	UX_c
G_1	U_1X_c
I	Intensity of radiation at a plane at a depth x from surface of a paint film
I_0	Intensity of radiation at the surface of a paint film
i	Light flux through the paint film; upwards direction
j	Light flux through the paint film; downwards direction
K	Absorption coefficient of paint film with density U
K_{av}	Average of absorption coefficients of paint film with density U
K_{100}	Absorption coefficient of paint film containing 100g solids evenly distributed over 1m^2
R	Reflectance of paint film over white surface (reflectance R_g)
R_b	Reflectance of black background
R_g	Reflectance of background
R_0	Reflectance of paint film over black surface
R_w	Reflectance of white background
R_0/R	Contrast ratio (C.R.)
R_∞	Reflectivity; reflectance of a paint film of such a thickness that any increase in thickness does not change the value of the reflectance
$(R_\infty)_{cal}$	Calculated reflectivity from measurements over white and black surfaces
$(R_0/R)_{cal}$	Calculated contrast ratio
$(R_0/R)_{av}$	$\Sigma R_0/\Sigma R$
S	Scattering coefficient of paint film with density U
S_{100}	Scattering coefficient of paint film containing 100g solids evenly distributed over 1m^2
U	Weight of paint solids (in g m^{-2}) in film for which reflectance measurements were made, assuming solids to be evenly distributed with density of first test area
U_1	$174W$ (the factor 174 converts the weight of solids in the 5,750mm^2 area of paint film to g m^{-2})
W	Weight of paint film (in g)
X	Thickness of paint film, here expressed in g m^{-2}
X_c	Film thickness necessary to give reflectance defined in the programme
X_{cav}	Average of X_c

Appendix I

H equations

It is assumed that the light intensity, I, at a plane at a distance x from the surface follows an exponential law and $I = I_0 \exp - (K + S)x$, where I_0 is the intensity at the surface. The light scattered from a paint film of thickness dx at the plane x is assumed to be $S\,dx\,I$ which on its way to the surface of the paint film will suffer an attenuation to $SI \exp(-Kx)dx = I_0 S \exp - (2K + S)dx$ and will emerge there. The total scattered light from the paint film leaving the surface can be found by integration of the foregoing expression from $x = 0$ to $x = X$, where X is the thickness of the paint film. This gives $I_0 \frac{S}{2K+S} \exp - (2K + S)x \Big|_0^X = I_0 \frac{S}{2K+S} [1 - \exp - (2K + S)X]$. The light intensity at X will be $I_0 \exp - (K + S)X$, and if the reflection of the background is R_g, $R_g I_0 \exp - (K + S)X$ will be reflected. This again is attenuated to $R_g I_0 \exp - (2K + S)X$. The total light, I, reflected from the paint over a background R_g will therefore be:

$$I_0 \frac{S}{2K+S} [1 - \exp - (2K + S)X] + I_0 R_g \exp - (2K + S)X$$

and the reflectance $I/I_0 = R$ over a background with reflectance R_g will be

$$R = \frac{S}{2K+S} [1 - \exp - (2K + S)X] + R_g \exp - (2K + S)X.$$

If X becomes very large R is called the reflectivity and becomes $\frac{S}{2K+S}$.

Appendix 2

Programme 1: based on K and M equations

In this programme the reflectance of a paint film of known thickness is measured over white and black surfaces. The calculations start from the equations

$$R = \frac{1 - R_w[a - b\coth(bSX)]}{a - R_w + b\coth(bSX)} \quad \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

and

$$R_0 = \frac{1 - R_b[a - b\coth(bSX)]}{a - R_b + b\coth(bSX)} \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

The symbols have the following meaning:

R_w = reflectance of the system Melinex film—white test plate
R_b = reflectance of the system Melinex film—black test plate
R = reflectance of paint film over white test plate
R_0 = reflectance of paint film over the black test plate
a, b = constants
X = film thickness expressed in weight of paint solids expressed in g m^{-2} of surface.

From (1)

$$\coth(bSX) = \frac{1 - a R_w + R(R_w - a)}{b(R - R_w)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

and from (2)

$$\coth(bSX) = \frac{1 - a R_b + R_0(R_b - a)}{b(R_0 - R_b)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Equating (3) and (4)

$$a = \frac{(R_0 + R_w)(RR_b - 1) - (R + R_b)(R_0R_w - 1)}{2(RR_b - R_0R_w)} \quad \ldots\ldots\ldots (5)$$

Once a is determined the other values are easily calculated[4].

$$b = (a^2 - 1)^{\frac{1}{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

from (4)

$$SX = \frac{1}{b} \coth^{-1} \frac{1 - a R_b + R_0(R_b - a)}{b(R_0 - R_b)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$R_\infty = a - b \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$K = S(a - 1) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$$X_c = \frac{1}{bS} \coth^{-1} \frac{1 - a R_b + 0.98 R_\infty (R_b - a)}{b(0.98 R_\infty - R_b)} \quad \ldots\ldots\ldots\ldots (10)$$

equation (10) follows from equation (7) by substituting 0.98 R_∞ for R_0. That is, X_c is the necessary film thickness to give a reflection of 0.98 R_∞ over a black surface.

Procedure

For each pair (R, R_0), a is determined from equation (5), b is then determined from equation (6) and R_∞ from equation (8). For the first pair (R, R_0), S is found from equation (7), assuming $X = 1$. From the other pairs of values (R, R_0), X is determined assuming that S is constant. K is determined from equation (9).

A value $U = \dfrac{174SW}{\text{av } X}$ is then determined where W is the weight of the paint film in g and av.X is the average of the X's. The expression has the following meaning. As already pointed out for the first pair (R, R_0), X has been assigned the value 1 so that the value of S can be calculated. The paint film is not uniform but it is assumed that S is constant within the comparatively small variation of the film thickness, and if this is granted X can be calculated.

$\frac{W}{avX}$ is therefore the weight of the paint solids if these were evenly distributed over the whole area of the paint film with the same density as occurs in the first test area (R, R_0). The factor 174 converts the weight of paint solids over the test film area (5,750mm^2) to g m^{-2}.

The value of X_c is calculated from equation (10) for each pair of values (R, R_0). Averages are calculated for R_w, R_0, R_0/R, a, b, R_∞, X, and X_c. S_{av} is calculated with the relevant average values from equation (7), with $X = 1$. That is, an even distribution of the paint solids is assumed. The value $U_1 = 174W$ is then found and this represents the weight of paint solids per m^2 on the assumption that the paint solids in the film are evenly distributed.

K_{av}, X_{cav} and U_1 X_{cav} are calculated using the average values. The following example illustrates the procedure just described:

Table 12 gives an example of the output of the computer and this is used in the following manner: $S = 2.0622$, which is a constant. Dividing by U and multiplying by 100 gives the scattering coefficient of 100g paint solids evenly distributed over 1m^2, the actual measurement being made at a density of Ug m^{-2}. This value is called S_{100}. Taking the value for K from the first line and using the same method of calculation as for S provides a value of K_{100} analogous with S_{100}. Multiplying U by X_c from the first line gives the weight of paint solids necessary to give a C.R. as defined by equation (10). Analogous calculations are then carried out on the assumption that the paint solids are uniformly distributed with density U, and the values $Sav_{100} = \frac{100S_{av}}{U_1}$ $K_{av100} = \frac{100K_{av}}{U_1}$ and $G_1 = U_1 X_{cav}$ are obtained. A table is then set up in which all the relevant data are recorded for easy comparison (Table 13).

The above calculations make sense only if the values obtained for the scattering and absorption coefficients are independent of the order in which the calculations are carried out. That is, if S is found from the fifth entry in Table 12 ($R = 0.7706$, $R_0 = 0.6528$) instead of being calculated from equation (7) with the help of the measurements $R = 0.7724$ and $R_0 = 0.6637$, the same or very similar values should be found for S_{100}, K_{100}, and so on. This is demonstrated in Table 8.

Table 12

Programme 1, Off-white gloss enamel, $R_\infty = 0.8025$

$R_w = 0.6400$, $R_b = 0.0200$, $W = 0.0686$

	R	R_0	R_0/R	a	b	R_∞	K	X	X_c	S
	0.7724	0.6637	0.8593	1.0111	0.1496	0.8616	0.0229	1.000	4.2243	2.0622
	0.7704	0.6660	0.8645	1.0130	0.1620	0.8510	0.0269	1.0218	3.9932	do
	0.7702	0.6678	0.8670	1.0136	0.1655	0.8481	0.0280	1.0343	3.9338	do
	0.7710	0.6674	0.8656	1.0130	0.1615	0.8514	0.0267	1.0286	4.0017	do
	0.7706	0.6528	0.8471	1.0097	0.1398	0.8700	0.0200	0.9420	4.4283	do
	0.7714	0.6552	0.8494	1.0097	0.1400	0.8698	0.0201	0.9350	0.4239	do
	0.7688	0.6574	0.8551	1.0121	0.1560	0.8561	0.0249	0.9743	4.1011	do
	0.7697	0.6700	0.8705	1.0144	0.1706	0.8439	0.0298	1.0510	3.8489	do
	0.7708	0.6584	0.8542	1.0109	0.1486	0.8624	0.0226	0.9735	4.2482	do
	0.7718	0.6676	0.8650	1.0125	0.1584	0.8541	0.0257	1.0269	4.0576	do
Mean ..	0.7707	0.6628	0.8598	1.0120	0.1552	0.8568	0.0248	1.0005	4.1261	

$U = 11.9299$, $U_1 = 11.9364$, $S_{av} = 2.0606$, $X_{cav} = 4.1373$, $U_1 X_{cav} = 49.2653$, $K_{av} = 0.02473$

Table 13

Example of summary of calculations. Off-white gloss enamel paint. $R_\infty = 0.08025$

U	R_0/R	S_{100}	K_{100}	G	U_1	$(R_0/R)_{av}$	S_{av100}	K_{av100}	G_1	R_∞ spot	$R_{\infty av}$
11.93	0.8593	17.2	0.192	50.4	11.95	0.8598	17.29	0.208	49.3	0.8616	0.8568
23.89	0.9492	15.7	0.303	45.2	23.49	0.9485	15.75	0.327	44.2	0.8222	0.8159

Appendix 3

Programme 2: based on K and M equations

In this programme the reflectance (R_0) of a paint film of known thickness is measured over a black surface and the reflectivity (R_∞) is determined separately. The four basic equations are[4]:

$$R_\infty = a - (a^2 - 1)^{\frac{1}{2}} \quad \ldots\ldots (1)$$

$$R_\infty = a - b \quad \ldots\ldots (2)$$

$$R_0 = \frac{1 - R_b[a - b\coth(bSX)]}{a - R_b + b\coth(bSX)} \quad \ldots\ldots (3)$$

$$a = 1 + \frac{K}{S} \quad \ldots\ldots (4)$$

from (1)

$$a = \frac{R^2_\infty + 1}{2R_\infty} \quad \ldots\ldots (5)$$

from (2) and (5)

$$b = \frac{1 - R^2_\infty}{2R_\infty} \quad \ldots\ldots (6)$$

from (3)

$$SX = \frac{1}{b}\coth^{-1}\frac{1 - a\,R_b + R_0(R_b - a)}{b(R_0 - R_b)} \quad \ldots\ldots (7)$$

from (4)

$$K = S(a - 1) \quad \ldots\ldots (8)$$

$$X_c = \frac{1}{bS}\coth^{-1}\frac{1 - a\,R_b + 0.98\,R_\infty(R_b - a)}{b(0.98\,R_\infty - R_b)} \quad \ldots\ldots (9)$$

X_c has the same meaning as in Appendix 2.

From the values found for a, b, S, and X, the reflectance R of the paint film over the white surface was calculated from the equation

$$R = \frac{1 - R_w[a - b\coth(bSX)]}{a - R_w + b\coth(bSX)}$$

The value R_0/R was found and compared with the experimentally determined value R_0/R. The calculated value R_0/R is designated in the tables as $(R_0/R)_{\text{cal}}$.

Procedure

This is similar to the procedure described in Appendix 2.

Appendix 4

Programme 3: based on H equations (for derivation see Appendix 1)

In this programme the reflectance of a paint film of known thickness is measured over black and white surfaces. The calculations start from the two equations:

$$R = \frac{S}{S + 2K} [1 - \exp - (S + 2K)X] + R_w \exp - (S + 2K)X \quad \ldots .(1)$$

$$R_0 = \frac{S}{S + 2K} [1 - \exp - (S + 2K)X] + R_b \exp - (S + 2K)X \quad \ldots .(2)$$

from which the following equations are derived:

$$S + 2K = \frac{1}{X} \ln \frac{R_w - R_b}{R - R_0} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .(3)$$

$$S = \frac{R_0 \dfrac{R_w}{R_b} - R}{\left(\dfrac{R_w}{R_b} - 1\right)\left(1 - \dfrac{R - R_0}{R_w - R_b}\right)} \frac{1}{X} \ln \frac{R_w - R_b}{R - R_0} \quad \ldots .(4)$$

$$K = \frac{- S + \dfrac{1}{X} \ln \dfrac{R_w - R_b}{R - R_0}}{2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots .(5)$$

$$X_c = \frac{1}{S + 2K} \ln \frac{R_w - R_b}{0.02 \dfrac{S}{S + 2K}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots .(6)$$

(X_c = thickness of paint film, so that the difference of the reflectance of the paint film over the black and white test plates is $0.02\, R_\infty = 0.02 \dfrac{S}{S + 2K}$).

Procedure

For the first pair (R, R_0), $S + 2K$ is determined from equation (3), assuming $X = 1$. For the other pairs (R, R_0), X is calculated from equation (3), with the value $S + 2K$ previously obtained. S, K, and X_c are then calculated. The subsequent steps are then similar to those described in Appendix 2.

Appendix 5

Programme 4: based on H equations

In this programme the reflectance R_0 of a paint film of known thickness is measured over a black surface and the reflectivity R_∞ is determined separately. The three basic equations are:

$$R = R_\infty [1 - \exp - (S + 2K)X] + R_w \exp - (S + 2K)X \quad \ldots\ldots(1)$$

$$R_0 = R_\infty [1 - \exp - (S + 2K)X] + R_b \exp - (S + 2K)X \quad \ldots\ldots(2)$$

$$R_{\infty} = \frac{1}{1 + \frac{2K}{S}} \qquad \text{...(3)}$$

from which the following equations are derived :

$$\frac{K}{S} = \frac{1 - R_{\infty}}{2\,R_{\infty}} = D \qquad \text{..................................(4)}$$

$$S = \frac{1}{X(1 + 2D)} \ln \frac{R_{\infty} - R_{b}}{R_{\infty} - R_{0}} \qquad \text{.......................(5)}$$

$$K = S\,D \qquad \text{...(6)}$$

$$X_{c} = \frac{1}{S(1 + 2D)} \ln \frac{R_{\infty} - R_{b}}{0.02\,R_{\infty}} \qquad \text{.......................(7)}$$

(X_c = necessary thickness of paint film, so that the reflectance over the black test plate is 0.98 R_{∞}.)

The reflectance over the white test plate is then calculated from the equation $R = R_{\infty}\,[1 - \exp - S(1 + 2D)X] + R_{w} \exp - S(1 + 2D)X$, and from this R_0/R. This value is designated as $(R_0/R)_{\text{cal.}}$ in the tables, and it is compared with the values of R_0/R found experimentally.

Procedure

For the first value R_0, S is determined from equation (5), assuming that $X = 1$. For all subsequent values of R_0 determine X by substituting the previously determined value for S. The rest of the procedure is then similar to that described in Appendix 2.

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A proposal for measurement of the hiding power of paint

By E. Hoffmann

Division of Building Research, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia

Summary

A new method is proposed for determining the hiding power of paint. It is based on the assumption that the ratio of the weights of two paint films of the same area at a given contrast ratio will be very much the same at other values of contrast ratio. By determining the contrast ratio/weight curve for a standard coating, other paints can be compared with it by finding one value of the contrast ratio of the unknown paint at some suitable weight of paint film.

This fundamental assumption has been proved correct for a number of types of paint.

Keywords

Properties, characteristics and conditions primarily associated with materials in general

contrast ratio

Une proposition à l'égard de la détermination du pouvoir couvrant d'une peinture

Résumé

On propose une nouvelle méthode pour déterminer le pouvoir couvrant des peintures. Elle est bassée sur la présomption que le rapport des poids de deux feuils de peinture ayant la même aire superficielle, à un rapport contraste particulier, sera un peu près semblable aux autres valeurs du rapport contraste. Après avoir déterminé la courbe rapport contraste-masse de peinture pour une peinture de contrôle, on peut comparer d'autres peintures auprès d'elle en trouvant une valeur du rapport contraste de la peinture qui fait l'objet de l'essai, à une masse de feuil qui convient.

On a démontré la justesse de cette présomption fondamentale dans le cas de plusieurs types de peintures.

Ein Vorschlag für das messen der Deckkraft von Anstrichfarben

Zusammenfassung

Zur Bestimmung der Deckkraft von Anstrichfarben wird eine neue Methode vorgeschlagen. Sie beruht auf der Annahme, dass das Gewichtsverhältnis zweier Anstrichfilme gleichgrosser Oberfläche bei einem gegebenen Kontrastverhältnis das gleiche auch bei anderen Kontrastverhältniswerten sein wird. Durch Bestimmung der Kontrastverhältnis/Gewichtskurve für eine Normfarbe können andere Anstrichmittel mit ihr verglichen werden, indem man einen Wert des Kontrastverhältnisses der unbekannten Farbe bei irgendeinem passenden Gewicht des Anstrichfilms auffindet.

Diese fundamentale Annahme erwies sich für eine Anzahl von Anstrichfarbentyps als richtig.

Предложение для измерения кроющей способности красок

Резюме

Предлагается новый метод определения кроющей способности красок. Метод основан на предположении что отношение весов двух красочных пленок одинаковой площади, при данном коэффициенте контрастности, будет почти одинаковым при других значениях коэффициента контрастности. Определив кривую зависимости коэффициента от веса для стандартного покрытия, другие краски могут сравниваться с ней путем определения одного значения коэффициента контрастности неизвестной краски, при некотором подходящем весе красочной пленки.

Доказано что это фундаментальное предположение справедливо для целого ряда красок.

Introduction

Most methods for determining the hiding power of paints are based on the theory by Kubelka and Munk[1, 2]. The authors started with the assumption that the reflectance of a paint over a reflective background can be described by two constants, the absorption and scattering coefficients of the pigments used. From this assumption they derived an equation, containing these two constants, for the reflectance of a paint film of known thickness over a background of a given reflectance.

In a previous paper[3] it was shown that the assumption as to the constancy of the absorption and scattering coefficients cannot be upheld, and that these seem to be constant only for paint films which are so thick that the contrast ratio (CR) is greater than 0.96. A suitable procedure to carry out the determination was described, but the method needs a great deal of calculation and a simplified quick procedure which obviates this would therefore be of advantage.

The present method is based on an assumption which is best explained by reference to Fig. 1, in which the CR of two paints has been plotted against the weight of a paint film of a given area. At CR 0.92, the ratio of the thickness $a/b = k$, which is here called the hiding power factor. The assumption is that this ratio will be very nearly the same at all other values of the contrast ratio. If this proves correct it would be possible, by determining the corresponding

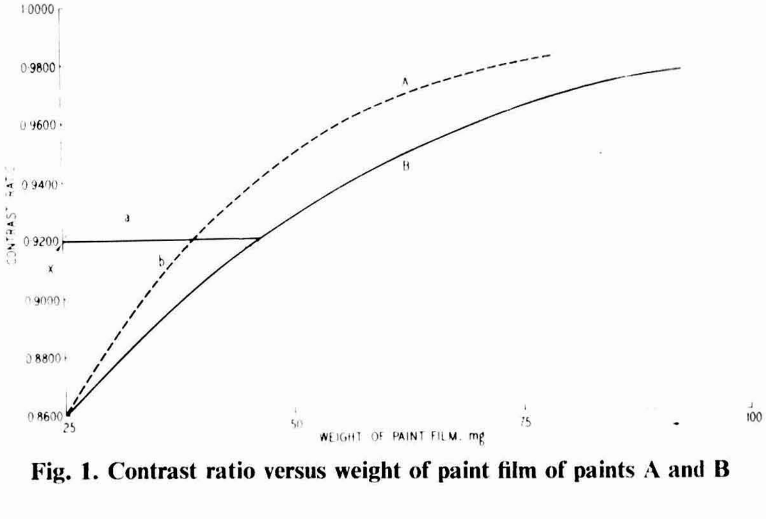

Fig. 1. Contrast ratio versus weight of paint film of paints A and B

curve for a standard paint, to find the hiding power of any other coating by determining the CR of this unknown formulation at some suitable film weight. For instance, if coating A has a hiding power of h m^2/l and the ratio of the film weight is k, then the hiding power of the unknown will be h k.

The paper deals with an investigation of this assumption.

Experimental

The paints used for the experiments and the reflectivity of each were: a commercial white gloss enamel, (C) (0.9030); a white gloss enamel, (D) (lab. preparation) PVC 5 per cent (0.8830); a commercial off-white yellowish gloss enamel (0.8025); a commercial white matt enamel, (0.8786); a commercial off-white matt enamel (yellowish), (0.8000); and a commercial gloss latex paint, (0.9200)

Preparation of paint films

The paint was applied with a "K" Handcoater over a Melinex film, type S, gauge 100. After drying for 48h, a given area was cut out with a template and weighed. The weight of the paint film was found as the difference between the painted and unpainted Melinex.

Determination of contrast ratio

The CR was determined over ten areas of the paint film with a Colour Master Model V over the small port, using the green filter, by the method described elsewhere[3]. The average CR was then calculated and this value was used for determining the hiding power factor. An example of the measurements of contrast ratio of the white gloss enamel (C) is given in Table 1.

Table 1

Determination of the CR of white gloss enamel film (C)

(weight of film, 156mg; area 5,750mm^2)

R	R_0	R_0/R
0.8759	0.8280	0.9453
0.8668	0.8234	0.9499
0.8744	0.8360	0.9561
0.8758	0.8348	0.9532
0.8708	0.8312	0.9545
0.8758	0.8246	0.9415
0.8725	0.8314	0.9529
0.8685	0.8228	0.9474
0.8736	0.8318	0.9522
0.8750	0.8316	0.9504
Av. 0.8729	0.8296	0.9503

R = reflectance over white tile
R_0 = reflectance over black tile
R_0/R = contrast ratio

The standard paint

The white gloss enamel (C) was chosen as the standard paint and the contrast ratio was plotted against the weight of the paint film. To be able to make accurate readings the scale chosen was 0.01 unit of contrast ratio and 22.5mg paint solids, represented by 2.5cm on the ordinate and the abscissae, respectively. The area of paint film which can be handled easily is about 6,000mm^2.

Discussion and conclusion

The results of the experiments are summarised in Tables 2 and 3. If the values of k for the white gloss paint D for CR values under 0.92 are omitted, the largest deviation from the average is 2.6 per cent. This justifies the assumption that k is nearly constant, and the proposed method for the determination of the hiding power would appear to be practicable. It would seem that k should be determined from paint films which have a CR larger than 0.93.

Gloss and matt enamels and latex paints were used in the experiments. The standard had a reflectivity of 0.90 and it proved possible to determine the hiding power of paints with a reflectivity of 0.80. If it is desired to determine the hiding power of darker coatings better results would probably be obtained with a paint of a lower reflectivity as standard.

Table 2

Hiding power factor (k) for off-white gloss, white matt, and off-white matt enamels referred to white gloss enamel C as standard

Contrast ratio	Hiding power factor (k)*		
	Off-white gloss (D)	White matt	Off-white matt
0.8970	$\frac{95.5}{81} = 1.17$	—	$\frac{94.5}{135} = 0.70$
0.9140	$\frac{112.5}{94.5} = 1.19$	$\frac{113}{135} = 0.84$	$\frac{112.5}{160} = 0.70$
0.9260	$\frac{126}{108} = 1.17$	$\frac{126}{151} = 0.84$	$\frac{126}{176} = 0.72$
0.9370	$\frac{140}{121} = 1.16$	$\frac{140}{164} = 0.85$	$\frac{140}{194} = 0.72$
0.9490	$\frac{157}{137} = 1.15$	$\frac{157}{180} = 0.87$	$\frac{157}{219} = 0.72$
0.9650	$\frac{193}{171} = 1.13$	$\frac{193}{222} = 0.87$	$\frac{193}{278} = 0.70$
0.9800	$\frac{252}{216} = 1.17$	—	$\frac{252}{366} = 0.69$
	Av. k = 1.16	Av. k = 0.855	Av. k = 0.705

$$*k = \frac{\text{wt of standard white gloss enamel (C)}}{\text{wt of unknown paint film}}$$

Table 3

Hiding power factor k for white gloss enamel (D) and white gloss latex paints referred to white gloss enamel C as standard

	Hiding power factor (k)		
Contrast ratio	White gloss enamel D	Contrast ratio	White gloss latex paint
0.8390	$\frac{27}{81} = 0.33$	0.9099	$\frac{108}{116} = 0.93$
0.8862	$\frac{40.5}{108} = 0.38$		
0.9270	$\frac{63}{151} = 0.42$	0.9421	$\frac{147}{156} = 0.94$
0.9510	$\frac{81}{197} = 0.41$	0.9667	$\frac{200}{221} = 0.91$
0.9600	$\frac{102}{243} = 0.42$		
0.9800	$\frac{252}{630} = 0.42$	0.9663	$\frac{200}{221} = 0.91$
	Av. k = 0.41		Av. k = 0.922

The proposed method is not judged to be acceptable on the basis of the measurements of a comparatively small number of paints, but it is considered that a good case has been put forward for the proposal to be investigated at different laboratories with a round robin procedure.

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References

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2. Kubelka, P., *J. opt. Soc. Am.*, 1948, **38**, No. 5, 448.
3. Hoffmann, E., Lancucki, C. L., and Spencer, J. W., *JOCCA*, 1972, **55**, 292.

Next month's issue

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

"The theory and practice of dispersion," *by V. T. Crowl*

"A review of the physical chemistry of electrophoresis," *by J. W. Bayles*

"Broad aspects of formulation and process control in electrophoretic deposition," *by R. E. Rouse*

Review

SOLVENTS

By T. H. DURRANS Eighth Edition revised by E. H. Davies, London: Chapman & Hall Ltd., 1971. Pp 267. Price £2.50

In his preface to the first edition (1930) the late Dr Durrans said that he aimed to collect "widely scattered information" into "a concise form wherein the scientific and fundamental aspects are expressed in a readily comprehensible manner and to show the relations of these aspects to general usage." One imagines that most readers approved of this approach at the time and that their successors of today would be even more grateful in view of the "information explosion." However if such an approach is to be successful it is essential that the brief summary of scientific aspects given should be based on a comprehensive and up to date review. Ideally the literature references should enable the reader to go further into the subject if he wishes. It is here that the 8th Edition now under review must be questioned. A check on chapters I to VI, which cover the scientific aspects, showed that more than half the references were dated earlier than 1930. Inevitably the text reflects this and recent work is not systematically covered. For example, under "Solvent action," chapter I, the three-parameter system of Crowley, Teague and Lowe is described, alone among post-war papers, while the equally interesting ideas of Hansen, or of Nelson, Hemwall and Edwards, are omitted. The dust cover is perhaps defending this sort of thing when it says ". . . the criterion for the inclusion of new material is still its value to the user of solvents." But this is begging the question. It may be argued that the "practical" man has no need of these theoretical concepts but it is not reasonable to make an arbitrary selection for him. In any case the problem arises again in the severely practical field of the solubility table of appendix II. Here the resins tested include, for example, mastic, sandarac, elemi and benzyl cellulose but no alkyd, polyester, thermosetting acrylic or epoxy resin. Similarly in the chapter on toxicity, information is given about mesityl oxide, amyl formate and carbon disulphide, but not about such widely used solvents as methyl iso-butyl ketone, iso-butyl acetate or iso-butanol.

The second, and larger, part of the book is a catalogue of commercial solvents and plasticisers and their properties, together with a summary of BS and ASTM specifications for the more common cases. Things are better here, a wide range of materials being covered with no very obvious omissions and a good deal of useful information. Solubilities of some more up to date resins are given in the text, although many out-moded materials still persist. Considering that there is a separate chapter on toxicity one wonders why some solvents are picked out for comment in the text from this point of view while for most this aspect is ignored. Thus several are stated to be "non-toxic," which seems a surprising thing to say about any material. On the other hand the toxicity of ethylene glycol is questioned on the grounds of its effects when taken internally, and of nitroparaffins it is said that ". . . about 0.1 per cent in air may be assumed to be dangerous." One imagines that many commercial solvents would justify one or other, if not both, of these comments. All in all therefore this part of the book hardly gives a balanced viewpoint on toxicity and it would surely be better to keep all this information in its separate chapter.

In spite of the above criticisms, this is a handy little book. It is well laid out. It does contain useful information and some spot checks indicated that this information was commendably easy to locate. But it has an old-fashioned air. As stated in the original preface the information is directed largely at nitrocellulose lacquer technology, not a field of major interest today. The all-embracing title "Solvents" is therefore difficult to justify. Nothing is offered for the solvent problems of, say, two-pack epoxy or polyurethane systems, of stoving paints or of formulations for electrostatic application. A book meeting Dr Durrans' original objectives in today's context, presenting a judicious selection of current work in a pre-digested form for the man with little time to spare, would indeed be a valuable contribution. Unfortunately this cannot seriously be claimed for the volume under review.

L. A. TYSALL

Student Review

Paint Technology Manuals. Part Seven: Works practice

Chapter III. Media manufacture

(Part II)

Processes involving heating in open vessels

The production of the great majority of the resins and media used in the paint industry involves heating to a greater or lesser extent, as regards both the time and the temperature.

Originally, practically all such operations were carried out in simple open vessels with no, or only rudimentary, fume extraction. These processes gave rise to terms such as "varnish kitchen" and "varnish kettle" and the lack of adequate control methods led to much of the mystique and art of "varnish cooking." It is fairly certain that open-pot methods are fast being replaced by properly controlled reaction vessels, due to the increasing use of alkyd and other largely synthetic resins in place of the earlier media based on natural resins such as copals, rosin etc., Economic considerations favour the production of large batches and consistent quality requires accurate control; both these favour the use of large, well controlled, reaction vessels. In general, open reaction vessels are unfavourable in both these respects, so that it is not solely the increase in use of resins such as alkyds that is causing the abandonment of open vessel production.

Some manufacture does take place in open vessels and considerable development has occurred since the days when they were heated directly by coke fires. The vessels used are usually produced in two sizes, 180 and 450 litres nominal capacity, and since they are to be moved and handled, they are made of the lightest possible construction consistent with the necessary strength. The materials of construction must resist heat and corrosion, so that generally stainless steel, copper and aluminium are used. When stainless steel is used, the pot is usually made entirely of this material, but when aluminium is used for the body, the bottom is nearly always copper. Two shapes are common, either a straight-sided cylinder or a tapered cylinder which is narrower at the bottom than at the top. Since the heating takes place on the bottom only, this part may require maintenance and possible renewal. Hence, it is made as a separate dished part with a flange at the top drilled with a number of bolt holes. The upper cylindrical or conical part of the pot is also finished with a similar flange at its lower end. The pot is assembled by clamping the dished bottom and top together by two steel rings held together by bolts. To make the joint completely leak-proof, it is usual to include a thin asbestos gasket between the two flanges. In order to move the vessel easily, lugs are welded to the sides of the stainless steel pots, or in the case of the composite type of pot, attachments can be made to a steel structure which supports the soft aluminium sides.

The pots are handled and moved when necessary by means of specially designed trucks sometimes known as "horses" or "chariots." In one type of "horse," a simple lever fork device is mounted on two large wheels; the longer arm of the lever is the operating end while the shorter arm has two slots, arranged to engage and hold the lugs on the pots. The disadvantages of this type are that it occupies space and involves hard work by the operator. The other type of "horse" is four-wheeled, with castor-type wheels at the front. The framework is arranged so that, when in position to carry the pot, the load is within the area covered by the four wheels. The pots are lifted by a fork device which engages and holds the lugs on the pot. When the pot is in the raised position, the fork can be locked so that the operator can use the towing handle of the truck without having to control the weight of the vessel; this results in much safer and more easily operated handling.

As considerable fumes are produced during the heating process, an efficient means of fume removal is necessary. This consists of a sheet metal cover which can be lowered on to, or swung into place on, the top rim of the pot, and is connected by a duct to a larger pipe which leads to the fume condensation system. The fumes are drawn away from the pot and into the condensers by means of a fan. (Details of the condensation system are given later.) The cover can be flat or conical, and should be made easily manoeuvrable in case an emergency should require the pot to be removed quickly from the source of heat. A means of introducing a thermometer into the batch is also required and, with the use of modern rigid mercury-in-steel dial thermometers, this need only be a simple reinforced hole in the sheet metal cover. Similarly, a larger hole is provided through which a stirrer can be operated. The stirrer consists of a spade-like implement, the lower portion being a rigid stainless steel plate, usually perforated. If hand stirring is to be used, the larger hole will allow much air to be drawn by the exhaust system towards the pot. In this case, the cover should be designed so that this air is not deflected into the pot, but passes under the cover, picking up the fumes in its passage. If the air is deflected on to the surface of the batch, darkening will take place and the risk of ignition will be increased. If the product is such that mechanical stirring is considered necessary and safe, a mechanical stirrer can be mounted on the cover. This is usually a direct-driven shaft attached to a small motor, and has a propeller stirrer at its lower end. In order to facilitate operations in the pot and increase the agitation, the stirrer is usually mounted off centre and towards the rear of the cover. With mechanical stirring, no permanent opening in the cover is necessary and the aperture can thus be closed almost completely. Visual examination of the contents can be carried out by removing the cover, or by having two glass windows in it, one of which is equipped with a lamp to illuminate the interior. When an almost complete closure is used, the cover can be fitted with a pipe which dips into the batch so that carbon dioxide can be bubbled through to assist in sweeping out the fumes. This generally results in a marked reduction of the darkening of the material during the heat treatment.

Heating

Heating is usually direct and (with the exception of the internal electric resistance method to be described later) is applied to the pot bottom. The pot stands in a cast iron ring recessed into the floor, the source of heat being below floor level; the weight of the pot and its contents is carried by the clamping rings. Coke, coal, gas or oil may be used for heating, but the first two methods are now more or less obsolete, and by far the most satisfactory method is gas heating. The main advantages are easy control of temperature and equal distribution of the heat over the whole of the bottom of the pot; however recent developments in oil burners indicate that this method may soon have the same advantages.

Gas heating

Nowadays the primary air is usually mixed with the gas in a mixing valve, which is so constructed that the required quantities of air and gas are measured and mixed, and then passed to a multi-burner system at the bottom of the burner pit below the pot. The mixing valve consists of a flexible diaphragm which is moved by increasing or decreasing the air pressure. This movement opens or shuts a valve regulating the gas. The air and gas then pass to a mixing section and are subsequently piped to the burners. The air is supplied by a low pressure blower connected by a pipe system to the mixing valve. The great advantage of this type of valve is that the heating rate can be controlled by one valve, viz that controlling the air. If no pressure exists in the air system, the gas valve is shut, but it gradually opens as the air pressure is increased. The mixing valve contains various safety devices to prevent the air pressure from being increased beyond the optimum required by the full gas pressure obtainable and to protect the valve against flame propagation back into it. It is essential, however, that a stop valve be installed in the gas pipe line before the mixing valve, and this should be shut except when the burner is in use. The burner pit is made sufficiently deep to receive the burners and to prevent the flames touching the bottom of the pot when the air is at full pressure. The secondary air required for complete combustion passes into the burner through a tunnel from a trench to the open air, and the primary air/gas mixture is piped to the pit along the same trench. The burner system usually consists of a circular closed box, with an annular opening at its centre for the secondary air. Mounted in the top of the box are a number of stems, each fitted with a slotted burner tip, usually made of stainless steel to resist the furnace conditions. For installation, it is usual to cement the box into the pit, and this cementing is continued using heat-resisting cement in such a way that only the slotted tips of the burners show above the surface. The box and stems are thus protected. The annular opening through which the secondary air passes is usually flared outwards to allow easy passage and distribution. The pit walls support the cast iron ring which carries the pot, and have a number of openings through which the burnt gases pass to an annular collecting flue; thence they pass to a vertical chimney, which also provides the draught necessary to induce the flow of secondary air.

Oil heating

The burners are mainly of the low-pressure air type, and the gas oil used gives stable operation without pre-heating and, because of its low viscosity, allows simple installation. In order that oil burners may operate steadily, it is necessary for the flame to burn in a relatively restricted space and, since an oil flame tends to be long, ample space should be allowed above the restriction so that the flame does not impinge directly on the bottom of the vessel. The distortion often encountered with this method of heating is thus reduced. The furnace is designed as a horizontal tunnel terminating in a cylindrical space. The main flame burns in the tunnel and combustion is completed in the cylindrical space. Above this space, the furnace pit is flared outwards conically until it meets the wall carrying the cast-iron ring supporting the pot. The flue gases then pass from the furnace to the chimney, which must be capable of inducing the necessary secondary air into the furnace. Control of the burners is not as easy as in the case of gas, since operation of both oil and air controls is usually required. However, designs are now available which allow for one movement to control the supply of both oil and air. Since the burner must be installed some distance below the floor surface, and because this floor surface must be free from obstruction and unprotected cavities, the burner pit is covered by a strong steel grating. Operation of the controls is then carried out by a removable key or keys projecting downwards through the gratings to the burner. Alternatively, the controls can be motorised and operated by a switch having three positions: to decrease, stop or increase the flow. To alter the burner setting, the switch is moved into the required position until the necessary change has been achieved. The switch is then moved to the stop position, when the motor controlling the movements ceases to rotate. As with the gas system, the control valves should not be the only means of shutting off the oil supply completely; a stop valve should be installed in the oil line, and must be kept closed except when the burner is operating. The oil is normally fed by gravity from a subsidiary tank fixed at a suitable height. Direct connection of the burner to a bulk supply is not recommended. Air is supplied by a low-pressure blower, of similar construction to that used in the case of gas/air burners.

Whether gas or oil is used for heating, care should be taken that the furnaces are built of good quality heat-resistant bricks and cement, of sufficient strength to carry the load of the pot and its contents; maintenance of the furnace walls and settings should be carried out whenever the slightest signs of wear are seen. This is essential to avoid serious accidents owing to the collapse of the furnace, overturned pots and ignited contents.

Internal electric heating

In this method, the contents of the pot are heated by immersing electric resistance elements in them. The elements are supported on a light framework suspended from the pot cover, and are well insulated and reasonably strong. However, they must be protected against damage caused by over-active stirring or by lumps of solid material being dropped on to them. The pots may be very simply constructed, since no difficulties with repairs arise, unlike the bottom-heated vessels, and it is easy to arrange lagging if necessary. Temperature control is easy and accurate, so much so that an automatic temperature cycle device can be fitted.

Manufacturing methods

Whatever method of heating is used, the procedures vary little. Except in the case of gum running or similar operations, the requisite amount of oil is measured or weighed into the pot. The vessel is then moved on to the furnace ring by the "horse," which should remain in position during the operation. Heating is started at an appropriate rate and the gum or resin, usually crushed into small pieces, is added. In this manner, charring of the resin on the bottom of the pot can be obviated, since most resins melt easily. Stirring, manual or mechanical, is continued during the operation. As the required temperature is approached, the controls are operated to reduce the rate of heating so that the correct temperature is not overshot. The controls are then set to maintain the pot contents at the desired temperature until the required end point is reached, which may be on the basis of viscosity, clarity etc., after which the burners are extinguished and the pot removed from the furnace. A grating or cover should be placed over the furnace opening to reduce the chance of accident. The cooling to thinning temperature may be achieved by exposing the pot, generally in a cooling bay (a roof without sides is excellent), or more quickly by spraying water on the sides of the pot. For this purpose, the pot is moved to an enclosure provided with water sprays which allow the water to impinge on the pot at about the usual level for a charge, or with a removable spray ring which can be suspended by lugs from the top of the pot. In either case, it is desirable to have light detachable covers placed on the pot to avoid contamination. At intervals during the cooling period, the contents of the vessel should be agitated so that they lose heat uniformly. This is particularly necessary with water cooling, in order to achieve a rapid fall in temperature throughout the contents.

When the temperature is low enough, the pot is removed to the thinning area, which should be some distance away from any place where naked flames are used. The building itself should be carefully designed to exclude any possibility of fire or explosion. The thinners are added to the contents of the pot, slowly at first, with constant stirring. The fumes evolved are removed by carrying out the thinning operation under a cowl with an induced draught; the fan used should be designed so that sparks (caused by defects in the fan) cannot occur in the ducts. The quantity of thinners is best measured by meters, but if this is not possible they can either be weighed or measured in a graduated tank.

The medium is now ready for further treatment, such as centrifuging or filtering, but the temperature may still be too high for these operations. Further, it may not be either convenient or satisfactory to proceed at once with these operations and the medium may have to remain in the reaction vessel for some time. In these circumstances it should be covered with a light lid to reduce the risk of contamination and loss of solvent and should be kept in an area where there is no chance of ignition as whilst it is still warm it may well be at a temperature above the flash point of the thinners present.

When open pot manufacture is used for a medium in fairly high demand, it is convenient and economic to make a run of 10-20 or so batches of the same medium. After cooling and thinning the individual pots they can be pumped into a blender in which they are bulked together, mixed thoroughly and the whole brought to the required solids content, viscosity or other property used for control purposes.

Such blenders, which may be of 4000-9000 litres capacity, are usually cylindrical or rectangular steel vessels, fitted with a cover carrying a stirrer, vent pipe to the open air outside the building, and manhole. The vessel is fitted with the piping and pumps necessary to draw the medium from the reaction vessels and to pump it to the storage tanks. If the vent pipe is of reasonable diameter and is carried to a considerable height it will act as an air condenser and avoid fire risk and solvent loss if comparatively hot, thinned media are pumped into it.

As mentioned, the manufacture of "copal varnishes," that is those made by dissolving a natural fossil resin, such as Congo copal, in a drying oil has now almost ceased, but it was most frequently carried out in small open vessels of the type described.

The fossil resin had first to be rendered soluble in oil by heat treatment—a process known as "gum running," and after this process the necessary preheated oil was incorporated in stages. It was possible to purchase at a premium Congo resins which had already been "run". Probably most paint manufacturers purchased their resins in this form. (See Paint Technology Manual Part III page 97 and Part II page 43. Oleo-resinous varnishes are discussed in Part II page 38 *et seq.*)

The use of small portable vessels is now limited to a few media which are either required only in very small amounts or which are difficult to manufacture in bulk. This difficulty generally arises with media containing, for example, tung oil, and those that have to be reacted to near gelation; in these cases the ability to remove a portable vessel from the source of heat and to cool rapidly with water is an advantage over a large fixed vessel.

Fig. 8 shows a typical "varnish kitchen" as usual before the introduction of alkyds and similar resins into the industry and Fig. 9 illustrates the more modern usage of small portable reaction vessels.

Rosin adduct resins

Rosin adduct resins require totally enclosed plant with a stirrer, an air condenser, and connection to a fume-extraction line. Carbon dioxide injection is useful. These resins, and the stand and blown oils discussed below, may also be produced in large fixed vessels, which will be discussed in the next section of this series.

Stand oils

Stand oils can be produced in conventional heating vessels, but in order to obtain the best colour and low acid value, a squat form has been designed which reduces both oxidation and refluxing of distilled compounds to the minimum. A standard dished bottom is used, but the top is conical and ends in a short vertical section covered by a manhole. In this section, two pipes of about 3in diameter are connected; the lower is connected to a tank to receive excess raw oil pushed out of the vessel as the heated oil expands, and the other (2in or 3in above the lower) is connected to the fume-extraction line. The second pipe is shaped so that its outer end is lower than its connection to the vessel. At the outer end, two pipe lines are attached by a T-connection, one to the fume-extraction line, and the other to an oilseal in a separate tank. Any condensed liquid can thus be collected. Carbon dioxide is injected near the base of the vessel and, in general, this provides the only agitation; stirrers are not fitted. The results of this design are that the vessel is always full during the heating and, with the tapering top, only a very small surface of the oil is exposed to oxidation. The injected carbon dioxide also protects the surface and helps to carry away any distillation products. The vapour pipe is designed to minimise condensation of the evaporated products, which might otherwise run back into the oil.

Blown oils

The stand oil plant described above can be used also for blown oils, but air is injected instead of carbon dioxide. As oxidation of the oil must be uniform,

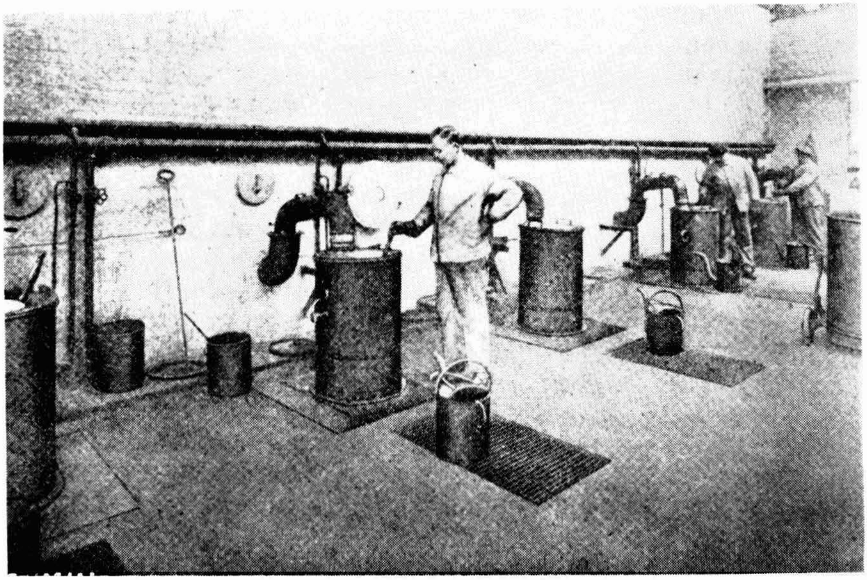


Fig. 8. A typical arrangement for the manufacture of varnish from natural resins

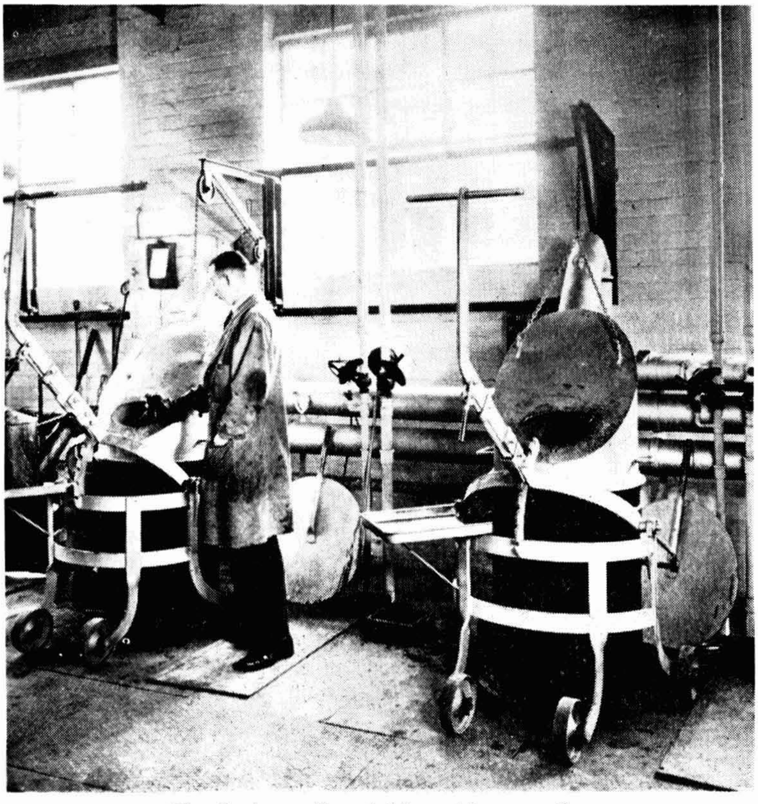


Fig. 9. A small portable pot in operation

provision of a modified manhole cover fitted with a small power-driven stirrer is an improvement. The stirrer only needs to be sufficiently large to induce slow movement in the batch, but should be large enough to achieve this throughout the contents of the vessel.

Fume treatment

Whether small open or large enclosed vessels are used for the production of varnishes, bodied oils and alkyd resins, a considerable amount of fumes are produced. These fumes are acidic and may have a nauseating odour; hence they are a "nuisance" within the legal definition of this term. The concentration of vapour must be reduced so that it is not offensive to occupiers of surrounding buildings, and the method adopted, in the case of small vessels, is to wash the fumes extracted with water. In the case of the larger vessels, which produce a greater amount of condensable material, condensation of the less volatile constituents of the fumes in condensers, either water or air-cooled, followed by water-washing, is more usual. In order to achieve the necessary flow through the system, the flow of fumes is induced by a fan, which is usually situated beyond the water-washing stage of the equipment, and which discharges into the atmosphere.

The general arrangement consists of a main collecting duct situated above the roof of the building, with vertical connections passing through the roof to the points where the fumes are produced. The collecting duct is connected to the water-washing system, and then to the fan; the system terminates in a vertical duct that discharges the treated fume to the atmosphere and carries a cowl to prevent the ingress of rain.

Vertical connections to reaction vessels

From the large fixed vessels, the fume duct should pass as soon as possible to a short length of pipe arranged with a slight fall, and terminating in a T-connection. A small-diameter pipe passing from the lower end of this drains condensate into a tank. The top end of the T-connection is connected to the vertically rising section of the duct and thus can pass through a water-cooled condenser, or can pass direct to the collecting duct above the roof, the vertical section behaving as an air condenser. Connection should be made to the top of the main collecting duct. Any condensate forming in the collecting duct is thus prevented from running back into vertical section. With the large vessels, it should be remembered that the rate of flow in the duct will be low, as no air can enter the system except through leaks. Cooling and condensation can therefore take place with relatively inefficient cooling systems.

In the case of the small portable pots, the flow can be much more rapid, since air must pass into the system through openings in the cover. Further, relatively small amounts of fume are produced. The connection is, therefore, a simple vertical pipe terminating at its lower end in a T-connection equipped with a drain as before.

Wherever possible, the drains from the lower ends of the vertical sections should be carried outside the building as near as possible to the collecting tank, which should be kept covered.

Main collecting duct

This is usually situated above the roof of the building so that, if fire occurs in the duct, as may easily happen, the risk of its spreading to the building is reduced. The main duct has a slight fall in order to drain any condensate. A system of pipes drains the fume condensate tank collecting material from the vertical sections, and this is apt to give trouble owing to corrosion by the acid constituents in the fumes. Organic coatings for the protection of the interior are not satisfactory, owing to the high solvent power of the condensed fumes. As a result, either frequent renewal must be faced or a corrosion resistant material must be used. Earthenware ducts would appear to be the easiest choice, but they are very heavy. Other possibilities are corrosion resistant metal ducts, e.g. stainless steel.

Water wash section

The water wash section may be arranged horizontally or vertically and is usually rectangular in section, with a cross sectional area of about four to six times that of the main duct. This reduces the speed of flow in the washing area and so achieves greater efficiency of fume removal. The break-up of the water to give the largest surface area is obtained either by spraying into the fume flow, or by means of rotating beaters or discs to produce a spray by centrifugal means. A more recent method draws the fume between a water surface and a lip in the washer which, when not in operation, just dips below the water surface. Passage of the fume through the washer produces highly turbulent conditions at this point and, in consequence, a highly concentrated water spray. Following the actual washing, arrangements must be made to remove most of the water droplets from the stream of gas. This is achieved by means of a series of baffles, attached alternately to the upper and lower surfaces of the washer, which cause rapid alterations in the direction of flow of the gas. The removal of spray from the gas is important since, with high-speed fans, erosion of the blades by the water droplets may be serious.

The water that has been used in the washer is allowed to drain to a labyrinth tank in which the baffles prevent any separable material of either lower or higher specific gravity than water passing to the outlet. From the outlet, the water is re-circulated by a centrifugal pump to the sprays. The separated material is skimmed from the top or drained from the bottom of this tank; its final disposal is determined by the position in which the factory is situated. Burning in an incinerator is by far the best method. Condensed fume from the ducts can also be burnt if no market for varnish fume can be found. Periodically, the wash water must be renewed; used water should be neutralised with alkali before it is passed to the drains. In the case of large quantities, the local authorities should be consulted to avoid difficulties at the sewage disposal works.

Hazards

The thinning operation, to be described later, probably involves the greatest risk of fire in the medium factory. This is due to the fact that it is carried out above the flash point of the solvent and that large quantities of solvent vapour are produced. A further risk, which is easily overlooked, is thaf, when emptied, the tanks retain a solvent vapour concentration which is often within the explosion range, so that ignition and explosion may take place. Entry of personnel into the tanks is also risky unless this vapour has dispersed or breathing apparatus is provided. The main fire precautions to be observed are outlined below.

Structure

The thinning shop should be of fire-proof material with a light roof, separated by about 15 feet from other buildings on all sides, and sited as far as possible from the source of heating used for the reaction vessels. A fire in the thinning house can thus easily be limited without involving other valuable plant and stocks. Alternatively the thinning may be carried out in the main manufacturing building, if it is carried out in a separate bay, separated by flame proof walls and doors. Apart from fire extinguishers of the foam type, the main fire fighting equipment is best stored in an easily reached position outside the area.

Ventilation

The air should be changed at a high rate by forcing air in at floor level and allowing it to exhaust at the peak of the roof. By this means, vapour that would tend to sink to floor level is constantly mixed with air in motion and carried away. It is considered better to use this method rather than either natural ventilation or exhausting the air at floor level, since both of these alternatives may allow pockets of vapour to form. Doors should be kept closed to increase the efficiency of the system, but must be designed to allow for immediate and easy opening outwards and must never be obstructed, as they provide the means of escape for personnel. The blower fan and motor should be located in a small erection outside, so that they can be stopped immediately in case of fire. This arrangement is not necessary if the operation is carried out only in enclosed blenders vented to the open air and the hot resin is fed by pipe from enclosed reaction vessels.

Lighting

Windows should be provided to give the maximum amount of natural lighting during daylight. Artificial lights must be flame-proof and of certified construction. If possible, their location should be such that unauthorised persons cannot interfere with them, and maintenance should be by properly trained personnel.

Power for stirrers

The drive to the stirrers can be arranged either by using flame-proof motors or by siting the motors outside the building, the driving shafts being equipped with vapour-tight glands where they pass through the wall of the building. Where flame-proof equipment is used, the necessary precautions associated with its maintenance should be carried out. Lubrication of all moving surfaces of bearings and glands should be carried out regularly to make sure that no overheating occurs on insufficiently lubricated moving surfaces. Electric bonding to earth of all shafts obviates the development of static charges on belt drives.

Cleaning

To permit safe cleaning of thinning tanks, the plate from the top should be removed and, if necessary, the vapour should be dispersed by blowing air through a flexible duct into the vessel. Complete safety should then be possible, but added security will be obtained by using non-ferrous spark-free scrapers, hammers, spanners etc. If for any reason it is necessary to enter the vessel when there is any possibility of vapour existing, breathing apparatus should be used. An assistant is allocated to each man working in the vessel, and he remains outside to control the breathing apparatus tube as well as a safety rope attached to the man in the tank. Adequate breathing apparatus consists of a service gas mask face piece and a long un-kinkable hose attached to the inhalation tube. The open end of this hose should be supported above floor level and in an area where there is no possibility of fumes of any kind, preferably in the open air. Maintenance and sterilisation of the face piece should be carefully carried out. Entering closed vessels without breathing apparatus should be prohibited, and only allowed in an extreme emergency.

Fire extinguishing

Since very few fires should occur anywhere but in the thinning tanks themselves, the fire extinguishing equipment is mainly designed to deal with this type of fire and, as already described, provides for the introduction of either an inert gas or foam into the affected vessel. The connections to allow for this have already been described; the supply of carbon dioxide can be arranged from a bank of cylinders and foam produced by proprietary fire extinguishing equipment.

Clarification of varnish and media

This subject is discussed here since media manufactured in open vessels invariably require clarification, whereas those made in closed vessels may after be clear enough for it not to be necessary. However, when media from closed vessels must be clarified the same methods are used.

After being thinned, the product must be strained, centrifuged or filtered to remove foreign matter, skins, and possibly gelled particles. Straining can remove only the larger contaminants, since the rate of flow through a fine mesh would be too slow even under pressure. Centrifuging removes substances having a specific gravity substantially greater or lesser than that of the medium. Filtration, especially with a filter aid, will remove all the contaminants down to the bed efficiency of the filter aid employed. It is doubtful if a case could be made out for a need for operation which could remove finer particles than those that pass a modern varnish filtration plant.

Centrifugal cleaning

In this method, sedimentation is accelerated by increasing the force acting on the settling particles. Obviously, a particle whose specific gravity is less than that of the liquid will float, one whose specific gravity is equal to that of the liquid will not sediment, and only particles of greater specific gravity will sink.

Stokes' Law expresses the rate of fall of a spherical body in a liquid as

$$V = \frac{d^2 (\rho_1 - \rho_2) g}{18\eta}$$

where d = diameter of the sphere in cm

ρ_1 and ρ_2 = specific gravities of the body and the liquid respectively in g cm^{-3}

g = gravitational acceleration

η = viscosity in poises

V = velocity of sphere in cm sec^{-1}.

From this equation it can be deduced that:

the lower the viscosity the faster the sedimentation;

the rate of settlement depends on the difference between the specific gravities of the liquid and the body;

the smaller the body, the slower the rate of fall, and that this dimension is important since the velocity varies as the square of the diameter;

If g can be increased, the rate of fall is increased.

By rotating the liquid at high speed, it is possible to increase the rate of sedimentation; the centrifugal force so generated acts in place of the gravitational force.

The force in dynes developed by the rotation $\alpha\ 2\ \pi\ r\ m\ n^2$

where n = no. of revs. per second

m = mass of particles in grams

r = radius of revolution in cm.

The centrifugal force is proportional to the number of revolutions in unit time and the radius of rotation. This force is exerted on the machine parts as well as on the liquid, and the stresses set up with large radii of revolution would introduce design difficulties. Thus a limit is set to the increase in r. On the other hand, the force is also proportional to the square of the number of revolutions in unit time and, as this factor is easily increased, the rotational speed is designed to be as high as it can be with safety.

Since the dimensions and speed of any particular machine are fixed, the only variable which is in the hands of the operator is the viscosity of the medium. In order to achieve the best sedimentation, the medium should be centrifuged as hot as possible, i.e. at a low viscosity. The operating temperature is affected by two other factors: the clearances in the working parts of the high-speed machine—on this point the makers of the plant should be consulted; and loss of solvent during treatment, which should not be excessive. The product from the machine will have lost all particulate impurities which have considerably higher specific gravity than the liquids, i.e. it will have lost all but the finer particles of impurities of specific gravity slightly greater than the liquid.

The centrifuge in commonest use is the Sharples type which consists of a cylinder, about 6in in diameter, which is rotated at high speed in a vertical position. An impeller on the inside of the cylinder is arranged to accelerate any liquid entering it to the speed of the rotating shell. The liquid is pumped into the bottom of the cylinder and passes upwards, being discharged through vents at the upper end of the cylinder, and collected in a totally enclosed trough surrounding the cylinder. From this it flows through a sump to a pump which transfers it to a prepared storage tank. The cylinder is suspended from a drive at its upper end, and the lower end is retained in a vertical position by a guide collar that is virtually frictionless, since its only purpose is to damp out oscillations. To remove the sedimented matter, the cylinder is detached from the machine and the material is scraped out.

Since the centrifuge is built with extreme accuracy and revolves at high speed, it is essential that maintenance and cleaning are carried out carefully and that re-assembly should be carried out only by trained personnel. The centrifuge has the advantage of being fully mobile and, with use of flexible connections to the pumping system, can be operated at any place in the plant. In view of the possibility that the machine may be operated in dangerous areas, the provision of flame-proof motors is advisable, and plugs for the electricity supply should also be flame-proof. If, however, design of the plant can eliminate the necessity to move the centrifuge, the provision of a building for its operation equipped with pipe lines to the various tanks and storage areas has much to recommend it.

Filtration

Varnish and medium filtration has the advantage that all particulate impurities can be removed efficiently. The operation is carried out in either conventional filter press equipment or in modified forms developed from it. The medium is passed under pressure through a filter which may consist of filter cloth, filter paper or of a paper on which a filter bed is formed with a filter aid material, which generally consists of diatomite of appropriate particle fineness and shape. The speed of filtration depends on a number of factors, of which the area exposed to the liquid is by far the most important. Since one large area would be cumbersome, all filters are designed to obtain a large number of surfaces arranged in parallel. This gives a compact, easily operated arrangement and it is generally easy to clean and replace the filter.

Filter press

The filter press for varnish and medium has been developed from the conventional equipment as used for pigment manufacture (see Pt. Tech. Manuals part 6, p. 313), but since the filtered material is required in this case, some changes in design are necessary to keep it free from contamination. The press consists of alternate units of plates and boxes which are built up on the press framework. The boxes and plates are drilled so that the inlet and outlet flows are at the bottom of the plates and boxes. This arrangement allows for drainage of both filtered and unfiltered product at the end of the operation, so that waste is reduced as much as possible. The filter cloth or paper fits between the box and plate, and when the assembly is complete, pressure is applied to the free endplate to produce liquid-tight joints between the units. The material to be filtered is now pumped into the systems and filtration commences. Air which has been trapped in the units is released through an air vent. As the operation proceeds, the rate of flow gradually decreases owing to the choking of the pores in the filters; this increases the pressure in the liquid and care must be taken that the paper or cloth does not burst. To control this, the pump, usually of the gear type, is arranged with a relief valve, set to allow the output to return to suction if the pressure exceeds the set value. When the flow has become too small to be economic, the press is drained and fresh cloth or paper is put into the press. This draining and replacement must, of course, take place when the press is required to change from one product to another. It can be easily seen that gelatinous impurities may produce a relatively impervious film on the paper or cloth, and it is this film which reduces the flow. The use of a filter aid increases the period during which efficient filtration can proceed. It should, in general, always be used, since a finer degree of filtration is obtained in its presence than with a layer of filter paper alone. Its action is effected by the large number of alternative channels which exist through the bed of the filter aid, and the progressive deposition of the impurities throughout the bed. Thus the impervious gel layer is built up much more slowly and, instead of being formed on the paper surface, it is widely dispersed through the bed. When using a filter aid, the procedure is slightly modified. A quantity of the medium is fed to a mixer tank, and the quantity of filter aid to produce the necessary thickness of bed is dispersed in the liquid. This dispersion is pumped to the press and followed by the bulk of the medium to be filtered. The paper filters out the filter aid as a bed on its surface, and filtration proceeds through it. The first filtered product is opalescent and is returned to the unfiltered store; as soon as the filtrate is clear it is allowed to pass to clean storage. When the operation is complete, the filter bed and papers are removed, fresh paper is fitted and bed preparation repeated. Many grades of filter aid are available. The finer the particle size of the aid used, the smaller the size of the particle retained upon it and the slower the rate of filtration. The coarser grades allow rapid filtration at a sacrifice of the particle size retained. It is usually possible to select a grade giving a suitable compromise between filtration rate and the particle size retained.

When media which contain a great deal of skins or gelled particles have to be filtered, the surface of the bed of filter aid may become blocked by them and the filtration rate will become very slow. In such cases, it may be an advantage to pass the medium through a centrifuge before attempting filtration. Alternatively, the difficulty can often be overcome by distributing filter aid throughout the whole of the batch to be filtered; by this means the gel or skins are distributed throughout a much thicker bed of filter aid leaving sufficient voids through which the liquid can pass and avoiding the build up of an impervious layer on the surface of the filter aid. The "dressing" of a filter press, that is the cleaning down, refitting new filter papers, assembling and forming a new bed of filter aid, is somewhat time consuming and should be avoided if possible by one of the above means.

Disposal of used filter material should be carefully organized; a tray below the press collects the small amount of drainings and collapsed filter bed. Under no circumstances should the material be left in the filter building, but should be removed and burnt as soon as possible.

Enclosed filters

The main developments in filtration plant have been directed towards the use of higher pressures, thus increasing the throughput for the same surface area, and improved methods of supporting beds of filter aid. The most obvious change is that the filter units are enclosed in a cylindrical vessel with removable top. The unfiltered material is pumped into the vessel, passes through the filter elements which are suspended from the removable top, and then passes out through a connection made externally to a header tank which collects the product from the filter elements. Two types of element are in common use;

(a) a number of circular boxes supported by a central header tank, the perforated plate for the filtrate being on the upper surface of the boxes, (b) a series of metal discs with shaped distance pieces assembled alternately on a rod arranged with channels. The distance pieces fix the size of the gap through which the filtered material passes; the gap has such a small size that the filter aid forms a bed directly on the disc assembly without the necessity to use paper. The Metafilter is an example of this type.

The circular box type of filter requires the provision of a support such as paper to carry the filter bed. Alternatively, it can be operated with paper or cloth alone. A typical example of this type of equipment is the Sparkler filter.

Both types can be easily cleaned and operated; the suspension of the filter units from a removable top makes for easy cleaning and removal of exhausted filter aid. The tank which contains unfiltered materials is drained through a valve at its dished bottom end.

The method of operation is much the same as for the filter press, except that in the case of the disc and spacer type, a filter aid must be used.

To produce "star bright" resin solutions, filter processes, as distinct from centrifuging, are needed, and the machine efficiency depends basically on how quickly the bits or impurities block up the filtration membrane. Practical testing of any piece of plant is the only way to decide whether it is suitable for the job on hand. Points to consider are: speed of output, total out-put before cleaning is needed, out-put per square foot of installed space, time taken for cleaning, simplicity of maintenance, initial cost, and running costs.

Filtration of alkyd solutions while still warm greatly improves the speed of through-put and, since two or three batches of alkyd are frequently blended, an adequately sized blending tank fitted with coil heating to keep the resin warm until it can be filtered, is frequently employed. Alternatively, a batch(es) of resin may be pumped into a "dirty" storage tank and passed, whilst still warm, through a filter press to a "clean" storage tank. The heat losses from an unlagged 2000-4500 litre tank are small enough to allow filtration to be complete, before a significant increase in viscosity occurs.

Storage of treated varnishes and media

Depending on the end use of the product (whether for use as a finishing varnish or for a medium for the manufacture of pigmented finishes, or as a blending component for a varnish or medium) the manufacturing processes vary in that the products for sale as finishing varnish usually have a drier addition made before storage, whilst the others do not.

Storage for finishing varnish

The product, after its final cleaning operation, is pumped to a storage tank in a varnish store area and is usually matured for varying periods, depending on the type of material. The tanks are generally rectangular, totally enclosed, and mounted on supports at a height which allows for easy filling into cans or barrels. After maturing for the requisite period, the product is drawn from the tank through a valve mounted some distance above the base. In this way any insoluble product which has formed during storage, usually by interaction with the drier metal, will have settled to the bottom of the tank, and so the product drawn from the filling valve will be free from this contamination. The contaminated material remaining in the bottom of the tank is periodically drawn off from a valve at the bottom and disposed of as varnish "foots." This separation of solid impurities during storage after filtration is more characteristic of the oleo-resinous finishing varnishes made from fossil resins, such as Congo copal. It should not occur with properly made alkyd, phenolic and other largely synthetic resins. Since resins to be used as finishing varnishes have to have driers added and are therefore prone to skinning, it is frequently an advantage to allow them to mature in a dirty tank prior to filtration and, when any separation of impurities is considered complete, to add driers and then, if necessary, pass through a filter press to a clean tank and fill out from this into tins as soon as possible.

The building used for storage of varnish and media should be separated from other buildings, since it will contain considerable quantities of valuable product with a high fire risk. Lighting should be from the roof rather than from the sides, and should be kept to the minimum so that direct sunlight falling into the building, with consequent temperature rise, is reduced as much as possible. Windows in a north facing roof are best. Artificial lighting and all other electrical apparatus should be flameproof. Since an even temperature of about 16°C is desirable, the building should be centrally heated with hot water from a boiler situated some distance away. To reduce heat losses during the winter and temperature rise during the summer, a well insulated fire-proof structure is necessary. Ample escape doors and unencumbered passageways in the building are essential.

Storage of media and intermediate products for blending

In general, these products are stored in tanks when the cleaning operations are complete. Storage may be in an area of the paint production building, if possible at ground level, but pumping direct from the storage tanks to the point of usage is to be preferred where the scale of the operations warrant the installation of pumps and pipelines for each individual medium, as outlined below. Since the products are usually undriered, storage problems are somewhat simplified, but steady temperature conditions are essential, as also are good precautions against fire. The tanks should be totally enclosed, and easy access to all parts of the area should be arranged.

In order to minimise skinning where drier addition has been made prior to storage, a supply of inert gas at low pressure is fed to the tanks, and is automatically controlled so that air never leaks into the tanks.

Supply of the medium to the point of use by pipeline is preferable when bulk operations are in progress, or by transportable containers if relatively small quantities are required. Pipelines are advisable only where very large quantities of a few media are in continous use. They can be pumped directly, or, alternatively, so that the pipelines are kept clear, a pumped ring main system may be adopted which continually circulates the medium against a spring loaded valve. When transportable containers are used, they should be filled at the tank with the exact quantity required, either by weight, meter, or a calibrated container. If the correct quantities are not measured at the tank, waste may occur owing to small excess quantities being left at various parts of the plant.

Manchester Section

Chlorinated rubber in paints and printing inks

Some 50 students and guests attended at the Manchester Literary & Philosophical Society, Manchester, to hear a talk by Mr W. D. Ferguson (ICI Mond Division) on "Chlorinated rubber in paints and printing inks", on Wednesday 12 January 1972. Mr F. Redman was in the chair and introduced the speaker.

Mr Ferguson began by stating that approximately 20,000 tons per year of chlorinated rubbers were produced, of which 14,000 tons went into paint, 3,000 tons in printing inks and a further 3,000 in miscellaneous, but mainly adhesive, uses.

He then described the physical properties of chlorinated rubber, emphasising the need for plasticisation and the importance of plasticiser type. Pointing out that chlorinated rubber was odourless, tasteless, non-toxic and non-inflammable, with good chemical resistance and very low water permeability, he enlarged on surface coatings utilising these properties in traffic paints, inks, high build coatings and masonry paints.

The lecture was concluded by a film showing various uses of chlorinated rubber paints.

A lively question time elucidated a number of further points, such as that minimum drying temperatures could be as low as −17°C, and the minimum surface preparation was considered to be Swedish standard ST2.

Chlorinated rubber was used mainly in gravure inks, often in conjunction with other resins.

Mr L. Webb proposed the vote of thanks which was received with acclamation.

A.MCW.

Information Received

(In case of difficulty regarding addresses, members and subscribers to the JOURNAL should apply for details to the Director & Secretary of the Association at the address shown on the front cover.)

Berger Paints has recently launched a new product for the DIY and trade markets. *Brolac Vinyl* is a satin finish, 100 per cent vinyl water-based interior paint. High dirt and moisture resistance are claimed for the new paint, and it is said to adhere well over vinyl wallcoverings, unlike most formulations.

A new *Brolac Colorizer* has also been introduced. The quality of the new system has been brought into line with existing *Brolac* products, and the colour range widened to over 300 colours from 5 bases and 12 colourants. All 324 colours will be available in gloss, emulsion and undercoat; 246 will be available in vinyl, and over 85 in exterior wallpaint.

Two new booklets have been issued by **Pyrene Ltd.** One deals with the *Parco-Lubrite* manganese phosphate coating for reducing wear on moving metal parts, and the other with the *Bonderizing* treatment for metal substrates.

An agreement has been reached between **Applied Research Laboratories Ltd.** and the Petrochemicals Division of **ICI Ltd.** by which ARL will sell, under licence, equipment for the analysis of organic chemicals. The analytical system consists of an ARL direct-reading optical spectrometer and a microwave excitation source. Techniques developed by ICI using a plasma source enable the system to be interfaced to gas chromatographs, resulting in a sensitive detector with good selectivity for a wide range of elements; it is claimed that sufficient accuracy may be obtained to determine empirical formulae.

Sigma Coatings Ltd. is the name of a new company formed by the integration of the marine and industrial marketing activities of **Craig-Hubbuck Ltd., Craig-Vettewinkel Ltd.,** and **Pieter Schoen Ltd.** This company is now responsible for all marketing operations of the individual companies. The existing facilities of the individual companies will continue to be used.

Vinyl Products Ltd. has recently issued a new leaflet giving a summary of the standard grades of all its products.

A divisional reorganisation has been announced by **Albright & Wilson Ltd.** The company's present four UK operating divisions will be regrouped into three by splitting the Associated Chemical Companies division between two of the others. The industrial chemicals part of ACC division will be combined with Oldbury division; this will include responsibility for **Albright Chemicals Ltd.** (Canada) and the 50 per cent investment in **Chrome Chemicals (South Africa) (Pty) Ltd.** The new combined division will be renamed the Industrial Chemicals division.

The agricultural part of ACC division will combine with Marchon division.

The **APV Company Ltd.** has issued a revised edition of its leaflet on the range of *APV Gaulin* homogenisers.

A link-up in the UK between **Barter Trading Corporation Ltd.** and **Polyvinyl Chemie Holland NV** has been announced recently. With effect from 1 February, Barter has been appointed sole UK sales agents for all Polyvinyl Chemie products, including the *NeoCryl, NeoRez* and *NeoVac* ranges.

"Solumins and Pentrones" is the title of a new booklet describing the fifteen anionic surface active agents offered by **Glovers (Chemicals) Ltd.** The use of these products—which include agents of the sulphate, sulphonate, sulphosuccinic and phosphate ester types—in emulsion paints, printing inks and many other products is outlined. Copies are available from Glovers on request. A similar booklet on the *Bitran* range of cationic surface active agents is also available.

Fluoro-Glide is a new PTFE aerosol product from **Marshall-Howlett Ltd.** The aerosol deposits a PTFE film which, it is claimed, is strongly adhesive to most substrates, will not stain, cake or run, and is resistant to dust, dirt, common solvents and heat. Among its many uses, the manufacturers recommend it as a lubricant where conventional types cause problems, and as a release or parting agent.

The merger of two of Norway's principal industrial companies—**Norsk Spraengstofindustri A/S** and **Grubernes Spraengstoffabriker A/S**—was announced recently. The new company is called **Dyno Industrier A/S,** with its head office in Oslo. The name forms the root of some of the organisation's registered trade names, such as *Dynomin* amino resins, *Dynorit* and *Dynosol* adhesives and laminating resins, and *Dynoten* plastic foil.

There will be four manufacturing and sales divisions: explosives, chemicals, plastics and packaging machinery. In the UK, **Barter Trading Corporation Limited** will continue to act as agents for the group's surface coating resins.

Defoamers for latex stripping in the manufacture of paints, adhesives, coatings and paper and paperboard are described in "Technical Bulletin PAD-1" recently published by **Nopco Hess Ltd.** Full details of six Nopco *Foamasters*, are shown giving suggested applications.

Farbwerke Hoechst AG has added two new products to its pigment range. *Hansa Orange RN 01* is a new, improved grade of Permanent Red GG and *Hansa Orange RN*, replacing the latter in the *Hansa* range, and is particularly recommended for printing inks. Permanent Yellow *DGR 20* is a special grade for publication gravure printing.

Sherwood Parsons Ltd., a member of the **Donald Macpherson Group,** has introduced a range of paints aimed specifically at the DIY motorist. *Re-Paint* finishes and undercoats are specially formulated for brush application, and are claimed to give good results even when applied by an amateur, flowing out readily to remove brush marks. Available in 25 colours, *Re-Paint* is now available in the London area, and should be in car-care shops nationally within the next few months. Sherwood Parsons Ltd. has concentrated until now on making paints for professional refinishes; it is said that the company is now considering the car-care market as a means of further growth.

CIBA-GEIGY (UK) Ltd., Plastics Division, has recently issued a new booklet entitled "Introduction to Duxford." Copies of the publication, which is intended to provide a concise survey of CIBA-GEIGY's resins activities at Duxford, and some details of the products' use in industry, are available from CIBA-GEIGY on request.

Bristol

Quality control

The November meeting of the Bristol Section was held at the Royal Hotel, Bristol, on Friday 26 November. The meeting took the form of a discussion on the subject of quality control, with a panel of experts consisting of Mr W. S. Grainger and Mr R. G. Stay of Bergers Paints, Mr D. S. Newton of the British Steel Corporation, and Mr J. R. Taylor of BP Chemicals International Ltd. This provided a balance between raw material suppliers, paint manufacturers and the paint users.

The discussion began with a consideration of the current and past levels of complaints concerning the products of interest. Mr Stay considered that the incidence of complaints had remained stable for several years. The meeting went on to discuss the philosophy of quality control, who should be responsible for it and whether all the tests carried out were important. Several speakers thought that some tests laid down in specifications by paint users and paint manufacturers were unrealistic and not important to the application involved. In practice, quality control often did not achieve the ideal of complete testing of all products involved because of the time and cost involved. A limited quantity of testing to ensure that the product should perform satisfactorily although certain test limits might not be met, was often the final outcome.

Following the end of the discussion, a vote of thanks to the panel was moved by Mr L. J. Brookes and warmly supported by all present.

T.I.P.

Hull

Flame retardant paints

A meeting, attended by 16 members and three visitors, was held at the Queens Hotel, Hull, on 3 January, with Mr N. F. Lythgoe in the chair. Mr A. G. Walker of Associated Lead Manufacturers Ltd gave a lecture entitled "Current thinking on flame retardant paints".

In the early part of his lecture, Mr Walker described American and British test methods which attempted to measure ease of ignition, flame spread and fire propagation, giving details of the performance of a number of building materials and the effect of flame retardant paints. Mr Walker then described how flame retardant paints—intumescent and non-intumescent types—worked and gave illustrative compositions. It is hoped that it will be possible to publish the paper in full in the *Journal* at a later date.

The lecture was well illustrated with slides, including colour photographs taken during a fire test on a model room. It was followed by a discussion in the course of which questions were asked by Messrs Siddle, Robinson, Wilkinson, Howells, Finn, Lythgoe and Hasnip. The vote of thanks was given by Mr J. R. Tinegate, who congratulated the speaker on his concise and well informed account of fire testing and performance.

J.A.H.

Irish

Reminiscences

The last meeting of the Irish Section in 1971 was held at the Clarence Hotel on 9 December. It was a social evening when members, their wives, and friends heard an extremely interesting talk given by Dr F. W. Stoyle entitled "Reminiscences". His talk covered his career from University days to the present time, and many colourful and interesting slides were shown of places he had visited in Africa and the Mediterranean countries.

A vote of thanks on behalf of those present was given by Mr P. Jones.

A.R.

Magazine production by the web offset process

The first lecture for 1972 was held at the Clarence Hotel on Friday 21 January. The subject was "Magazine production by the web offset process" and there were two speakers who covered the subject in a most detailed manner.

The first speaker was Mr J. I. McEleny of Lorilleux & Bolton Ltd, who dealt with the principles of the web offset process. With the aid of many slides, Mr McEleny covered the different types of presses available, inking and damping systems, web tension and feed mechanisms, including automatic pasters, ink drying systems and the delivery equipment that converts the web, printed on both sides, to pages of a magazine ready for collating.

The second speaker was Mr J. B. Brown, the production manager of Creation Ltd, a Dublin based firm, printing magazines for both the home and export markets by the web offset heatset process.

Mr Brown took his audience through the different stages that occur in the production of a magazine, from receipt of art work and copy, through to packing for despatch. Art work, transparencies, layouts, flats and photograph film, proofs and printing plates were shown to illustrate the great amount of detailed planning and skilled work that takes place to produce a magazine.

Mr D. Power, on behalf of the 25 members and visitors present, proposed the vote of thanks to the two speakers, who had obviously put a considerable amount of time, effort and thought into the preparation of their talks.

A.R.

London

Building paints, their use and abuse

A half-day symposium, with the above title, was held by London Section on 26 January 1972 at the Polytechnic of the South Bank. After a brief introduction by the Chairman, Mr D. E. Eddowes, the chair for the meeting was taken by Mr D. Bayliss.

Mr L. Coleman, of QAD (Mats), Woolwich, spoke first, on "The testing of building paints". The present status of test methods was very different from that existing 10 years ago. International testing methods had been proposed and adopted, based on the work of ISO Technical Committee 35, Sub-Committee 9. Mr Coleman then spoke of the special requirements for building paints: they were applied over a variety of surfaces, from metals to highly porous substrates; they were required to provide decoration and protection for a long time; and they needed tolerance of environmental extremes in outdoor situations. Thus they were used in coastal conditions, in heavily polluted industrial areas, and in rural environments. It was clear that no single standard product could give satisfaction throughout such a range of environments.

Test methods must be relevant to the environmental conditions concerned. For example, there was criticism that accelerated weathering did not correlate with natural outdoor exposure. But what was natural exposure? What was the solar energy distribution under different conditions? Even a single structure such as a bridge provided a variety of differing environments. One really needed a site investigation to determine the particular conditions in each case. One important need was for test methods for painting on contaminated and inadequately prepared substrates. It was very difficult to produce standard rusted panels in the laboratory. Modern paints were less tolerant of adverse conditions such as low temperature and high humidity than the traditional oil paints.

Mr Coleman then considered some particular aspects of testing. First, brushability. There was a need for a standard mechanised test to remove the subjective factor. Frequently brushability tests were done on a test panel, which was rather remote from some conditions encountered in practice. Second, accelerated weathering. The Inter-Services Committees had done a lot of work on correlation between accelerated weathering and practical performance of decorative paints; a lot was known now, and if the period of exposure was extended one could get useful results and information. Concerning specification testing, one was conscious of the fact that one tended to play safe, relying too much, perhaps, on past experience.

The next speaker was Dr G. Foster, of ICI Paints Division, who gave "The paint manufacturer's point of view". The objective of a paint manufacturer was to provide a range of products having the widest appeal and practicability. However, one needed to limit the number of products by having a wide range of usefulness of each type. It was a matter of aiming for the best overall balance of properties. The manufacturer was in a position to get a feedback of information on the behaviour of his paints from the user. It was also possible to use consumer research. However, there were differences between what a consumer thought he needed, and what he actually required.

Formulations of paints tended to be "composition orientated" rather than "performance orientated"; to the end user, performance was the critical factor. There was a general split into trade and retail markets. For the former, one needed a paint which would do a professional and economic job. For the retail market, one needed, above all, convenience in use.

It was good to be able to meet specifications with branded products. A branded product would almost always be above the minimum levels required by the specification. The customer was liable to become very articulate when: expectations of an improved product were not realised in practice; or he found that a special paint lacked certain normal paint properties.

A paint manufacturer could build in a certain amount of tolerance to abuse, though sometimes this was difficult. For example, a two-pack urethane finish could give ideal performance under favourable conditions, but was liable to show difficulties under poor conditions. For a comparison, an alkyd was extremely tolerant of poor application conditions.

The consumer had certain responsibilities; troubles most frequently arose from: a failure to observe the instructions; a fault in the design or construction of the substrate; and a failure in surface preparation. The second factor was frequently a very important cause of paint failures. However well formulated, a paint designed to keep water out would also keep water in the substrate.

Dr H. Lehmann, of Farbwerke Hoechst, then spoke on "Continental practice", giving some very interesting statistics of the use of various types of paint in European countries. Thus, compared with the figures in the USA of 900,000 tons of emulsion paint, and 400,000 tons of alkyd and oil based paints per year, Germany used 360,000 tons emulsion, and 300,000 tons alkyd and oil paints, while in the UK the figures were 110,000 tons emulsion, and 350,000 tons alkyd and oil paints. In other continental countries the consumption ratio between emulsion and alkyd paints, etc., was similar to that in Germany.

The *per capita* consumption of paint throughout Europe showed some very interesting differences. Compared with 19.5Kg per person in the USA, other countries varied from: Sweden 18.1Kg, West Germany 17.4Kg, France 13.8Kg, down to the Netherlands 9.6Kg, Great Britain 9.3Kg, and Italy 7.3Kg.

The continental market was considered to be more steady: for example, the shift from homopolymers to copolymer latices was slower. There were also differences in other respects. In France it was easy to change a binder, while in the Netherlands it was difficult. Even in the one country there were marked differences; for example in France there was a marked variation in climate and atmospheric conditions from north to south. Thus lithopone could be used in the south, while in the north it turned grey. Specification practice varied from country to country. It had been found that in Germany there was a tendency to use the lower limit of specifications so that good quality paints were lost to the market.

Another factor was that, in many continental countries, paint was sold by weight. In Germany, emulsion paints contained 60-70 per cent solids, and were used with the addition of 10-20 per cent of water, compared with the range of 50-60 per cent solids in the UK. UK paints showed better flow properties, so that roller application was used in Germany instead of brush as in the UK. In practice it was found that in Germany there was too much dilution of emulsion paints, so that thin coatings were obtained.

Different building techniques in the various European countries resulted in quite different types of substrate. This ranged from wood in the Scandinavian countries to bricks in the northern parts of Germany, and plaster in the southern parts. Economic factors in each country governed the choice of binder. Thus butyl acrylate was cheaper on the continent than ethyl hexyl acrylate. It was clear that the European continent was much less uniform than it appeared from outside.

The final speaker was Mr P. Whiteley, of the Building Research Station, who discussed "Exterior masonry coatings". Mr Whiteley raised the question of whether external concrete walls needed painting. Also, how far should the coatings be decorative and how far protective? Usually one considered the decorative aspect, but sometimes a coating was needed for waterproofing. There was, however, a need for porous walls to allow the escape of moisture, and by putting an impervious coating on the outside, one increased the risk of interior condensation. One needed a high vapour permeability and good proofing against liquid water. Permeability could be measured in the laboratory, but on site, the greater wetness of north walls, and of regions near to the ground, had a more marked effect. One tended to prefer natural weathering, in spite of its variability from year to year.

Mr Whiteley then described work at the BRS in which a large scale brick wall was built, and used to test a number of types of coating. The behaviour of the coatings was studied in terms of water uptake by the wall, which was measured using a microwave instrument. They also had a blister hut, with a high relative humidity. Permeability was also an important factor, particularly in relation to crazing. It was desirable that a coating should be sufficiently elastic to bridge the cracks formed. It was found that the best results were shown by the thickest films, even though the extensibility was not particularly high.

Appearance was an important factor. Chalking must be low in coloured paints, and one must avoid chalk run-down on to lower surfaces. Mr Whiteley finally referred to the question of durability and cost in use. One could make useful predictions based on film thickness.

Following a break for tea, there was an extensive discussion of the four papers. Among the points raised was the use of fungicides; one should try to cure the defects, for example, poor ventilation, which gave rise to mould growth in interiors; mercurial fungicides should not be used in the interiors of buildings. For external use fungicides were generally considered to be essential; on the continent mercurial fungicides were forbidden. The use of zinc oxide was also discussed, but it was pointed out that cost factors and the problems of stability occurred. Paint testing was discussed and in particular the effects of temperature and humidity on test results in relation to practical behaviour. The question of cracking was raised, and the effect of "sideways" forces in relation to adhesion to the substrate. It was pointed out that alkyd paints showed poor adhesion under wet conditions, but also good extensibility, and so they performed well. Many other topics were raised, and the discussion lasted over an hour.

V.T.C.

A new approach to the preparation of alkyds based on the glycidyl ester of a branched-chain acid

A meeting of the London Section was held on 9 February 1972 at the Polytechnic of the South Bank, with Mr D. E. Eddowes in the chair. Mr G. Rossa, of Shell Research Ltd, presented a paper with the above title.

Mr Rossa said that Cardura resins based on the glycidyl ester of Versatic acids had been established for several years in the surface coatings industry. Their good qualities, especially against weathering, were attributed to the protective action of branching at the alpha carbon atom. The final resin consisted of a phthalic anhydride/glycerol backbone from which were suspended chains of alternate phthalic anhydride and Cardura E molecules terminated in the branched acid structure. These resins could be stoved with melamine/formaldehyde resins for 30 minutes at 135°C.

After discussing the basic chemistry of these resins, Mr Rossa discussed the production of low-bake automobile refinishing systems, based on short oil DCO fatty acids in combination with a highly reactive melamine resin. These resins gave good overall film properties, but had poor weathering properties. A novel system of resin production had been developed, based on a two-stage, one-kettle, process. The first stage reactants were Cardura E/phthalic anhydride and DCO fatty acid; after reaction at 150°C for 1 hour the polyol was added and the temperature increased to 220-240°C for about 3 hours. Gel-permeation chromatography indicated that the pendant hydroxyl formed by reaction of Cardura E with DCO fatty acid reacted with phthalic anhydride forming a fatty acid/Cardura E monophthalate, which then reacted further with Cardura E or the remaining fatty acid/Cardura E ester. A large number of variations in the types of monobasic fatty acid and polyol used had been examined, and the resistance properties of paints based on these resins and stoved for 45 minutes at 80°C were shown.

Initiation of the Cardura E/phthalic anhydride by a monobasic fatty acid had been used so far. It was also possible to initiate the reaction by a polyol, e.g. glycerol, and details of the synthesis of the resins and the properties of paint films obtained were described. These test results showed that satisfactory properties could be obtained by stoving at temperatures as low as 100°C.

A third method of initiation of the reactions used a dibasic acid, and results were presented using azelaic acid as initiator. Both gloss and hardness were good on stoving at 100°C for 40 minutes, and flexibility was also good.

The lecture was followed by a discussion, after which a vote of thanks to the speaker was proposed by Dr S. R. W. Martin.

V.T.C.

Manchester

One man's views on new approaches to paint manufacturing techniques

Some 70 members and guests attended at the Royal Institution, Colquitt Street, Liverpool 1, on 8 December 1971 to hear a paper entitled "One man's views on new approaches to paint manufacturing techniques" by Mr B. L. Lucas of Joseph Mason & Co Ltd.

Before introducing the lecturer, the chairman, Dr F. M. Smith, welcomed all members to the new venue in the Liverpool area, and then pointed out that Mr Lucas had kindly consented to give his lecture after a rather late cancellation by the European lecturer originally booked.

Mr Lucas began with a discussion of manufacturing techniques for synthetic resins, particularly alkyds. He described work carried out in his firm in co-operation with the Electricity Council. An attempt was made to utilise off-peak electrical power. Originally heat storage was attempted using Cassel's salt whereby the major heat sink was due to latent heat of fusion. This proved impractical as solidification of the salt caused an insulating effect. Use of a block of high silicon cast iron proved far more effective, and continuation of the work showed a sintered ferric oxide block to be most efficient. Using this to heat air which circulated round the kettle gave fuel costs which were half those of gas fired heating, if town gas were used.

Improvements in control of viscosity by automatic means were also tried, but proved unsuccessful due to mechanical failure of the probe.

Moving on to paint manufacturers, Mr Lucas stated that high speed mixers were extremely useful, but in his opinion required variable speed. Sand mills were useful for long runs but, for a medium sized company such as his own, where rapid changes of product were required, they were not very good. A much better machine under these circumstances was one of the types of totally enclosed bead mills. Experience had indicated that the best method of cleaning such a mill was using the medium as a rinse. Reference was also made to the use of Porter-Lancastrian tanks by Mr Lucas's firm.

In conclusion, Mr Lucas criticised the general housekeeping of paint firms in this country; then on a light-hearted note produced statistical "evidence" to show that the odds against producing a satisfactory painting job were approximately 56,000,000 to one.

Mr Topham opened the discussion, stating that all connected with resin manufacture were very interested in costs. He had obtained some figures for heating costs. Using a four ton kettle, natural gas to maintain it at temperature for a suitable period cost £7. MANWEB were contacted and stated that the cost of electrical heating for the same kettle and conditions would be £23-24 for normal on-peak tariff. For off-peak tariffs MANWEB said they could not quote. It would seem that off-peak would have to be a very small fraction of on-peak charges to give the differences suggested.

Mr Lucas said his actual figures were: costs for a 2 ton kettle on town gas £4-60; for off-peak £1-60. The East Midlands Gas Board had stated that given everything in their favour, i.e. lowest tariff, natural gas and good efficiency, they might break even with the off-peak electricity but would not beat it.

Regarding the difference between the figures obtained by Mr Topham and his own, it was worth noting that the Electricity Board's tariffs varied between areas and in any case usually included a fairly hefty maximum demand charge as well as unit costs.

A number of questions were asked regarding the use of the Porter-Lancastrian tanks. In reply to them, Mr Lucas stated that little trouble had been experienced with settling, possibly due to the formulation of good non-settling paints. They had been partially successful with the use of an umbrella-shaped stirrer introduced through the bottom valve. This worked well until the tank was empty enough for the plastic liner to foul the stirrer. Normal pressures used for emptying were in the region of 15psi but the tanks were tested to 45psi if higher pressures were required.

A number of contributions were offered confirming Mr Lucas's remarks on sand mills and bead mills, during which Mr Lucas confirmed that he did not consider these mills really suitable for highly pigmented systems.

Referring to the subject of alkyd manufacture, Mr Lucas gave figures for costs of plant as 3 per cent above conventional gas fired types and also referred to cooling systems where cold air had originally been used but proved too slow, so that a water spray system had been introduced.

Mr Redman proposed the vote of thanks, which was received with enthusiasm.

A.MCW.

Pyrolysis gas chromatography

On Friday 14 January, some 60 members and guests attended at the Manchester Literary and Philosophical Society, Manchester, to hear a paper entitled "Pyrolysis gas chromatography" by Mr C. E. Roland Jones of Vinyl Products Ltd.

Mr Jones commenced by saying that gas pyrolysis chromatography was an apparently simple method of fingerprinting polymeric materials. In fact the mechanics were very complex and it was only in the last 12-18 months that reasons for the existence of some fractions in the chromatogram had been elucidated. There was no doubt that a thorough understanding of polymer chemistry was required to use this technique.

Four types of pyroliser were mentioned, these being: the furnace, which produced too large a quantity of gas; the laser beam, which required addition of carbon black or similar pigment and in the opinion of the speaker was not controllable enough, although the use of long wave attenuated beams might give results approximating to weathering characteristics; the filament or platten, which was dependent on design and treatment of the sample; and the Curie probe, which was quite useful. The speaker himself preferred an integral pyroliser.

In the techniques he recommended, a 3-4 microgram sample dissolved in solvent containing dioxan was normally used, the dioxan being present as a "wetting agent" so that an even film of approximately 200Å could be laid down. Rapid heating to about 700°C followed, although a number of authorities had recommended heating only to decomposition temperature. Tests carried out had shown significant differences between samples of the same polymer which had been tested by treating directly from room temperature and others that had been heat treated at 100°C and 60°C. Larger samples than those already mentioned produced bulk effects.

Polymer orientation was shown to have a great effect on the results and in simple copolymers entirely different chromatograms could be shown to be produced, depending on whether a simple alternating copolymer or a block copolymer was produced.

An extended question time was spent in extending the various points brought out in the lecture. Mr Jones re-emphasised his abhorrence of the technique of heating the sample in the pyroliser to dry it, quoting the results of heating given above.

He also pointed out that at the present moment a sub-group was attempting a correlation using model polymers and standardised pyrolysis temperature, sample size and column performance.

Mr Topham expressed the thanks of the section for Mr Jones's clear exposition of this important new analytical technique.

A.MCW.

Midlands

Coil coating in the Seventies

The 155th meeting of the Midlands Section took place at the Birmingham Chamber of Commerce on Friday 21 January 1972. This being the Annual Dinner Lecture, the evening began with an excellent meal. Mr H. J. Griffiths, the Section Chairman, then introduced the speaker, Dr A. D. Gilmour of the British Steel Corporation Research Centre, who gave a lecture entitled "Coil coating in the Seventies".

Dr Gilmour outlined the coating operations of the Corporation, who ran three lines, one laminating and two prepainting. The paint lines coated 50in wide strip at 200ft per min using a primer cure of 30-60 sec and finish cure of 1-3 min. A recent pretreatment development was to include a resinous binder in the chromate solution. Typical performance was discussed for a variety of finishes including appliance and architectural acrylics, pvc plastisols and laminates, siliconised alkyds, acrylics and polyesters, polyvinyl fluoride, polytetrafluoroethylene and polyimides. Polyimide coatings were discussed as an economic alternative to vitreous enamel.

Promising areas of recent paint development were in one-pack thermosetting acrylic emulsions and oil free polyester coatings for appliances. A number of questions were asked and answered including the usual interest in the use of powder and electron-beam cure, and the vote of thanks was proposed by Mr R. McD. Barrett.

R.J.K.

Newcastle

The use of zinc oxide in photocopying techniques

The 4th meeting of the current session was held at the Royal Turks Head Hotel, Newcastle, on Thursday 6 January 1972, when a paper was presented by Mr P. J. Robinson of Durham Chemicals entitled "The use of zinc oxide in photocopying techniques".

Mr Robinson introduced his paper by briefly outlining the history of photocopying from its development in the USA in the 1940s, mentioning that the use of zinc oxide as a photoconductor really became important during 1953/54.

He mentioned that one of the major new uses for zinc oxide was in the manufacture of paper coatings for electrostatic copiers. This coating was essentially a highly pigmented zinc oxide paint which was applied to the entire paper area. To produce a copy the paper was electrically charged and a light allowed to shine through the item to be photocopied. The area not protected by the print of the item to be photocopied was desensitised leaving the print, etc., still electrically charged. The paper was then passed through a reservoir containing carbon black which picked up on the charged areas giving a permanent copy of the original document. The photoconductive property of the zinc oxide was the basis of this technique, and the commercial success of electrostatic photocopiers had depended to a great extent on the development of grades of zinc oxide in which the photoconductive properties had been controlled at the optimum.

The properties of the paper coating and the behaviour of the zinc oxide in the coating was discussed in detail, and the effect of variables such as pigment/binder ratio, zinc oxide dispersion, dye type and concentration were mentioned. Some of the properties of the zinc oxide which determined its photoconductive quality were also highlighted.

Mr Robinson concluded his paper by mentioning some of the possible future developments, such as photography and application of primers by electrostatic coating.

At the end of the paper Mr Robinson was bombarded with numerous questions which were skilfully handled, and Mr Duell finally closed the meeting by thanking Mr Robinson for his paper, stating that the number of questions raised was evidence of the interesting paper which had been given. This was endorsed by the rest of the audience.

A.L.

Alpha olefins—new monomers for surface coatings

The 5th meeting of the current session was held at the Royal Turks Head Hotel, Newcastle, on Thursday 3 February 1972, and a paper entitled "Alpha olefins—new monomers for surface coatings" was presented by Messrs. K. B. Gilkes and A. Laws.

Mr Laws first outlined the general chemistry of the alpha olefins, indicating the origin and the chemistry of these monomers. The alpha olefins were almost exclusively obtained from petroleum, and certain members of this family could be obtained at relatively low cost. The inert carbon backbone would indicate that alpha olefins should impart good chemical resistance and resistance to degradation to polymers derived from these monomers.

He then discussed the use of olefins with a carbon chain length of six carbon atoms and above, in emulsion and solution polymerisation.

Work on solution polymers was outlined, in which it was shown that although the alpha olefin was difficult to polymerise, techniques had been developed which improved the rate and degree of conversion of copolymers derived. Different sources of commercial olefines were shown to have a marked effect on the degree of conversion, and high olefin levels in general were shown to be more difficult to copolymerise. Another general observation was that the higher olefin chain length resulted in greater difficulty in copolymerisation.

The use of alpha olefins in vinyl modified air drying alkyds was also discussed, and the improvement in aliphatic solubility of styrenated alkyds using alpha olefins in combination with styrene was mentioned.

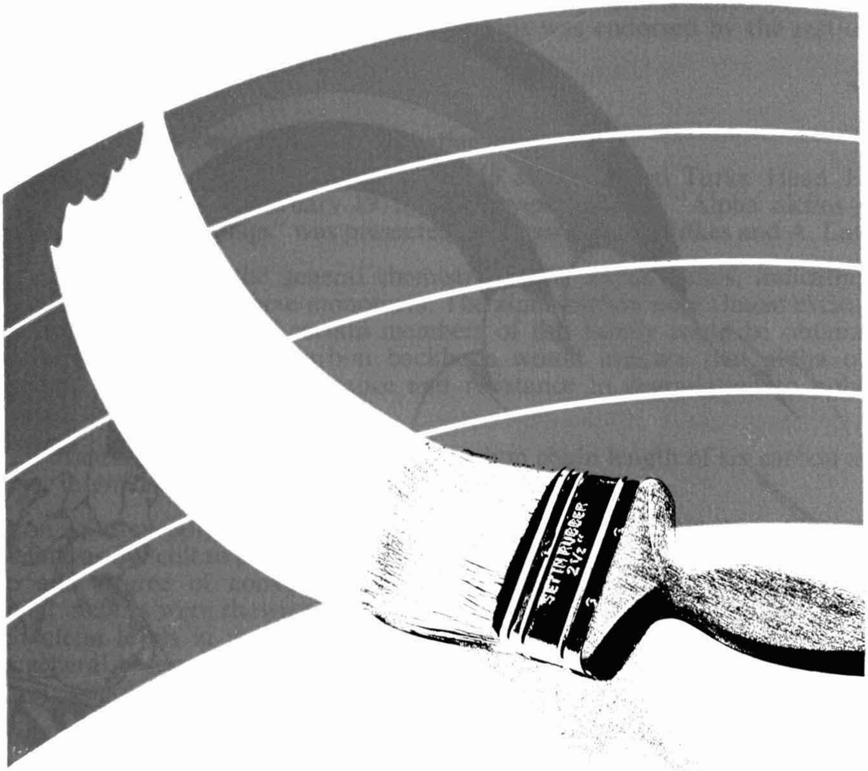
Mr Gilkes then discussed the testing of the polymers that Mr Laws had described. The alpha olefin modified pva copolymers showed no advantage in properties over conventional acrylate copolymers. With regard to styrene containing thermo-setting acrylics, the test results showed that the use of olefins gave improvements in detergent resistance, stain resistance and flexibility and a lowering of hardness. There was also evidence of improvement in durability.

The use of olefin modified styrenated alkyds gave surface coatings with similar wetting, gloss, colour, opacity and brushing characteristics to conventional vinyl modified alkyd paints at a lower cost. The drying was found to be slightly extended when alpha olefin was used.

Finally, Mr Gilkes mentioned the use of alpha olefins in vinyl modified printing ink alkyds for white tin-printing inks where the performance was shown to be equivalent to conventional vinyl modified alkyds.

After questions from Messrs Baxter, Price, Blenkinsop, James and Clark the meeting was brought to an end with a vote of thanks from Mr Dowling.

A.L.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Scottish

Modern trends in building finishes and surface coatings

The December meeting of the Scottish Section was held on Thursday 9 December 1971 at St. Enoch Hotel, Glasgow, at 6.15 p.m. The meeting was addressed by Mr D. K. Barron of the Department of Environment Building Research Station, East Kilbride, on the subject "Modern trends in building finishes and surface coatings".

Mr Barron traced the changes in building techniques and materials during the 26 years since the end of the war. The reasons for these changes were varied but, generally speaking, resulted in building by non-traditional methods. Factory-built units were also responsible for changes in methods and site organisation, handling and transportation together with changes in finishes.

Leading on to plastics and surface coatings, Mr Barron prefaced his remarks by stating that whilst he was no expert in either of these fields, the performance of these products was of great concern to him. He expressed the opinion that while "plastics" provided a new and interesting range of materials for the building industry, with particular reference to external cladding, etc., a great deal of care was required in choosing a correct type to withstand the particular environmental conditions. Turning to surface coatings, Mr Barron stressed the importance of the substrate being treated as playing as large a part as the coating which was being applied. While it was a fact that only around 5 per cent of the cost of new building was taken up with decoration, etc., this figure multiplied greatly over the lifespan of the building and, as such, initial treatments were obviously very important. Regarding treatment of wood, Mr Barron expressed the opinion that probably one of the greatest strides forward in this field was in the development of preservatives and the result these materials had on the lifespan of the timber.

Finally, ending on a note of caution, it was stressed that while most surface coating manufacturers were striving to produce coatings of greater impermeability, it was Mr Barron's feeling that by doing so there was a grave possibility of causing internal condensation, owing to the vapour barrier being on the wrong side of the construction. It was felt that perhaps a greater time lapse might be better to allow a state of equilibrium to be reached before application of a highly impermeable film.

An interesting discussion period followed, after which Mr T. Humphreys offered a vote of thanks on behalf of the Members and visitors present.

H.A.M.

West Riding

A funny thing happened to me on the way to the Patents Office

A joint meeting with the Society of Dyers and Colourists was held on Thursday 9 December 1971 at Bradford University, at which Mr A. T. Ransom, a Patent Agent, gave a talk with the above title. Mr Furness of the SDC took the chair.

Mr Ransom outlined the history of Letters Patent, which could cover many activities: he was concerned only with inventions. The issue of patents dated back to the 1600s, when it was usually the person with the most influence, rather than the inventor, who obtained patent rights. The basic idea of the patents system was to add to the sum of common knowledge by encouraging full disclosure of inventions. In return, the inventor was granted monopoly rights for a limited period of time before the invention passed into the public domain.

In the United Kingdom, approximately 60,000 patent applications were filed each year and this figure was rising. Most applications were from industry rather than independent inventors and, on average, about 50 per cent of applicants eventually gained patent rights. The vast number of applications received created problems, and in some countries it could take 5-10 years for an application to be approved.

The UK Patents Office was widely acknowledged as being very efficient, and a decision was normally obtained from it within a short period of time. Moves were afoot for the creation of a European patent, and the UK was one of the major contributors in setting up the necessary organisation.

Mr Ransom then mentioned some of the many examples of amusing patents which had been granted. Very often these were of American origin, although the UK also had its share.

The vote of thanks was proposed by the West Riding Section Chairman, Mrs K. Driver, and endorsed by all present for an interesting and entertaining lecture.

R.A.C.

Notes and News

Technical Exhibition

17-21 April 1972

Preview

More overseas participation in 24-OCCA

Four further companies have now been allocated space for 24-OCCA, to take place at the Empire Hall, Olympia, London, 17-21 April 1972. Three of these are drawn from overseas, A. Strazdins Pty. Ltd., of Wollongong, Australia, Emser Werke AG of Switzerland, and Matrep SA from Lille, France, the fourth company being International Colloids Ltd., of Widnes, Lancashire. Full descriptions of all four companies' exhibits are given in this issue. The total number of overseas countries from which exhibits are directly drawn is now twelve—Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Holland, Italy, Switzerland and the United States of America—and once again this Annual Technical Exhibition is shown to be the international focus for the suppliers to display the latest technical advances in the raw materials used in the manufacture of paint, printing ink, colour and other surface coating products. Of the exhibitors showing on 88 stands, 14 have not shown previously at OCCA exhibitions and eleven more were not present at the 1971 Exhibition.

Copies of the *Official Guide* have been despatched to all members of the Association, in the UK and abroad, to chemists and technologists in Europe, to technical colleges and, through the courtesy of the trade associations, to companies in the paint, printing ink and pigment industries in the UK. Any intending visitor may obtain a copy of the *Official Guide*, without charge, from the Association's offices.

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

The Underground train service will operate at 10 to 15 minute intervals to Olympia from Earls Court (District and Piccadilly lines), the first train leaving Earls Court at 09.00 and the last train leaving Olympia at 19.00 hours. Olympia is situated within easy access of West End hotels, which is particularly welcomed by overseas visitors, always prominent at OCCA Exhibitions, 38 overseas countries being represented in 1971.

Hours of opening

The Committee has decided to maintain the hours of opening for the Exhibition week as follows:

17 April	Monday	15.00-18.30
18 April	Tuesday	09.30-18.30
19 April	Wednesday	09.30-18.30
20 April	Thursday	09.30-18.30
21 April	Friday	09.30-16.00

Exhibition Luncheon

As already reported, Lord Ironside, Vice-President of the Parliamentary and Scientific Committee, has accepted the committee's invitation to be the Guest of Honour at the Exhibition Luncheon, which will be held at the Savoy Hotel, London WC2, on 17 April, and to reply to the Address of Welcome by the President. Principal officers of other scientific bodies, industrial research associations and organisations representing both suppliers and consumers have accepted invitations to attend. A form of application for tickets at £4.00 each was enclosed in each copy of the *Official Guide.*

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

Technical education

As in previous years, a stand will be devoted to Technical Education, and invitations have been extended to schools to send parties of senior science students to the Exhibition on the mornings of 18, 19 and 20 April, when they will be given a short introductory lecture by Members of the Association in a separate lecture room before visiting the exhibition. The Technical Education Stand will be staffed by representatives from the Association, technical colleges and trade associations, and details will also be shown not only of the courses available in the technology of the industries but also of the optional professional grade recently introduced by the Association for its Ordinary Members. The theme of the stand this year will be "Pigments", and the manufacture and structure of six typical paint and ink pigments will be shown.

New Exhibitors

Stand 10a—Emser Werke AG,
Selnaustrasse 16, Zurich, Switzerland.
UK representative: R. F. Bright,
The Limes, London Road, West
Kingsdown, Nr. Sevenoaks, Kent.

The new product to be featured on the *Emser Werke AG* stand is an outstanding unmodified liquid epoxy resin known as *Grilonit G 16.05*, which is distinguished from conventional liquid types by its low viscosity and its complete freedom from the tendency to crystallise under adverse conditions. *Grilonit G 16.05* is a 100 per cent reactive, unmodified expoxy resin based on bisphenol and epichlorhydrin. When fully cured it possesses outstanding mechanical, thermal and chemical resistant properties which are to some extent superior to those of previously known unmodified epoxy resins. Even when modified with reactive diluents, fillers, etc:, *Grilonit G 16.05* still does not crystallise, which makes it particularly suitable for use in the surface coatings industry (solvent-free coatings), the building and electrical industries, and in the casting, laminating and adhesive fields. The relatively low intrinsic viscosity of *Grilonit G 16.05* enables the required application viscosity to be achieved by the addition of smaller quantities than usual of modifiers, by which means considerable improvements in mechanical, thermal and chemical resistant properties can be obtained with existing basic formulations. Further details and technical data are given in Data Sheet V—A 1, which will be available on the stand.

Stand 71a—International Colloids Limited, Dennis Road, Widnes, Lancashire

International Colloids will continue to reflect the importance it attaches to pre-dispersed pigments and chemicals, particularly in the paint and printing ink industries. Modern formulating techniques are increasingly emphasising the the use of polymer dispersions which allow the manufacturer considerable latitude to formulate his requirements with the minimum of production effort. *International Colloids* has recognised and advocated this trend for some years and at OCCA 24 will be showing three further additions to the comprehensive range of pigment dispersions.

Intersperse 53 is a new product group based upon low molecular weight polyethylene. Pigmentation of the pigment chips is characterised by high concentration yielding maximum economies to the end user.

Intersperse 53 is available in standard primary colours. The new product also exhibits compatibility with pvc and most polyolefins.

Melamine pigment pastes have been introduced this year to complement the existing range of *Alkasperse* alkyd pigment dispersions.

An addition to the *Microsperse* product group of aqueous carbon black pastes will be *Microsperse D 1/24* which is based upon 50 per cent high jet furnace carbon black and is recommended for colouring and tinting emulsion paint systems.

International Colloids will also continue to emphasise the custom processing service to the paint and printing ink industries.

Stand 53—Matrep SA, 8 Rue de la Halle, 59 Lille, France

Matrep produces a wide range of equipment for the resin and paint industries, including high speed mixers and dispersers and complete plant for the manufacture of synthetic resins. A speciality of the company is pneumatically operated transport systems for the factory and office, in particular pneumatic systems for the movement of pigments and other raw materials from stores to the manufacturing vessel.

Technical personnel from France will be present on the stand to give full details of all Matrep's activities.

Stand 77—A. Strazdins Pty. Limited, Wollongong, New South Wales, Australia

The latest developments in large capacity colourant dispensers will be displayed. These machines have been designed primarily for bulk blending for the factory or depot using trade sales colourants or in-plant tinting using universal industrial colourants.

The dispensers shown can measure and dispense quantities of colourant or liquid as large as 600 ml and in increments as small as 0.2ml with an accuracy of ± 1 per cent.

Smaller 50ml capacity dispensing machines for use in retail stores will also be shown.

News of Exhibitors

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

Stand 65—Baker Castor Oil Company

As well as the more recently developed Thixseal and Rheox thixotropes, Baker will highlight the effectiveness of the established products *Thixatrol GST* and *MPA-60*. Also on display will be *Alfa-841*, a polyurethane elastomeric coating and adhesive which is claimed to adhere well to difficult substrates, such as plasticised pvc. Full technical back-up will be provided by staff from Baker, and from Kronos Titanium Pigments Ltd., Baker's UK representative.

Stand 7a—Bromhead & Denison Ltd.

Further details have now been released regarding the new *Special Extender* from Talkumwerke Naintsch to be exhibited at OCCA 24. The material is an unusual natural mineral consisting of hydrous magnesium silicate intergrown with a pure calcium magnesium carbonate, only known to exist in Austria. It has a plate-like laminar structure, which coupled with low water solubility, is thought to be responsible for increased scrub and chalk resistance in emulsion paints, and is claimed to have extreme whiteness, excellent covering power and a capacity to convey brightness. Bromhead & Denison say that *Special Extender* combines sufficient properties for universal use, thus eliminating the necessity of holding stocks of different extenders; it is available in three grades, standard, micro and super.

Stand 23—Degussa

Degussa has recently carried out investigations on the use of the furnace black *Corax L* in conductive polychloroprene adhesives. It was found that the specific resistivity of such adhesives under controlled test conditions could be reduced by increasing the content of *Corax L*.

The particular matting agents to be featured by Degussa will be the products coded *HK 125* and *OK 412*. Information and advice on these and the other Degussa products listed in the Official Guide will be provided on the stand by representatives of Bush Beach and Segner Bayley Ltd., the company's sole UK concessionaire.

Stand 7b—DH Industries Ltd.

DH Industries will include a *Dispermix D-25*—a mechanically driven dissolver/cavitation mixer by *Sussmeyer/Oliver & Batlle*. This machine has an infinitely variable speed range of 500-1,500rpm and is supplied with three multi shearing action turbines of 250—285—325mm diameter. The machine is designed for mixing up to 1,000 litres (220 gallons) and dispersing up to 475 litres (100 gallons).

A laboratory version—the *DL*—will also be exhibited. This has a drive motor of 1.35hp and has infinitely variable speed range of 1,700-5,000rpm.

Stand 75—Eastman Chemical International AG

New *Tenite* butyrate and propionate powders for electrostatic spray and fluidised bed powder coating applications have been introduced by Eastman. The powders are marketed in 50, 70 and 150-mesh particle sizes, and are designed for indoor and outdoor applications in a wide range of colours. The coatings are claimed to have excellent durability, weatherability, appearance, and "feel", and Eastman points out that, under the US Food and Drugs Administration, propionate powders can be used in contact with any foodstuff.

Stand 44—Elcometer Instruments Ltd.

Two prototype instruments are to be added to the range exhibited by Elcometer. The first is a *Minitector* capable of measuring plating thickness in the range 0-1 thou, and the other a new instrument, the *Miditector*. The latter is a development from the Minitector and will enable measurements to be taken over a range of coating thicknesses, from the thinnest (0-1 thou) to a maximum of 200 thou, using a total of four scales.

Stand 15—Ferranti Limited

Information recently released by Ferranti indicates that the *Ferranti-Shirley* cone and plate viscometer, developed by Ferranti from work carried out by the British Cotton Industry Research Association, has been most successful overseas. Over 60 per cent of all units manufactured have been exported, says Ferranti, a large proportion being used in the USA.

Stand 73—Imperial Chemical Industries Ltd.

ICI Plastics Division has issued a series of data sheets on the use of its *Fluon* PTFE resins. Several applications are featured, and five sheets on coating applications are included.

Stand 80—Kollmorgen Color Systems

The new *KCS-18 Automatic Color-Eye*, to be introduced at OCCA-24, is the cheapest instrument of its class available in the UK, claims Kollmorgen. Operating on the double-beam principle, the *KCS-18* is capable of straight differential comparisons (either coloured batch sample to white or coloured batch sample to approved coloured sample); it can also deal reproducibly with dark shades by use of the two alternative averaging times of 2 sec and 8 sec. Computer coupled operation will be demonstrated on the Kollmorgen stand.

Stand 14—Maschinenfabrik Heidenau VEB

The incorporation of the four point pressure control on the rollers of the *NVH 813* triple-roll mill, together with the other new features on this model: extra heavy duty bearings and enclosure of all gears on one side of the machine; has led to production increases of up to 30 per cent in use on the continent, claim Marchant Brothers Ltd., Maschinenfabrik Heidenau's UK, Canada, USA, Spain, Portugal and Eire agents. The chief technical design engineer from Heidenau will be present to help visitors interested in this and the other machines shown on the stand.

Stand 1a—Mastermix Engineering Co. Ltd.

An additional feature of the Mastermix exhibit will be the *Mastermix HVS Twin Head Change Can Disperser*. This machine combines high speed cavitation dispersion with high torque intense mixing, and is designed for processing a wide range of consistencies, including highly viscous and thixotropic materials. Each shaft has independent hydraulic drive, with infinite variation from zero to maximum.

Stand 12—Microscal Ltd.

Microscal will add the light fastness tester to the range of instruments on its stand. This instrument is an inexpensive and straightforward means of testing the light fastness of dyed or surface-treated materials; special cells are available which facilitate simultaneous studies under various temperature and humidity conditions.

Stand 30/31—Produits Chemiques Ugine Kuhlmann

There have been a number of changes in the structure of this company, including its change of name from the previous Societe des Usines Chemiques Ugine Kuhlmann. As part of the reorganisation, Francaise des Matieres Colorantes SA, shown in the *Official Guide* under Stand 30, has become the pigments division of Ugine Kuhlmann, and will no longer trade under its own name.

Stand 62—The Steetley Company Limited

The theme of the Steetley stand will be "Spice merchants to the paint industry", under which heading the company will promote high quality special purpose additives for the paint and ink industries, enabling manufacturers to make continuing improvements to their products.

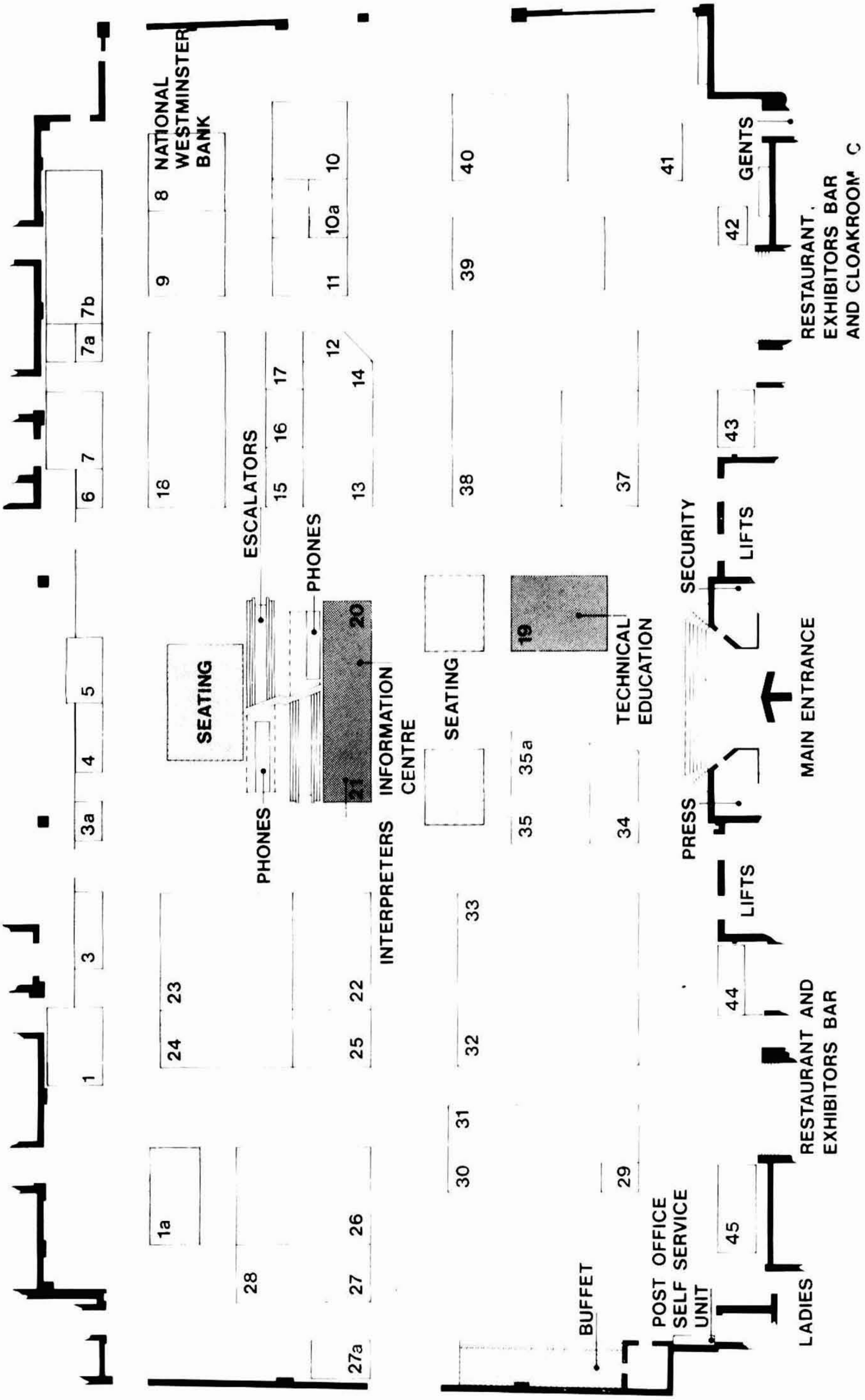
Stand 10—Torrance and Sons Limited

Further details have now been released on the 10hp cavitation disperser mentioned in the *Official Guide*. To be known as the *Torrance Intermediate Cavitation Disperser*, the new machine is fitted with infinitely variable hydraulic drive, and is designed to handle intermediate and smaller batches. The disperser head is fitted with a traverse and hydraulic elevating ram, and the complete unit is claimed to be compact, simple to operate, and easy to clean and maintain.

Corrigendum

Allied Colloids Manufacturing Co. Ltd. Please note that the telephone number for this company, which appears on the advertisement on page 2 of the *Official Guide*, has now been changed. The new number is Bradford 671267.

Plan of Exhibition



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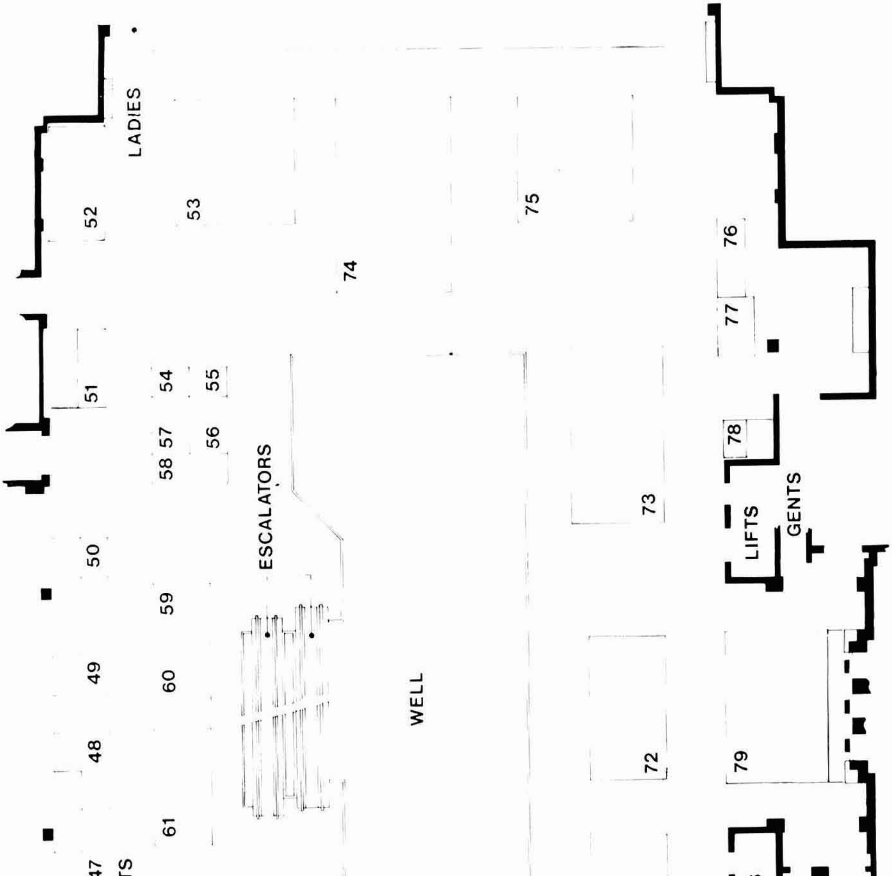
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WELL
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GENTS
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LIFTS
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SEATING
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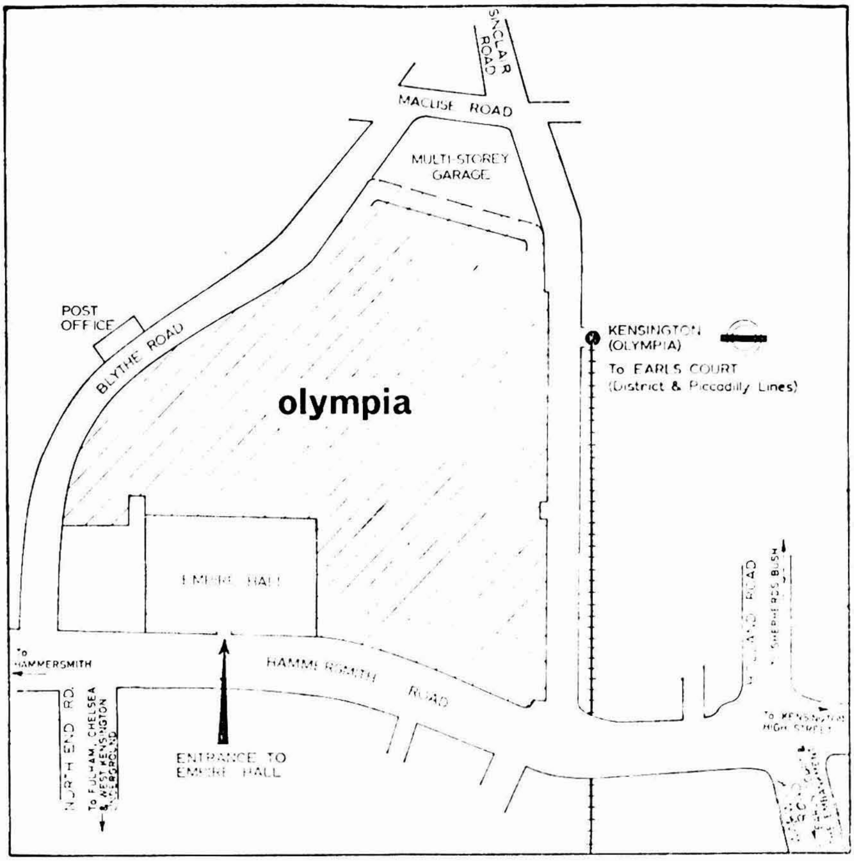
BUFFET

FIRST FLOOR

Plan of Olympia



1. For those travelling by road, there are car parking facilities available in the multi-storey garage, the entance to which is from Maclise Road.

2. Visitors arriving at the West London Air Terminal may board District Line trains at Gloucester Road Underground Station to Earls Court from which station a special Underground train is available to Olympia.

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

4. There are a number of bus routes which also serve Olympia:
   Bus Nos.: 9, 27, 28, 49, 73, 91, 207A and 270.
   Green Line Coaches Nos.: 701, 702, 704, 705, 714 and 716A.

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

Numerical List of Exhibitors—OCCA 24

Stand	
1	Cal/Ink Chemical Co. of Canada Ltd.
1a	Mastermix Engineering Co. Ltd.
3	RK Chemical Co. Ltd.
3a	Hunter Associates Laboratory
4	Torsion Balance Co. (GB) Ltd., The
5	William Boulton Ltd.
6	Research Equipment (London) Ltd.
7	Paint Research Association
7a	Bromhead & Denison Ltd.
7a	Talkumwerke Naintsch
7b	DH Industries Ltd.
8	National Westminster Bank Ltd.
9	International Lithopone Association
9	Pigment-Chemie GmbH
9	"Sachtleben" Chemie GmbH
10	Torrance & Sons Ltd.
10a	Emser Werke AG
11	Cabot Carbon Ltd.
12	Microscal Ltd.
13	Marchant Brothers Ltd.
14	Maschinenfabrik Heidenau Veb
15	Ferranti Ltd.
16	Winter Osakeyhtiö
17	The Leneta Co.
18	Scado NV
19	Technical Education
20	OCCA Information Centre
21	Interpreters
22	Rhone-Poulenc Group
23	Degussa
24	British Standards Institution
25	Sterling Colour Co. Ltd.
26	Amoco Chemicals Europe
27	Amalgamated Oxides (1939) Ltd.
27a	G. J. Erlich Ltd.
28	Morris Ashby Ltd.
29	The Society of Dyers and Colourists
30/31	Produits Chimiques Ugine Kuhlmann
32	Tioxide International Ltd.
33	Titanium Intermediates Ltd.
34	Diaf A/S
35	Croxton & Garry Ltd.
35a	Grace GmbH
37	CdF Chimie
38	Montedison SpA
39	Durham Raw Materials Ltd.
40	Lennig Chemicals Ltd.
41	British Steel Corporation
42	Winkworth Machinery Ltd.
43	Winn & Coales (Denso) Ltd.
44	Elcometer Instruments Ltd.
45	Peter Silver & Sons (Engineers) Ltd.
46	Henkel & Cie GmbH
47	Sheen Instruments (Sales) Ltd.
48	Carless, Capel & Leonard Ltd.
49	Cray Valley Products Ltd.
50	Georg M. Langer & Co.
51	Instrumental Colour Systems Ltd.
52	Bowater Industrial Packaging Ltd.
53	Matrep SA
54	Daniel Products Co.
55	Arco Chemical Co.
56	Vuorikemia Oy
57/58	Cornelius Chemical Co. Ltd.
59	Casa Chemicals Ltd.
59	Thomas Swan & Co. Ltd.
60	Akzo Chemie NV
60	Noury and Van der Lande NV
61	BIP Chemicals Ltd.
62	The Steetley Co. Ltd.
64	Kingsley & Keith (Chemicals) Ltd.
65	Baker Castor Oil Co.
66	Anchor Chemical Co. Ltd.
67	Hercules Powder Co. Ltd.
68	Allied Chemical International SA
69	Rex Campbell & Co. Ltd.
69	The Chemical Supply Co. Ltd.
70	Victor Blagden & Co. Ltd.
71	Metrication Board
71a	International Colloids Ltd.
72	Joseph Crosfield & Sons Ltd.

Stand	
73	Imperial Chemical Industries Ltd.
74	Laporte Industries Ltd.
75	Eastman Chemical International AG
76	*Paint Manufacture*
77	A. Strazdins Pty. Ltd.
78	*Pigment & Resin Technology*
79	Schering AG
80	Kollmorgen Color Systems
82	*Polymers, Paint & Colour Journal*
83	Worsdall Chemical Co. Ltd.

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

Stand	*Company*	*Official Guide Page No.*
7b	Ateliers Sussmeyer	69
70	Buckman Laboratories Inc.	55
23	Bush, Beach & Segner Bayley Limited	70
71	Cabot Corporation	58
27	Canadian Zincoli Pigments Ltd.	44
70	Cargill Chemical Corporation	54
70	Chemetron Corporation	54
70	Claremont Polytechnical Corporation	55
1	Colwell Color Cards	59
64	Dainippon Ink	88
80	Davidson & Hemmendinger	89
28	Deanshanger Oxide Works Ltd., The	48
51	Digico Ltd.	85
39	Durham Chemical Group Ltd.	73
74	Eastman Kodak Company	74
83	Esterchem Pty. Ltd.	135
1	Fischer, H. G., & Co.	59
22	Greeff, R. W., & Co. Ltd.	111
27a	Halin, G. E.	75
1	Hubron Sales Ltd.	60
80	Instrument Development Laboratories	89
60	Interstab GmbH	41
60	Interstab Ltd.	41
83	Lamotte & Coiffard	135
80	Leres AS	89
80	Macbeth Corporation	89
66	Marbon Chemical Corporation	47
13	Marchant Bros. (Canada) Ltd.	93
22	M & B Plastics Ltd.	111
57/58	Mearl Corporation	64
27a	Molteni Off. Mech.	75
14	Nagema, Transportmaschinen, Export-Import	95
70	Neville-Cindu NV	55
64	Nippon Oils & Fats	88
60	Novadel Ltd.	41
60	Oelwerke Noury & Van der Lande GmbH	41
7b	Oliver & Batlle	69
35/35a	Omya	67
27a	O'Toole Ltd.	76
57/58	Oulu Oy	64
83	Penfound Varnish Co. Ltd.	135
83	Pope Chemical Corporation	134
27a	Pressindustria	76
271	Previero	76
57/58	Roehm GmbH	64
64	Sherwin Williams	88
70	Societe de Produits Chemiques et Matieres Colorantes de Mulhouse	54
27	Stolberger Zincoli GmbH	44
64	Ugilor SA	88
7b	Volrath, Paul	70
7b	Vree, J. De, & Co.	70
38	Weil, Joseph, & Son Ltd.	100

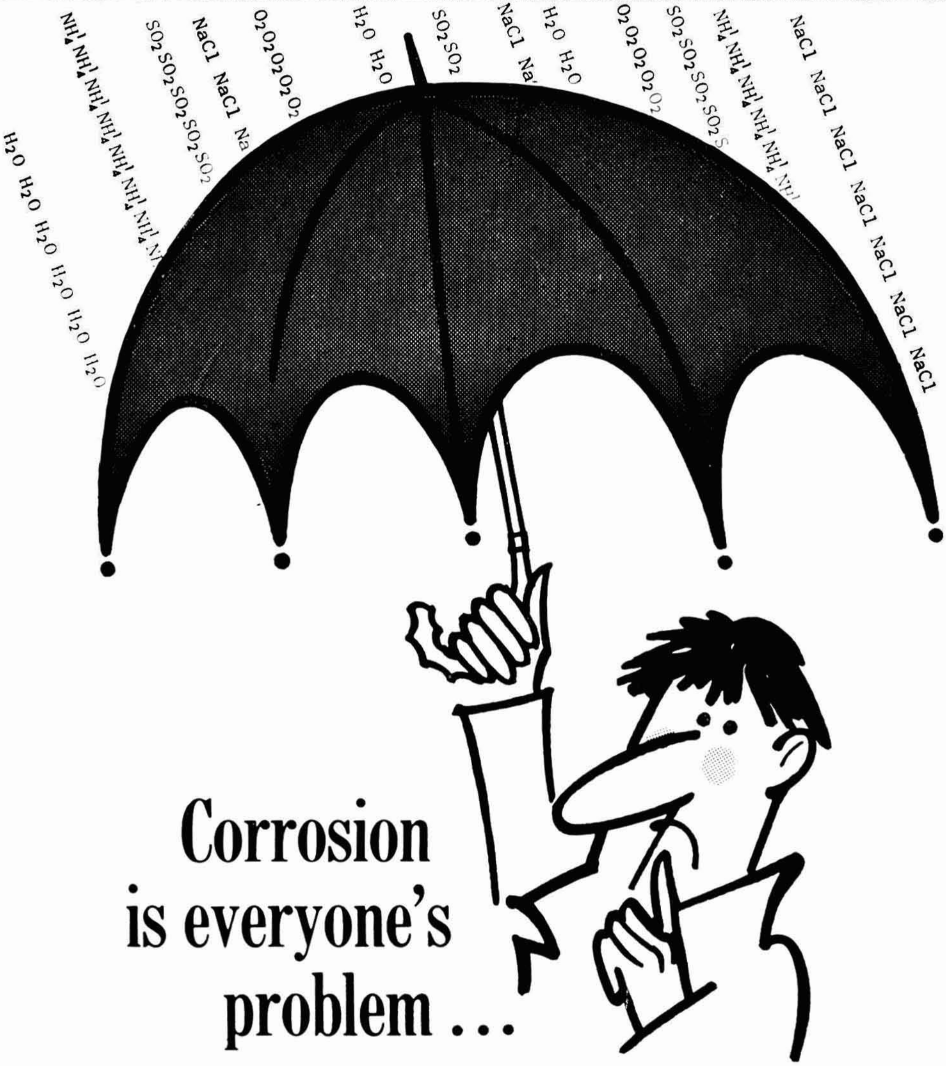
Analysis of Exhibits

Stand No.	Exhibitor	Resins	Pigments	Extenders	Additives	Solvents	Oils	Machinery	Lab. Machinery	Instruments	Misc.
60	Akzo Chemie NV	●			●		●				Intermediates, accelerators
68	Allied Chemical International SA	●	●		●						Resin-forming chemicals
28	Amalgamated Oxides Ltd.		●								
26	Amoco Chemicals Europe										Resin materials
66	Anchor Chemical Co Ltd.				●						Curing agents for epoxide resins
55	Arco Chemical Co.	●			●						
27/28	Ashby, Morris, Ltd.		●								
65	Baker Castor Oil Co.				●						
61	BIP Chemicals Ltd.	●									
70	Blagden, Victor, & Co. Ltd.	●	●		●						
5	Boulton, William, Ltd.							●	●		
52	Bowater Industrial Packaging Ltd.										Non-returnable drums
41	British Steel Corporation	●		●		●					
7a	Bromhead & Denison Ltd.			●							
11	Cabot Carbon Ltd.		●		●						
1	Cal/Ink Chemical Co. of Canada Ltd.		●							●	Colour cards
69	Campbell, Rex, & Co. Ltd.	●	●		●	●					
48	Carless, Capel & Leonard Ltd.					●					
59	Casa Chemicals Ltd.	●			●						
37	CdF Chimie	●			●	●					
57/58	Cornelius Chemical Co. Ltd.	●	●	●	●						

Stand No.	Exhibitor	Resins	Pigments	Extenders	Additives	Solvents	Oils	Machinery	Lab. Machinery	Instruments	Misc.
49	Cray Valley Products Ltd.	●									
72	Crosfield, Joseph, & Sons Ltd.			●							Matting agents, thickening agents
35	Croxton & Garry Ltd.		●	●	●						
54	Daniel Products Co.		●		●						Pigment dispersions
23	Degussa		●	●	●						
7b	DH Industries Ltd.							●			
34	Diaf A/S							●	●		
39	Durham Raw Materials Ltd.		●	●	●						
75	Eastman Chemical International AG	●			●	●					
44	Elcometer Instruments Ltd.									●	
10a	Emser Werke AG	●									
27a	Erlich, G. J., Ltd.							●	●		
15	Ferranti Ltd.									●	
35a	Grace GmbH		●		●						
46	Henkel & Cie GmbH				●						Fatty acids
67	Hercules Powder Co. Ltd.	●	●								Fatty acids, water soluble cellulose derivatives
3a	Hunter Associates Laboratory									●	
73	Imperial Chemical Industries Ltd.	●			●	●					
51	Instrumental Colour Systems Ltd.									●	
9	International Lithopone Association			●							
71a	International Colloids Ltd.		●								

Stand No.	Exhibitor	Resins	Pigments	Extenders	Additives	Solvents	Oils	Machinery	Lab. Machinery	Instruments	Misc.
64	Kingsley & Keith Ltd.		●		●	●					Monomers
80	Kollmorgen (UK) Ltd.									●	
50	Langer, Georg M., & Co.				●						
74	Laporte Industries Ltd.		●		●						
17	Leneta Co., The									●	Paint test charts
40	Lennig Chemicals Ltd.	●									
13	Marchant Brothers Ltd.							●	●		
14	Maschinenfabrik Heidenau Veb							●	●		
1a	Mastermix Engineering Co. Ltd.							●	●		
53	Matrep SA							●			
12	Microscal Ltd.									●	
38	Montedison SpA	●	●			●					
60	Noury and Van der Lande NV				●		●				
76	Paint Manufacture										Technical journal
7	Paint Research Association	●							●	●	
78	Pigment & Resin Technology										Technical journal
82	Polymers, Paint & Colour Journal										Technical journal and year book
6	Research Equipment (London) Ltd.									●	
22	Rhone-Poulenc Redis	●			●	●					
3	RK Chemical Co Ltd.								●	●	
9	"Sachtleben" Chemie GmbH		●	●							
18	Scado NV	●									

Stand No.	Exhibitor	Resins	Pigments	Extenders	Additives	Solvents	Oils	Machinery	Lab. Machinery	Instruments	Misc.
79	Schering AG	●			●						
47	Sheen Instruments (Sales) Ltd.									●	
45	Silver, Peter, & Sons (Engineers) Ltd.							●	●	●	
29	Society of Dyers and Colourists, The										Publications on colour and colouration
62	Steetley Co. Ltd.	●	●	●	●						
25	Sterling Colour Co. Ltd. ..		●								
77	Strazdins Pty Ltd. ..									●	Tinting system
7a	Talkumwerke Naintsch ..			●							
32	Tioxide International Ltd.		●								
33	Titanium Intermediates Ltd.										Titanium alkoxides, titanium chelates
10	Torrance & Sons Ltd. ..							●	●		
4	Torsion Balance Co. (GB) Ltd., The									●	
31	Produits Chimiques Ugine Kuhlmann	●	●		●	●					
42	Winkworth Machinery Ltd.							●	●		
56	Vuorikemia Oy		●								
43	Winn & Coales (Denso) Ltd.							●	●		
16	Winter Oskeyhtiö									●	Tinting system
83	Worsdall Chemical Co. Ltd.	●					●				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Association Dinner and Dance 1972

PMA President to speak on behalf of guests

At the end of December, Members attached to the United Kingdom, Irish and General Overseas Sections will have received the application form for the Association's Biennial Dinner and Dance, to be held on Friday 12 May 1972 at the Savoy Hotel, London WC2.

The Reception will take place at 7.00 p.m. for Dinner at 7.30 and, on this occasion, there will be two short speeches only—a Welcome by the President and a Reply on behalf of the guests by Mr A. S. Hooper, the president of the Paintmakers Association—so that dancing, to the Jerome Orchestra, can commence as soon as possible and continue until 1 a.m. There will be an interval at 11.30 p.m. for tea and cakes.

The price of single tickets is £5.00 each and applications should be made by Members as soon as possible after receipt of the form. Tables will be arranged to accommodate 12 or 10 persons each, although it may be possible to arrange a few tables for eight persons.

Non-members wishing to receive forms should contact the Association's offices.

towards 2000

eastbourne 19~23 june 1973

OCCA Biennial Conference

Venue and dates

The outline programme of the Association's next biennial conference, to be held at the Grand Hotel, Eastbourne, from 19-23 June 1973, has now been arranged. As announced last month, the theme of the conference is to be "Towards 2000," and it is intended that the papers given will give delegates an insight into the future of the paint and allied industries, not only from a technical viewpoint, but also where economic and marketing aspects are concerned.

Structure of technical sessions

It is felt that, in the present climate of mushrooming technology, delegates to a conference require the maximum technical content, and thus the programme has been arranged so that there will be a session on each half-day of the conference, and there will be no parallel sessions. Technical sessions will be held on the mornings of the Wednesday, Thursday and Friday, and on Thursday afternoon; there will be a session concerned with techno-economic factors, including international relations, on the Wednesday afternoon, and three Workshop sessions will follow the Association's AGM on the Friday afternoon.

A further change from previous conferences will be in the structure of the Technical Sessions. It is planned that each session will have a broad sub-theme, and that each will be opened by a major paper on this sub-theme, delivered by a speaker of some eminence in the field. The remainder of the session will be taken up with papers on more specialised topics within the sub-theme, amongst which it is hoped to include papers of a technological nature.

Submission of papers

Full details of the titles of the Workshop Sessions and the sub-themes of the

Technical Sessions will be announced in the near future. Any person who feels that he can give a paper which would fit the framework of the conference should send an abstract of about 250-500 words to the Association's Honorary Research and Development Officer, Mr A. R. H. Tawn, 34 Crest View Drive, Petts Wood, Kent, BR5 1BY, as soon as possible, and not later than 1 June 1972. Papers selected for presentation will be required in final draft by 2 October 1972 so that full pre-prints can be prepared and sent to all delegates some time before the conference; with the possible exception of the major lecturer in each Technical Session, authors will only be required to outline their papers, highlighting points of particular interest, and it is thus particularly important that delegates are given the opportunity to read the full paper in advance, so that the maximum benefit may be obtained from the discussion period following each lecture.

Registration forms

Full details concerning registration fees, and a registration form, will be sent to all Members of the Association before the end of 1972. Non-members wishing to receive these items, when available, should apply in writing to the Director & Secretary, at the Association's offices, at the address shown at the front of this *Journal*.

Report of Meeting of Council

A meeting of the Council was held at Wax Chandlers' Hall, Gresham Street, London, on Thursday 27 January with the President, Mr A. W. Blenkinsop, in the chair. There were 22 members present.

It was with regret that members had learned of the death on 7 January of Dr H. Houlston-Morgan, a Founder Member, Honorary Member and President (1922-24) of the Association; members stood in silence as a mark of respect. An appreciation by Dr S. H. Bell appeared in the March issue of the *Journal*.

The arrangements for the Annual General Meeting on 7 June 1972 at Wax Chandlers' Hall were finalised, including the Council's nominations for Vice-Presidents and the appointment of the President Designate, resulting from the customary ballot. The agenda for the meeting was approved.

A report was received on the number of applications which had been considered to date by the Professional Grade Committee; full lists of successful applicants had been published in the January and March issues of the *Journal*. Judging by the number of applications received, it was felt that the scheme had demonstrated the need for this facility within our industries, and it had also stimulated an increase in the recruitment of new Members.

Information was given concerning a statement issued by the Council of Science and Technology Institutes on the formation of a trade union as a result of the Industrial Relations Act. Membership of the new union would be restricted to the members of those societies of which the CSTI was composed, i.e. the Royal Institute of Chemistry, Institute of Biology, Institute of Mathematics and its Application, the Institution of Metallurgists and the Institute of Physics. Representation had been made to this body that this Association should be affiliated to the Council of CSTI so that members of this Association (in particular, those in the Professional Grade) should be afforded an opportunity of joining the proposed new union. It was understood that other organisations with a similar membership structure (in that membership is not entirely restricted to those professionally qualified) had also made application but all had been rejected. It was felt by Council that members of the Association would like to know that representations had been made on their behalf in this way.

Many applications for tickets for the Dinner Dance to be held at the Savoy Hotel on 12 May 1972 had been received and all members were urged to send in their applications as soon as possible. The President particularly wished that both present and past Section Chairmen should wear their badges at this Association function. Ten top table guests had so far accepted the invitation to attend, and Mr A. S. Hooper, President of the Paintmakers Association, had accepted the invitation to reply on behalf of the guests to the Address of Welcome to be given by the President.

Council were informed of the arrangements in hand for the Foundation Lecture to be held in October and full details would be circulated to members in due course.

A suggestion had been made that the Chairmen of the three Branches in the UK (London-Southern, Midlands-Trent Valley and Scottish-Eastern) would appreciate an insignia of office to wear at Branch meetings. This idea was welcomed by the Sections and Branches and the insignia had been provided. Since there were three Branches in the South African Section, and in order to maintain the good relationships between these Branches, it was agreed that similar arrangements be made.

A report was received on the Exhibition Luncheon, which would be held at the Savoy Hotel on Monday 17 April and at which Lord Ironside had kindly consented to be Guest of Honour. Invitations to the principal officers of other societies and the press to attend had been despatched and the list of acceptances was published in the March issue of the *Journal*.

As an additional promotional feature to attract even more visitors to the Exhibition, a reply postcard requesting a copy of the *Official Guide* together with an information leaflet in six languages had been included in the January issue of the *Journal* sent to non-members, as well as in the journals of the Institute of Metal Finishing, Institution of Corrosion Technology, the Plastics Institute, the Society of Dyers and Colourists and a trade journal covering the rubber industry. These are in addition to the usual circulation to paint manufacturing companies in Europe and in other countries. Many replies had been received from all over the world showing a greater response than previously at this stage.

It was reported that, as a result of the Publications Committee meeting on 22 November 1971, SI units would be used whenever possible in order to introduce their use gradually to the readership, since they would be adopted throughout the Transactions & Communications from January 1975.

The proposed title for the OCCA Conference to be held at Eastbourne in 1973 was "Towards 2000" and any authors wishing to present a paper were invited to submit a summary of the paper to the Hon. Research & Development Officer, Mr A. R. H. Tawn.

It was announced that the 1972 FATIPEC Congress would take place in Florence from 11-16 June; the official OCCA contribution would be a paper by Mr K. McLaren and Dr D. A. Plant entitled "ANLAB—a uniform colour space for pigment evaluation".

It was reported that Mr R. M. W. W. Wilson's term of office as one of the Association's representatives on the Technical Training Board for the Printing Ink and Roller Making Industry terminated on 31 December 1971 and it was agreed that Mr A. R. H. Tawn should represent the Association in this way.

Section reports were received from Section representatives on the activities held since the last Council meeting in October.

New Zealand Sections

We were interested to see recently a copy of the December 1971 issue of *Chemistry and Industry* in New Zealand, in which the New Zealand Sections were prominently featured. In all, nine pages were devoted to the Sections, in particular to a report of the recent convention at Wairakei, and the exhibition which was held concurrently. A history of OCCA and New Zealand Sections was also included, together with general information on Section membership, etc.

West Riding Section

At the West Riding Dinner Dance: (left to right) Mr A. A. Duell (Chairman, Newcastle), Mrs Sharp, Mr F. D. H. Sharp (Chairman, Irish), Mrs Duell, Mrs Blenkinsop, The President, Mr A. W. Blenkinsop, Mrs K. Driver (Chairman, West Riding), Mr D. E. Eddowes (Chairman, London), Mr R. H. Hamblin (Director & Secretary), Mrs Fourness, Mr B. A. Richardson (Chairman—London, Southern Branch), Mrs Richardson, Mr R. K. Fourness (Past-President, SODAC)

Annual Dinner and Dance

The Annual Dinner and Dance of the Section was held on 26 November 1971, at the Crown Hotel, Harrogate, and was attended by a record number of members and guests.

The Chairman, Mrs K. Driver, extended a warm Yorkshire welcome to all present and in particular the guests, Mr and Mrs R. K. Fourness, Past-President of the Society of Dyers and Colourists, the President, Mr A. W. Blenkinsop and his wife, Mr R. H. Hamblin, Director & Secretary, and Chairmen of Sections and their partners, as follows:

Mr A. A. Duell (Newcastle)
Mr D. E. Eddowes (London)
Mr H. J. Griffiths (Midlands)
Mr B. A. Richardson (London—Southern Branch), and
Mr F. D. H. Sharp (Irish).

The Guest of Honour, Mr Fourness, referred to the similarity of interests between OCCA and the SDC and was encouraged by the co-operation between the two bodies such as the joint meeting now traditionally held each year by the respective local West Riding Sections.

With the formal proceedings over the assembly moved into the ballroom and, in true West Riding tradition, everyone let their hair down, enjoyed the dancing and renewed old friendships.

R.A.C.

News of Members

Members may have been interested to see Mr R. J. Woodbridge, an Ordinary Member attached to the Bristol Section, and a past-Chairman of the Section, in recent TV commercials for Berger Paints' Brolac products. Mr Woodbridge, who is technical manager for Brolac, will also be featured in a series of press advertisements.

A reception was held at the Mayfair Hotel in February to celebrate the 25th anniversary of the foundation of the Silver Paint & Lacquer Company, of which Mr L. H. Silver, an Ordinary Member attached to the West Riding Section, former chairman of that Section, and currently a Vice-President, is the Managing Director. Owing to the power cuts, the reception was held in candlelight which added to the atmosphere of a very pleasant occasion.

FSPT 50th Annual Meeting

The 50th Annual Meeting of the Federation of Societies for Paint Technology is to be held at the Chalfonte-Haddon Hall, Atlantic City, New Jersey, from 24-28 October 1972. The theme of the FSPT's Golden Anniversary programme is "Proud past, colourful future," and full details will be announced in due course. The 37th Paint Industries Show will run concurrently with the Annual Meeting.

Register of Members

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

Ordinary Members

ABEL, ADRIAN GEORGE, BSc, ASDC, 11 School Grove, Prestwich, Manchester. *(Manchester)*

CASTLE, CHRISTOPHER, 30 Coniston Drive, Darwen, Lancashire. *(Manchester)*

CHATER, ROBERT KEITH, BSc, 14 Tansley Hill Road, Dudley, Worcs. *(Midlands)*

CURME, GEOFFREY CHARLES, BSc, GRIC, Revertex Ltd., Temple Fields, Harlow, Essex. *(London)*

DEAN, DAVID JAMES, BSc, 96 Rosegate, Darwen, Lancs. *(Manchester)*

DUCKER, BERNARD HAROLD, LRIC, 7 Nine Acres Road, Cuxton, Rochester, Kent. *(London)*

GIBSON, ANNE MCARDLE, 122 Munro Road, Jordanhill, Glasgow. *(Scottish)*

INGLESTON, ROY, 47 South Road, Smethwick, Warley, Worcs. *(Midlands)*

KEITH, GORDON, BSc, 13 Osborne Close, Harrogate, Yorks. *(West Riding)*

LOVELL, PETER ANTHONY, BSc, "Carennac", 18 Warrenside Close, Wilpshire, Nr. Blackburn, Lancs. *(Manchester)*

MILLARD, RAYMOND JOSEPH, BSc, 8 Siskin Road, Pedmore, Stourbridge, Worcestershire. *(Midlands)*

MCCLEAN, MICHAEL, 45 Abridge Park, Abridge, Romford, Essex. *(London)*

PEPPER, KEITH, 24 Downham Close, Woodthorpe View Estate, Arnold, Nottingham. *(Midlands-Trent Valley)*

TRUEMAN, CHRISTOPHER MICHAEL, 72 Woodlands Farm Road, Erdington, Birmingham. *(Midlands)*

VARDIGANS, PETER GLENDENNING, 42 The Crest, Bristol. *(Bristol)*

WILLIAMS, PETER LEWIS, LRIC, 55 Allendale Road, South Yardley, Birmingham. *(Midlands)*

Associate Members

MITTENS, ROBERT JOHN, 282 Witcombe, Stanshawe Estate, Yate, Bristol (*Bristol*)

MUNNS, P. J. D., Robanna House, Boroughbridge Road, Knaresborough, Yorkshire. (*West Riding*)

Students

LOMAX, BRIAN, University Hall, Great Horton Road, Bradford 7, Yorkshire. (*West Riding*)

MOBBS, ALLEN CHARLES, 73 Wright Road, Alum Rock, Birmingham. (*Midlands*)

WRAITH, JAMES NEIL, Pickard Macnair Ltd., Rutland Road, Sheffield 53, Yorkshire. (*West Riding*)

Forthcoming Events

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

Thursday 6 April

Midlands Section—Trent Valley Branch: Annual General Meeting followed by "Printing banknotes" by Mr D. R. Lowther of Thomas de la Rue & Co. Ltd., to be held at the British Rail School of Transport, London Road, Derby, at 7.00 p.m.

Newcastle Section: Annual General Meeting, followed by "Wine production in Europe" by Mr M. Goschalk of Newcastle Polytechnic, to be held at the Lambton Worm, Birtley, at 6.30 p.m.

Friday 7 April

Scottish Section: Annual General Meeting and Smoker, to be held at the St. Enoch Hotel, Glasgow, at 6.00 p.m.

Bristol Section: "Industrial relations in the surface coatings industries" by Mr J. L. Thomas of the University of Bristol, Department of Extra Mural Studies, to be held at the Royal Hotel, Bristol, at 7.15 p.m. **Please note change of date.**

Tuesday 11 April

West Riding Section: Annual General Meeting, to be held at the Griffin Hotel, Boar Lane, Leeds, at 7.30 p.m.

Friday 14 April

London Section: Annual General Meeting followed by "Cheeses" by Mr A. R. Cornwell of the English County Cheeses Council, to be held at the Polytechnic of the South Bank, London SE1, at 6.30 for 7.00 p.m.

Manchester Section: Annual General Meeting, to be held at the Lancashire County Cricket Club, Old Trafford, Manchester, at 6.30 p.m.

Midlands Section: Annual General Meeting, to be held at the Birmingham Chamber of Commerce and Industry, 75 Harborne Road, Birmingham 15, at 6.30 p.m.

Monday 17 to Friday 21 April

24 *OCCA, 24th Annual Technical Exhibition:* To be held at the Empire Hall, Olympia.

Wednesday 19 April

Scottish Section—Eastern Branch: "Airless spray applications" by Mr D. I. Muirhead of Wm. Sim & Sons (Paints) Ltd., to be held at the Carlton Hotel, North Bridge, Edinburgh, at 7.30 p.m.

Thursday 20 April

Thames Valley Section: Annual General Meeting, followed by "The river Thames" by Mr Compton of the Thames Conservancy Board, to be held at the Beech Tree Hotel, Maxwell Road, Beaconsfield, at 7.00 p.m.

Friday 21 April

Irish Section: Annual General Meeting, followed by an open forum, to be held at the Clarence Hotel, Wellington Quay, Dublin, at 8.00 p.m.

Friday 28 April

Bristol Section: Annual General Meeting, to be held at the Royal Hotel, Bristol, at 7.15 p.m.

West Riding Section: Luncheon Lecture, "The effect of the Common Market on the paint industry" by Mr S. Coppins of ICI Paints Division, to be held at the Astoria Hotel, Roundhay Road, Leeds, at 12.30 for 1.00 p.m.

Monday 1 May

Scottish Section: Golf outing, details to be arranged.

Tuesday 2 May

Thames Valley Section—Student Group: "Analysis of paint films" by Mr N. Falla (Paint Research Association) to be held at the main Lecture Theatre, Slough College, at 4.00 p.m.

Friday 12 May

Oil and Colour Chemists' Association: Dinner Dance to be held at Savoy Hotel, London, at 7.00 for 7.30 p.m.

Saturday 20 May

Irish Section: Annual Treasure Hunt. Details to be announced.

Oil and Colour Chemists' Association

President: A. W. BLENKINSOP

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

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

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

Ordinary Membership is granted to scientifically trained persons, and Associate Membership to others interested in the industries covered. An optional Professional Grade, conferring designatory letters, is given to Ordinary Members. Student Membership, which is intended primarily for students, is open without restriction to persons under the age of 21 and to those up to 25 who are following a course of technical study. The annual subscription in each case is £5.25, except for Student Members whose subscription is £1.05. An entrance fee of 50p is payable by all members. Applications for membership are invited from suitably qualified persons who are engaged or otherwise interested in the industries noted above. Applications, which should be supported by two members of the Association (one of whom must be an Ordinary Member), should be forwarded to the Director & Secretary at the address given below. Application forms and full details of membership may be obtained from the offices of the Association.

PUBLICATIONS

Journal of the Oil and Colour Chemists' Association. Published monthly. Subscription rate to non-members in UK and abroad; £10.00 p.a. post free; payable in advance.

An Introduction to Paint Technology (Second Edition with additional chapter). Pp. 187, illustrated, with index, £1.00 (including postage).

Paint Technology Manuals (Parts 2-5 at present out of print).

Part 1: "Non-convertible Coatings," Second Edition, Pp. 343, £1.80.
Part 2: "Solvents, Oils, Resins and Driers," Second Edition, Pp. 268, £1.80.
Part 3: "Convertible Coatings," Pp. 318, £1.75.
Part 4: "The Application of Surface Coatings," Pp. 345, £1.75.
Part 5: "The Testing of Paints," Pp. 196, £1.75.
Part 6: "Pigments, Dyestuffs and Lakes," Pp. 340, £1.75.

Director & Secretary: R. H. Hamblin, M.A., F.C.I.S., Wax Chandlers' Hall, Gresham Street, London EC2V 7AB.

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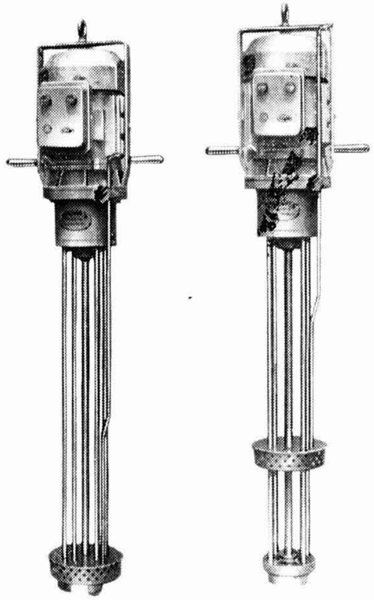

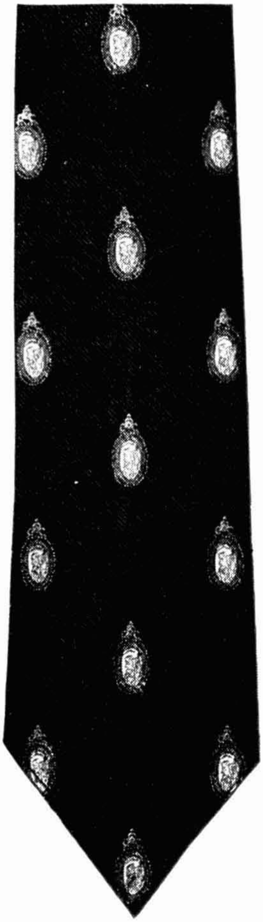

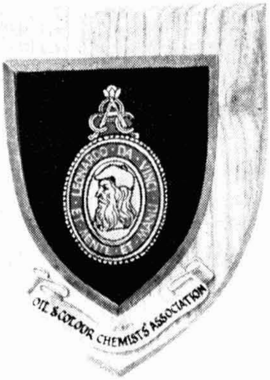

The tie is blue terylene, with the Association's insignia woven in red and gold silk.

The blazer badge has the insignia embroidered in silver and gold wire on a red and blue ground.

The plaque has the insignia hand-painted in red and gold on a blue ground.

The car badge has the insignia embossed in red and gold on a blue ground, the whole being covered in transparent polypropylene, with a thick chrome surround. Bar and grille fittings are available.

Council has authorised the production of a tie, blazer badge, wall plaque and car badge bearing the Association's insignia. These items are available only from:—

THRESHER & GLENNY

Lancaster Place, Strand,
London, W.C.2.

To: Thresher & Glenny Ltd., Lancaster Place, Strand, London, W.C.2.
As a member of the Association, please accept my order for the following:

.......OCCA tie @ £1.40 ....
.......OCCA blazer badge @ £3.90 ....
.......OCCA wall plaque @ £2.30 ....
.......OCCA car badge @ £2.30 ....
(state bar or grille) ______

(All prices include postage and packing) ______

If tie is required airmail add 35p ______

Total Remitted ______

Name ....

Section/No. ....

Address ....

....

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....

The ties will be supplied from stock; all other items are made to order. Only the tie can be supplied by airmail at an extra cost of 35p.

CLASSIFIED ADVERTISEMENTS

Classified Advertisements are charged at the rate of 50p per line. Advertisements for Situations Wanted are charged at 12½p per line. A box number is charged at 5p. They should be sent to the Director & Secretary, Oil & Colour Chemists' Association, Wax Chandlers' Hall, Gresham Street, London, EC2V 7AB. Telephone: 01-606 1439.

SITUATIONS VACANT

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This is an opportunity to join a company which is the market leader in its field and to contribute to the development of a product range new to it. It already has a successful record of product development in other areas. Initial salary is by negotiation; non-contributory superannuation and other medium sized company benefits are in force.

(Ref: D9338/JOCCA)

REPLIES will be forwarded direct, unopened and in confidence to the client unless addressed to our Security Manager listing companies to which they may not be sent. They should include comprehensive career details, not refer to previous correspondence with PA and quote the reference on the envelope.

PA Advertising Limited, St. James's House, Charlotte Street, Manchester M1 4DZ. Tel: 061-237 4531.

Senior Paint Chemist

Salary c. £2,500 to c. £3,000 p.a.

is required at our Chiswick Laboratory to take charge of the section which deals with paints and related subjects including surface pre-treatment.

Applicants must have had several years user orientated experience in this field, with particular reference to application, specification, testing, analysis and choice of paints, and to the investigation of problems arising under service conditions with paints and protective treatments. They must be capable of providing practical advice to engineers responsible for the construction and maintenance of vehicles, buildings and structures, and of keeping in close touch with manufacturers' technical staff.

A First or Second Class Honours degree in Chemistry, or an equivalent, is an indispensable minimum qualification.

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CLASSIFIED ADVERTISEMENTS

SITUATION VACANT

Chief Chemist

(Technical Director Designate)

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In preparation for the forthcoming retirement of the Technical Director we shall need a Chief Chemist whom we would expect to take over as Technical Director when he has proved himself. He will be responsible for all technical aspects of the business and particularly the development of new products.

The company has a close liaison with Bergolin Lack and Farbenfabrik of Bremen for the development of the types of finish used in the Continental market.

Applicants must have a knowledge of the technical requirements of all branches of the wood finishing industry and must be able to maintain a close liaison with customers in that field.

Please write, giving brief details and asking for an application form, to:

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Managing Director
Croda Polymers Ltd
153 New Bedford Road
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CLASSIFIED ADVERTISEMENTS

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We are interested in meeting applicants aged 25-35 with HNC as a minimum educational qualification or preferably a degree. Technical German would be a distinct advantage.

Candidates should have practical experience in the formulation and development of a wide range of surface coating and a thorough knowledge of the raw materials used by the paint industry. A minimum of 5 years' experience in the U.K. with a paint manufacturer or the technical service department of a raw material supplier to the paint industry is essential.

We offer competitive salaries and generous Company benefits.

Please write with career and personal details to date to:

Mr. H. H. Drummond, (C/JOC),
Personnel Manager,
Berger Paints,
86 Carpenters Road,
Stratford, London, E.15.

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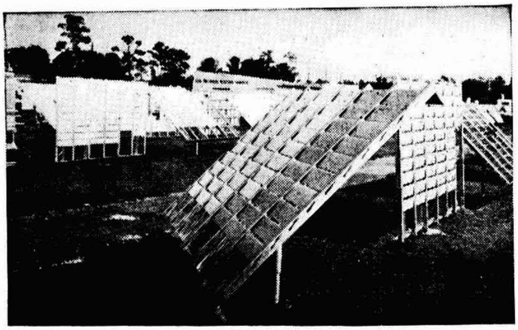

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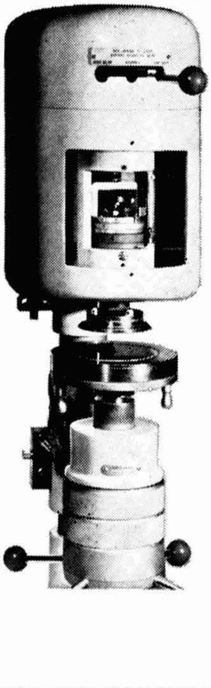

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