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Papers from the South African Symposium

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

A review of pigments and pigmentation of paints suitable for electrodeposition *T. Entwistle*

Pollution *R. A. Fish*

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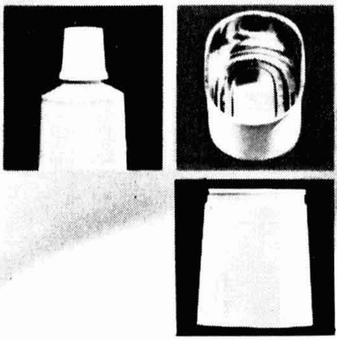

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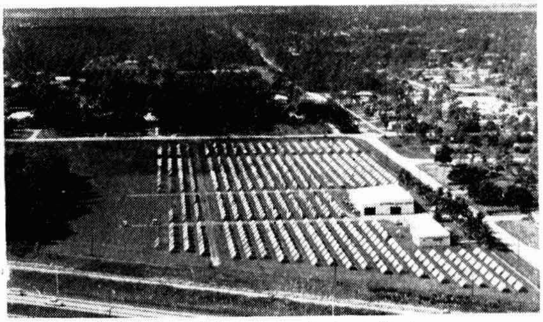

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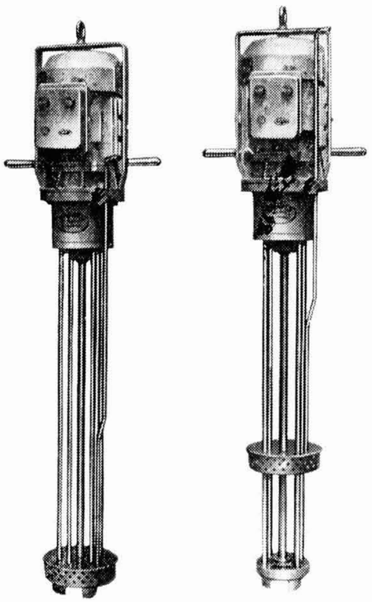

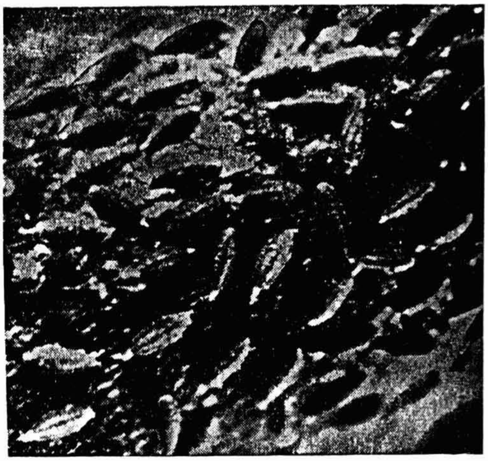


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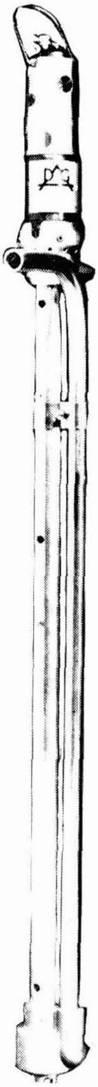

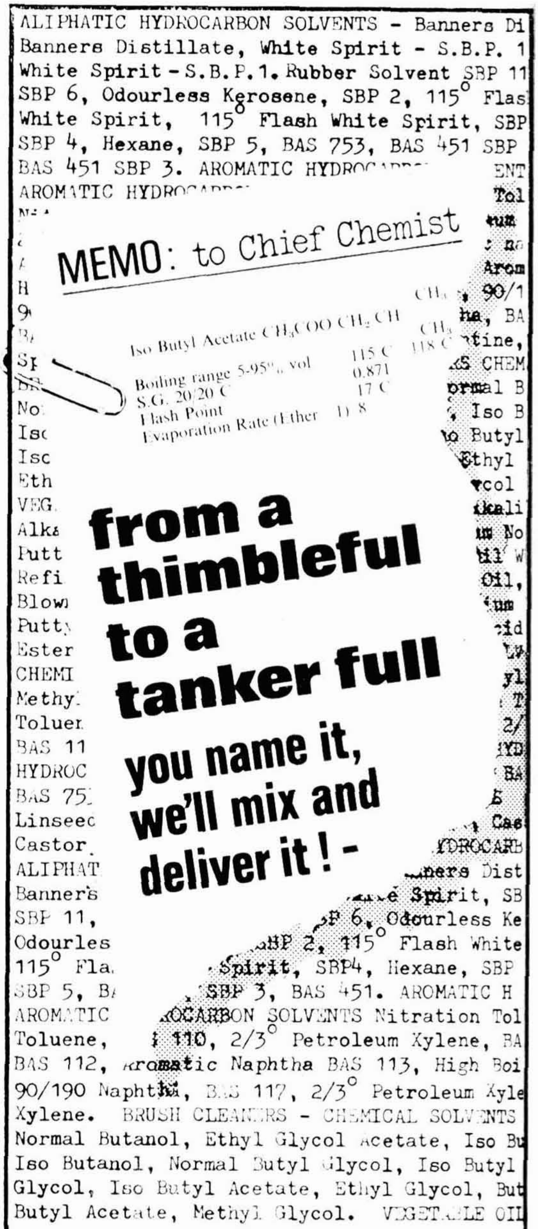

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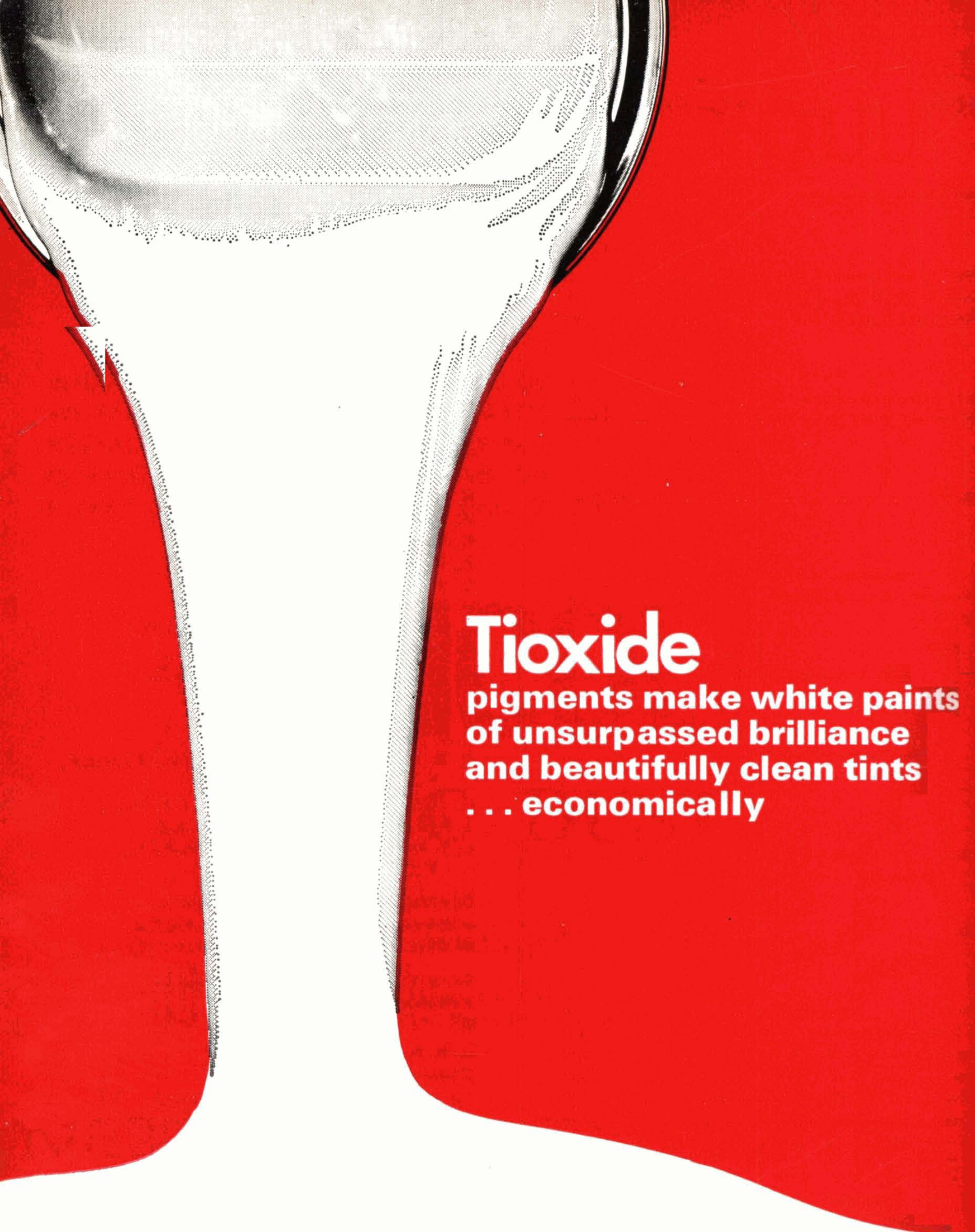

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Transactions and Communications

A review of the physical chemistry of electrophoresis*

By J. W. Bayles

University of Natal, King George V Avenue, Durban, South Africa

Summary

Electrical methods of paint deposition rely mainly on the phenomena of electrophoresis and electro-osmosis. A brief explanation of the physical chemistry of these phenomena is given, including a description of ionic hydration and a discussion of the "double layer" theories of behaviour at electrified interfaces. For a full understanding of electrophoretic deposition it is also necessary to consider the factors causing colloidal precipitation and adsorption at electrodes. Finally, the effect of the film deposited on the electrode is discussed.

Keywords

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

electrocoating
electro-osmosis
electrophoresis

Un aperçu des principes physico-chimiques d'électrophorèse

Résumé

Les méthodes électrophorètiques pour la déposition de peintures se basent largement sur les phénomènes d'électrophorèse et d'électro-osmose. On donne une explication brève des principes physico-chimiques de ces phénomènes, et une description de l'hydration ionique et une discussion des théories par lesquelles on tente d'expliquer le comportement des doubles couches aux interfaces qui portent une charge d'électricité. Afin d'arriver à une compréhension ample de la déposition eléctrophorètique, il est nécessaire de considérer les facteurs qui provoquent la précipitation et l'adsorption colloïdale aux électrodes. Enfin, on discute l'effet sur l'électrode qu'exerce le feuil déposé.

Ein Überblick der Physikalischen Chemie der Elektrophorese

Zusammenfassung

Elektrophoretische Methoden der Elektrotauchlackierung verlassen sich hauptsächlich auf Elektrophorese und Elektroosmose. Die physikalische Chemie dieser Phänomene wird kurz erklärt, Jonenhydratation beschrieben, und die "Doppelschicht"—Theorien über das Verhalten an elektrifizierten Grenzflächen besprochen. Zum vollen Verständnis des Elektrotauchverfahrens müssen auch die Faktoren, welche kolloidalen Niederschlag und Adsorption an Elektroden verursachen, in Betracht gezogen werden. Schliesslich wird auch die Auswirkung des auf die Elektrode gefällten Films besprochen.

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*Presented at the Third National Symposium of the South African Section, held 11-13 September 1970 in Winterton, Natal.

Обзор физической химии электрофореза

Резюме

Электрофорезные методы отложения красок полагаются главным образом на явления электрофореза и електро-осмоса. Дается краткое объяснение физической химии этих явлений, включая описание ионной гидратации и обсуждение теорий «двухслойного» поведения на электризованных поверхностях раздела. Для полного понимания электрофорезного осаждения, необходимо также учесть факторы вызывающие коллоидное отложение и адсорбцию на электродах. В заключение обсуждается влияние пленки осажденной на электроде.

Electrophoresis

When a voltage is applied to a suspension of colloidal particles, it is found that all the particles move in one direction. This is usually towards the anode for inert materials with no acid-base centres, showing that the particles are negatively charged.

To understand this phenomenon and some of the more subtle implications, there must be an understanding of ionic mobility and of the electrified interface ("double layer") between the surface of the colloid and the solution. The structure of an ion in water must also be borne in mind. These points will be considered separately.

Ionic hydration

The movement of an ion in an aqueous system is accompanied by the movement of water. This can be demonstrated by performing an electrolysis on a solution containing a non-ionic solute (urea and sucrose have been used), after which the concentration of this solute becomes non-uniform. From experiments such as this it is possible to assess the number of water molecules which accompany a given ion as it moves through the solution. These numbers are called hydration numbers. For a given ion, the hydration number depends on the method used to measure it and, in particular, hydration numbers derived from measurements on moving ions are considerably lower than those assessed from equilibrium studies. Tables 1 and 2 show typical hydration numbers for common ions. The cations are more strongly hydrated than the anions and, in general, the smaller cations are more strongly hydrated than the larger. The first effect arises because the water dipole is a forked one with one relatively strong negative charge on the oxygen and two relatively weaker positive charges on the hydrogens, see Fig. 1.

Table 1

Primary hydration numbers

Ion	From compressibility	From entropies	From apparent molal vol	From mobility	Most probable integral value
Li^+	5–6	5	2.5	3.5–7	5 ± 1
Na^+	6–7	4	4.8	2.4	4 ± 1
K^+	6–7	3	1.0	—	3 ± 2
F^-	2	5	4.3	—	4 ± 1
Cl^-	0–1	3	0	—	2 ± 1
Br^-	0	2	—	—	2 ± 1
I^-	0	1	—	—	1 ± 1

Table 2

Comparison between the hydration numbers determined by different methods

Ion	Compressibility	Mobility	Entropy	Theoretical calculation
Li^+	5–6	6	5	6
Na^+	6–7	2–4	4	5
Mg^+	16	14	13	—
Ca^{++}	—	7.5–10.5	10	—
Zn^{++}	—	10–12.5	12	—
Cd^{++}	—	10–12.5	11	—
Fe^{++}	—	10–12.5	12	—
Cu^{++}	—	10.5–12.5	12	—
Pb^{++}	—	4–7.5	8	—
K^+	6–7	—	3	3
F^-	2	—	5	5
Cl^-	0.1	0.9	3	3
Br^-	0	0.6	2	2
I^-	0	0.2	1	0

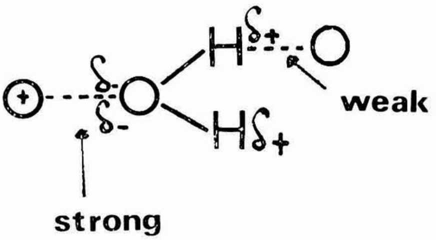

Fig. 1. Water dipole

The second effect arises because, regarding the ion as a sphere with its charge uniformly spread over its surface, the water dipole can interact with a higher concentration of charge at a shorter distance (strictly it can get into a region of higher field strength) when a smaller ion is involved.

In studies in which hydration of ions play a part, it is normally assumed that large singly charged cations (eg K^+, $Rb,^+$ Cs^+) and large anions (eg I^-) are to a first approximation not hydrated.

Electrified interfaces

To understand the mobility of charged colloidal particles and even the finer points in ion migration, the concept of an electrified interface must be introduced. Whenever two regions in space have different affinities for electric charge, then in general there will be a non-uniform distribution of charge between them. This is an electrified interface and is popularly known as a double layer. The concept applies to practically all aspects of electrochemistry from the macroscopic (electrodes) through intermediate colloidal systems to the molecular situation.

As a result of this universality, a basically uniform theory applies to all these situations, and minor differences occur only because there are special physical circumstances in each case.

Table 3
Electrified interfaces

Interface between	Name	Theory	Physical features
Metal and solution	Electrode double layer	Stern and Gouy-Chapman	Planar and adsorption
Colloid and solution	—	Stern and Gouy-Chapman	Adsorption and mobile
Ion and solution	Ion atmosphere	Debye-Hückel	Spherical symmetry

The detailed structure of electrified interfaces has been discovered as a result of studies on the thermodynamics of ions in solution and the relation between the surface tension of a mercury drop used as a polarised (i.e. irreversible) electrode and its potential relative to an ideal electrode, i.e. the electro-capillarity curve.

The thermodynamic studies on ions in solution show that their activities and hence free energies are less than their concentration would predict, and that this is due to the ion atmosphere effect. The ion atmosphere of diffusely distributed counter-ions can be regarded as being at an effective distance K^{-1} from the centre of the ion which is treated as a point charge. The difference in potential between the centre of an ion and the effective radius of its cloud of diffuse counter-ions is $\zeta = -Z_i e/DK^{-1}$.

It is, however, the interpretation of electrocapillarity studies which leads to detailed knowledge of surfaces on which adsorption has occurred.

This applies particularly to electrodes but also, by implication, to colloidal particles. Very briefly the reasoning is as follows:

If the interface were a rigid condenser (Fig. 2) then the capacity, C, of the layer would be constant at all voltages and all concentrations. The variation of potential with distance is then given by Fig. 3.

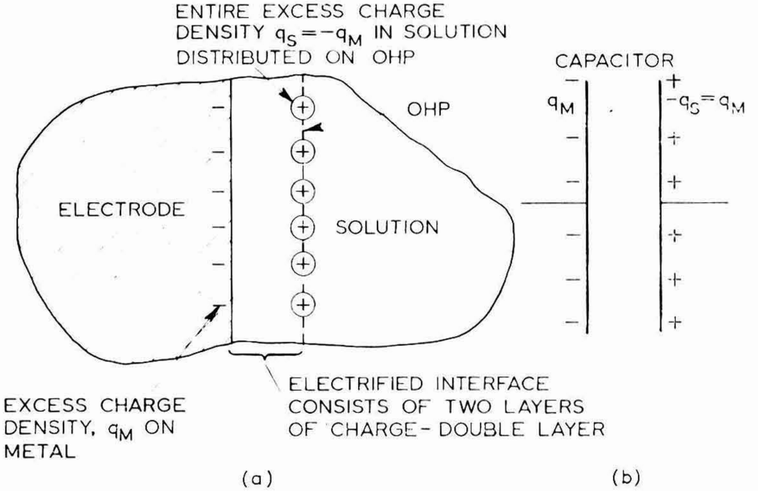

Fig. 2. Representation of the interface (a) as a solid condenser (b)*

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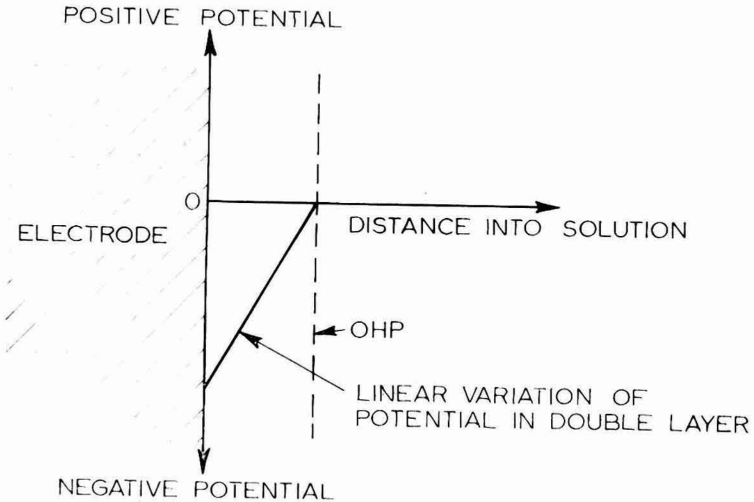


Fig. 3. The linear variation of potential corresponding to the double layer of Fig. 2(a)

However, C varies with voltage, so the layer must stretch as the voltage is increased. This can be shown from a model in which one plate of the condenser, the plate in the solution, consists of a diffuse distribution of counter-ions. Such a model is entirely analogous to the Debye-Hückel ion atmosphere and can be regarded as having a voltage-dependent thickness K^{-1} where this K^{-1} is the same as the Debye-Hückel K^{-1}. This leads to an exponential relationship between potential and distance.

However, there will nevertheless be a region very near the electrode where ions are in contact with the electrode and are therefore immobile. Over this short distance, the rigid condenser model applies. The inner (electrode) and outer (solution) boundaries of this immobile layer are referred to as the inner and outer Helmholtz planes (IHP and OHP). The variation of potential with distance now becomes that shown in Fig. 4.

Sometimes the surface adsorption is of ions of the same charge as the electrode (superequivalent adsorption). Then the linear portion of Fig. 4 slopes in the opposite direction from the OHP to the IHP. Such cases only arise when special chemical effects are present.

Precipitation of colloids

So far, the picture of the electrified interface allows an explanation of the physicochemical principles underlying the precipitation of colloids. It is assumed that the surface of a colloidal particle carries the same type of double layer as has been found for an electrode. The only difference is that the potential of this particle cannot be altered as that of the electrode, so that little can be deduced about it.

When two similar colloidal particles approach one another, there will be a repulsion because of the approach of two equally charged layers. However, if the approach were to be forced to closer distances, then eventually, as with all material systems, van der Waals forces of attraction (London dispersion forces) would develop and eventually take over, leading to coagulation.

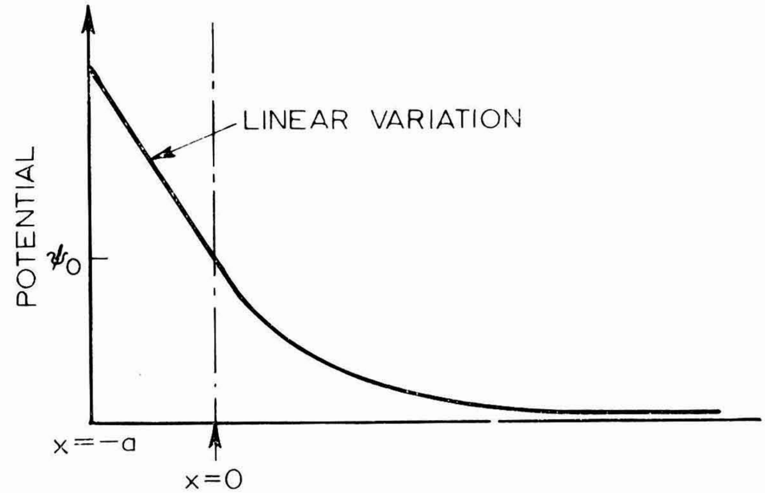


Fig. 4. Potential variation according to the Stern model

In the above situation, the only factors which can be controlled are the thickness of the diffuse double layer K^{-1} and the adsorption. If the layer is made thin, then the colloid loses its stability. Figs. 5 and 6 show the two situations. Now this is governed by the product of the density of ions and the square of their valence, i.e. NZ^2, a high value of this product leading to a thin layer. This, therefore, is the explanation of the well-known facts that added ions cause precipitation and that added ions of high charge are more effective than added ions of low charge.

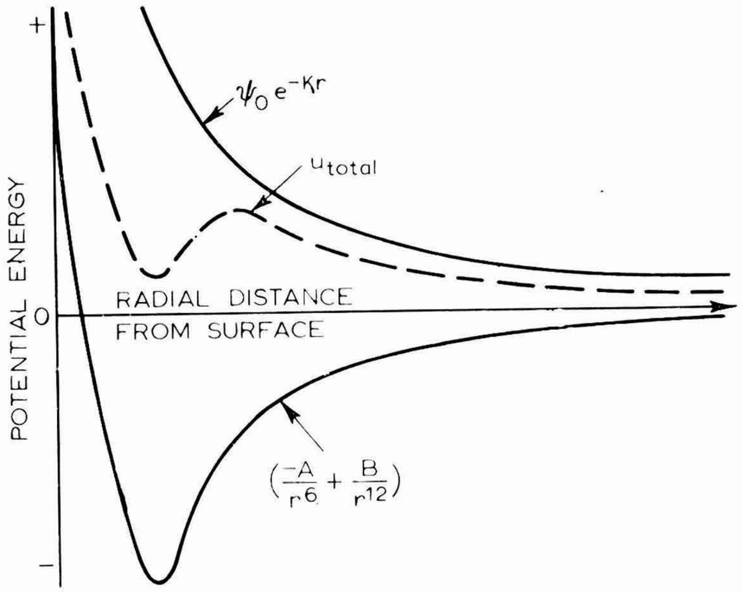


Fig. 5. Energy of interaction between two colloidal particles as a function of their distance apart, when the conditions favour stability of the colloid

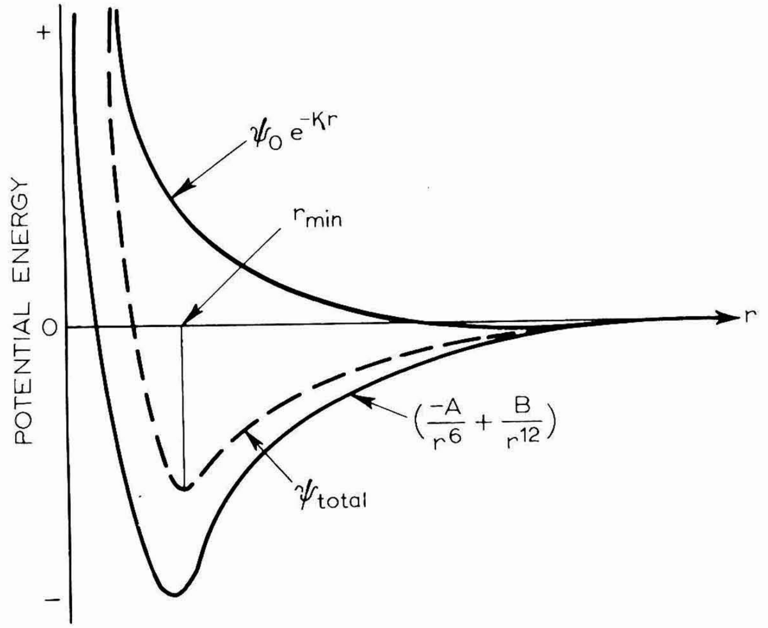


Fig. 6. Energy of interaction between two colloidal particles as a function of their distance apart, when the conditions favour coagulation of the colloid

If there is contact adsorption at the electrode, then there is an initial rapid drop in potential with distance, and again precipitation will occur (Fig. 7).

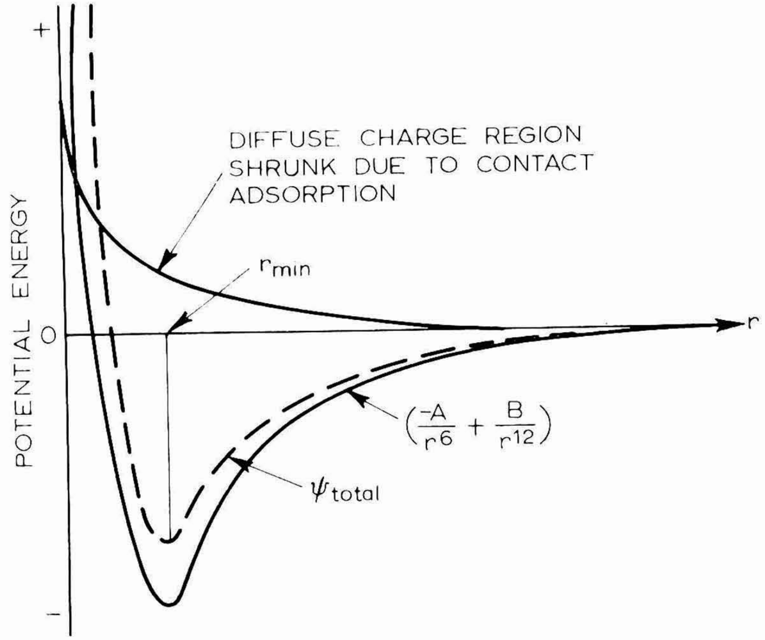


Fig. 7. The effect of the contact adsorption of ions on the condition of the stability of the colloid

Electrophoretic mobility

In order to form a theory for electrophoresis it is necessary to quantify the double layer. There is a potential difference between the mobile entity (particle and immobile layer) and the solution through which it can move. This pd is the zeta potential ζ, and is related to the charge, q_d, on the moving sphere by:

$$\zeta = \frac{q_d}{DK^{-1}}$$

If a field X is applied, the force on the moving sphere is Xq_d. The viscous drag on a sphere radius K^{-1} moving with speed v is $6 \pi K^{-1} \eta v$ by Stokes law. For the steadily moving particle these are equal, so, replacing q_d by ζDK^{-1} gives:

$$\frac{u}{X} = \frac{\zeta D}{6\pi\eta}$$

This is the speed under a potential gradient of 1 absolute volt per cm.

Electrophoretic mobility is governed, therefore, primarily by the zeta potential of the colloid. This in its turn is proportional to the charge on the moving sphere and inversely to the thickness of the double layer. The previous remarks on control of double layer thickness by added electrolytes and contact adsorption, therefore, apply to the determination of electrophoretic mobility and govern the separation of colloids by electrophoresis. When a colloidal particle has acid-base functions, the pH of the system is an additional parameter governing mobility.

Electro-osmosis (electro-endosmosis)

Electro-osmosis consists of the movement of the supporting liquid phase when a potential is applied to a system containing an immobile phase having a double layer.

The model for calculation is a condenser with one mobile plate (the solution), Fig. 8 carrying a charge density q_d and having a separation between plates

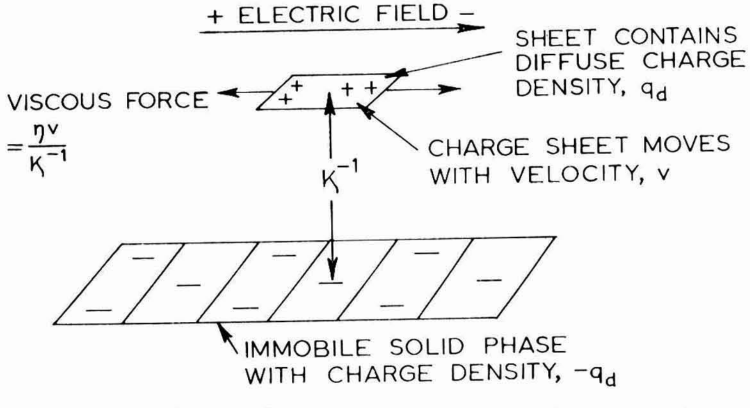
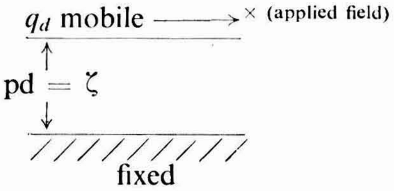


Fig. 8. A schematic diagram for the computation of the electro-osmotic mobility

of K^{-1}. The pd between the plates is ζ as previously defined, and therefore the field inside the condenser can be written either as ζ/K^{-1} or as $4\pi q_d/D$. So equating these,

$$q_d = \zeta D/4\pi K^{-1}$$



If a field X is applied tangentially along the mobile plate, there will be a force Xqd. By the laws of viscosity, the viscous drag between the plates is $\eta \frac{v}{K^{-1}}$. These are equal when the motion is steady, so

$$Xq_d = \eta \frac{v}{K^{-1}}$$

and substituting for q_d

$$\frac{v}{X} = \frac{D\zeta}{4\pi\eta}$$

Apart from the use of 4 instead of 6 in the denominator, this is the same formula as that for electrophoretic mobility. The changed constant arises from fact that the symmetry of the earlier system is spherical whereas this one is cylindrical. Otherwise both are simple cases of relative motion.

Adsorption at an electrode: electrode modifiers

To understand in more detail the properties of electrodes, in particular, to understand the physical chemistry behind the use of some additives in electroplating, the model of the surface must be brought very much more up to date.

The relation between the capacity, C, of the double layer at an electrode and the charge, q_m, on the electrode shows a hump (Fig. 9) which remained unexplained until recently. To understand what follows, it is helpful to have a summary of the equations used to derive the relevant results.

Electrocapillarity studies enable the charge q_m per unit area of electrode surface to be measured, since

$$-q_m = \left(\frac{\partial \gamma}{\partial V}\right) \qquad \text{(Lippman equation)}$$

where γ = surface tension, V = potential, T = temperature. This is equal and opposite to the excess charge, q_s, in the solution. $-q_m = q_s$. The capacity of the double layer follows from

$$C = \left(\frac{\partial q}{\partial V}\right)_T$$

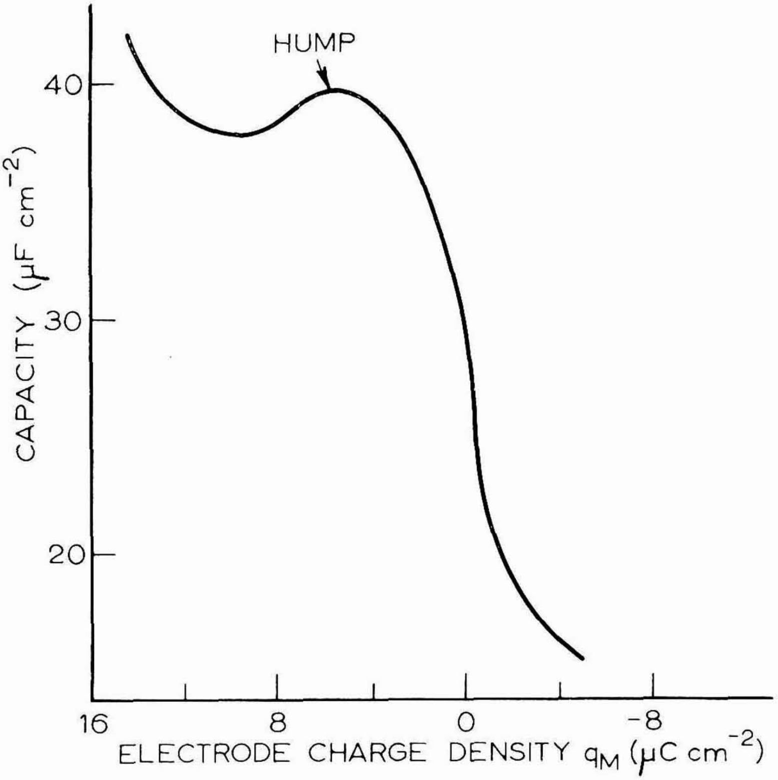


Fig. 9. The hump in the experimental capacity/electrode charge density curve

The surface excess of each ion on the electrode can be obtained from:

$$\Gamma_+ = -\frac{1}{2RT}\left(\frac{\partial\gamma}{\partial \ln a_\pm}\right)_{V_-}$$

$$\Gamma_- = -\frac{1}{2RT}\left(\frac{\partial\gamma}{\partial \ln a_\pm}\right)_{V_\pm}$$

where:

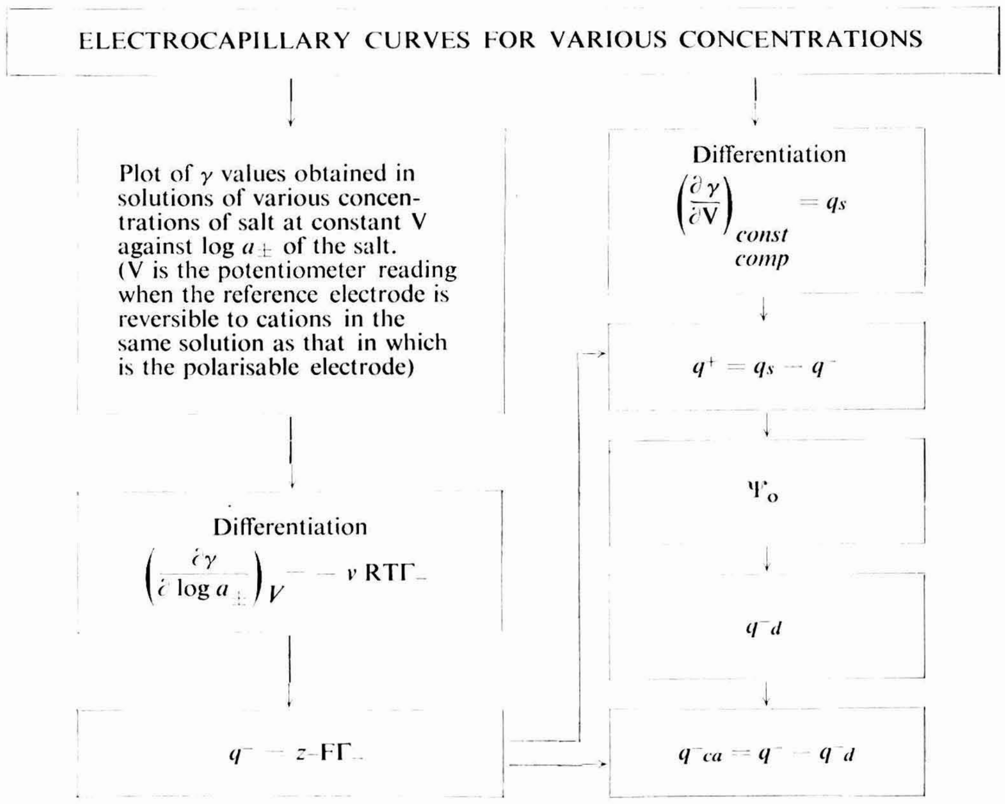
$a_\pm$ = mean ionic activity

Γ_+ or $-$ are the surface excesses

V_- or V_+ indicates that the conditions of measurement require that the surface should be reversible with respect to the ion whose excess is *not* required.

The train of reasoning indicated in Fig. 10 enables a remarkably clear picture of the electrified interface to be obtained.

At the interface, it must be assumed that, despite ion adsorption, the most common molecule is water. As the potential of the metal is altered, the metal surface may carry an excess of positive charge, negative charge, or it may be neutral.



ELECTROCAPILLARY CURVES FOR VARIOUS CONCENTRATIONS

Plot of γ values obtained in solutions of various concentrations of salt at constant V against log $a_\pm$ of the salt. (V is the potentiometer reading when the reference electrode is reversible to cations in the same solution as that in which is the polarisable electrode)

Differentiation

$$\left(\frac{\partial \gamma}{\partial \log a_\pm}\right)_V = -\nu RT\Gamma_-$$

$$q^- = z_- F\Gamma_-$$

Differentiation

$$\left(\frac{\partial \gamma}{\partial V}\right)_{\substack{const\\ comp}} = q_s$$

$$q^+ = q_s - q^-$$

$$\Psi_0$$

$$q^-_d$$

$$q^-_{ca} = q^- - q^-_d$$

Fig. 10. The procedure for calculation of the contact adsorbed charge density q^-_{cA}

When it is neutral, the double layer will be absent, $C = O$ and $\frac{\partial \gamma}{\partial V} = O$. This is the zeta potential, since the metal can be regarded as having been brought to the same potential as its own double layer, thus causing the latter to disappear.

In these circumstances, neutral species such as organic molecules may compete on equal terms with water for the electrode surface, and these additives therefore modify the surface most effectively at the zeta potential. To understand how they then actually alter the nature of a deposit is another problem, at present largely unsolved.

When the electrode surface carries a net charge (say negative) then cations will be adsorbed, and they may adsorb in two ways (Fig. 11): either with their hydration shell (hydrated adsorption), in which case the nearest molecules to the surface are still water molecules, or without their hydration shells (contact adsorption) in which case the ion itself is next to the electrode. In both cases this causes the capacity of the electrode to rise, but in the second case, the rise is followed by a fall, as when these bare ions are so numerous on the surface that ion-ion repulsion becomes important, they become unstable on the surface and give way to more hydrated ions. When this idea is applied theoretically it affords an explanation for the hump in the plot of C against q_d.

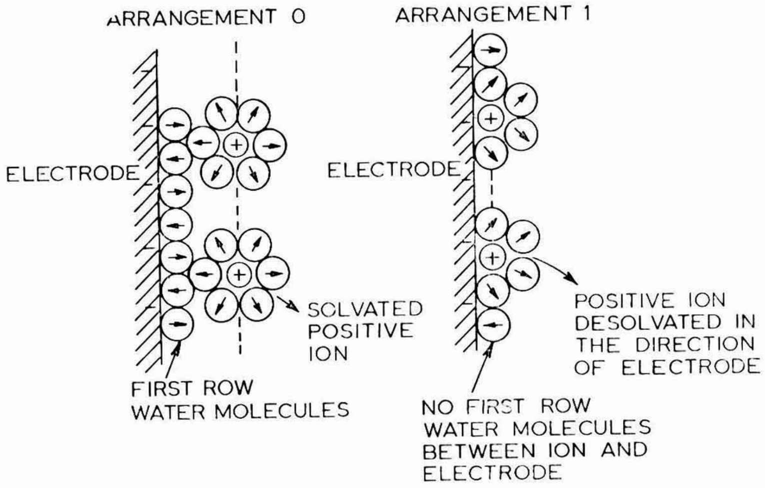


Fig. 11. Adsorption of cations

It is therefore believed now that the immobile layer has a rather complicated structure:

adsorbed water in contact with the surface,

solvated ions next to the first water layer,

ions adsorbed directly in contact with the surface, replacing some of the water,

perhaps some ions specifically held by strong chemical forces in addition to the above.

Electrophoretic deposition

The deposition of a colloidal particle on an electrode is initially analogous to the coagulation of two colloidal particles. There is an initial repulsion between the double layers of the particles and the electrode. However, the potential of the electrode, the zeta potential of the metal and that of the colloid together determine whether or not deposition will occur. Normally it will occur, but as a film builds up on the electrode, there is a change in the surface and the greater part of the voltage drop in the cell occurs across the film. The double layer of the surface, therefore, becomes very extended (large value of K^{-1}) and conditions for repulsion are established. In practice, it seems that this occurs at a film thickness of about 10—20μ. This is about 20 times the initial value of K^{-1}.

When the film has ceased to grow, it still contains solvent which is therefore subject to electro-osmosis. The solvent moves out of the film due to this effect until only about 5 per cent of it remains.

All the above has assumed that the situation is ideal, and no ions discharge at the metal surface (ideal polarised electrode). To some extent this can be arranged by ensuring that anions with low deposition potentials are absent from solution. For aqueous solutions, however, there is always a limitation imposed by the presence of OH^- which will give rise to oxygen evolution and film breakdown if it is permitted to be discharged.

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A review of pigments and pigmentation of paints suitable for electrodeposition*

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Summary

The literature concerning the pigmentation of paints suitable for electrodeposition has been reviewed. Particular reference is made to the effect on paint deposition and on film properties of using different types of pigment and extender; different grades of the same type of pigment, and different quantities of pigment. Points of agreement and disagreement of various workers are mentioned.

Keywords

Prime pigments and dyes
titanium dioxide

Processes and methods primarily associated with application
electropainting

Une appréciation des pigments et de leur application en peintures pour être appliquées par électrodéposition

Résumé

On a passé en revue la littérature à l'égard de la pigmentation des peintures pour électrodéposition.

En particulier on souligne l'influence sur la déposition de la peinture et les caractéristiques du feuil qu'exercent les variables suivantes:—

Les différents types de pigments et de matières de charge.

Les différentes qualités du même type de pigment.

Les différentes quantités de pigment.

On fait mentionne des points d'accord et de désaccord parmi les divers auteurs cités dans cet exposé.

Eine Besprechung der Eignung von Pigmenten und von der pigmentierung für Elektrotauchlacke

Zusammenfassung

Eine übersicht für die geeignete Pigmentierung von Elektrotauchlacken wird gegeben.

Im besonderen wird Bezug genommen auf die Auswirkung auf das Niederschlagen von Tauchlacken und Filmeigenschaften bei Anwendung von

verschiedenen Arten von Pigmenten und Extendern,
verschiedenen Abstufungen desselben Pigmenttyps,
verschiedenen Zusatzmengen von Pigment.

Gesichtspunkte, über welche Übereinstimmung und Meinungsverschiedenheiten zwischen verschiedenen Forschern bestehen, kommen zur Sprache.

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*Presented at the Third National Convention of the South African Section, held 11-13 September 1970 at Winterton, Natal.

Обзор пигментов и пигментации красок пригодных для электролитического осаждения

Резюме

Дается обзор литературы о пигментации красок пригодных для электролитического осаждения.

Особое внимание уделяется вопросу влияния на осаждение красок и на свойства пленок, при применении:

разных типов пигмента и наполнителя,
разных сортов пигмента того же типа,
разных количеств пигмента.

Упоминаются согласия и разногласия, на эту тему, различных сотрудников.

Grade of pigment

Whilst the literature contains a wealth of information on types of resins and the effect of varying parameters, such as voltage, substrate, pH etc., there has been much less written on the choice of suitable pigments. This suggests that in many cases the grade or type of pigment is not critical with respect to its ability to be electrodeposited. This is probably to be expected, as most workers[1, 2, 3, 4, 5] agree that, in solution systems, the pigment particles are enveloped by resin, whilst in emulsion systems there is some mutual entrainment of pigment and emulsion particles, so that the direction of movement of the pigment and its rate of deposition are functions of the material adsorbed on the surface.

Cooke[4], discussing the physical chemistry of the process, considered the paints to be "colloidal electrolytes, having a low viscosity, typically 1-3 cP, in which are dispersed pigment particles, which contribute little to, but also detract little from, their electrolytic properties".

This point of view is supported by the electrodeposition of paints pigmented with two or more, widely different, pigments when the relative ratio of the pigments in the film generally agrees with that in the wet paint.

Tasker and Taylor[2], using a primer based on a water soluble resin and pigmented at a P/B of 1/1 with a mixture of rutile titanium dioxide, ferrite yellow, carbon black and phthalocyanine blue, found that similarly coloured films were obtained whether applied by electrodeposition or by conventional spraying, apart from the slight difference of the absence of flotation of the tinting pigments when applied by the former method.

The same authors[6] later used a red oxide primer pigmented at a P/B ratio of 1/1 using an oil modified type of resin. The paint was deposited over a period of time and, in order to maintain the non-volatile content of the bath at 12 per cent, they added a white paint, also at a P/B of 1/1. The ratio of titanium dioxide to red oxide in the bath varied from 0/1 initially, to 19/1 at the conclusion of the experiment. Over a period of three months the shades obtained by electrodeposition were similar to those obtained by mixing known amounts of the two paints in proportions corresponding to the calculated amounts of each paint in the bath.

Electron microscope examination of film sections of titanium dioxide/ phthalocyanine blue also showed even distribution of pigment particles with no difference between films produced by electrodeposition and those by spraying.

Martin[7] selected two pigments of widely different densities—rutile titanium dioxide and phthalocyanine green, in a water soluble alkyd and coated a total area of 500,000cm^2. After each 50,000cm^2 the shade was compared with a standard panel. In each case the deposited paint gave an identical colour, even though the non-volatile content in the bath dropped from 10.3 per cent to 3.15 per cent. However, he did find that the degree of dispersion was very important.

Landon and Ashton[8] used a water soluble acrylic/melamine resin pigmented at a P/B of 0.5/1 with titanium dioxide and tinted separately with phthalocyanine blue, phthalocyanine green, Hansa yellow and dibromoanthranone red. Twelve successive panels were coated from each paint, thereby removing 8 per cent of the total solids from the bath. With each paint, the colours of the panels were comparable with those obtained by spraying, with virtually no difference between the first and last panels. Analysis of the films showed that the ratio of TiO_2 to phthalocyanine was constant and equal to that in the bath within ± 2 per cent.

Thus in many instances the selection of pigments for paints to be applied by electrodeposition is governed by the usual paint technology requirements, such as ease of wetting and dispersion, freedom from settling, non-reactivity, production of correct colour etc., and not by any consideration of its electrical properties, the deposition properties of the paints being very largely dependent upon the resin.

However, several workers have reported that the pigment can influence factors such as film resistance, throwing power and film thickness, in addition to the usual film properties such as opacity, gloss and prevention of corrosion.

For example, Tasker and Taylor[9], using constant current conditions (3 amps ft^{-2}) showed that the film resistance increased as the pigmentation increased, reached a maximum, generally in the P/B region 2/1-4/1 (PVC 40-50 per cent), and then dropped off rapidly. The values of the maximum resistance varied widely for different pigments and extenders and even different grades of the same type of pigment showed wide variation, e.g. of five grades of titanium dioxide tested, three gave high film resistance and two gave low film resistance. The authors suggested that, for maximum throwing power, a pigment giving a high film resistance should be used, whilst for a thicker film with lower throwing power, a pigment giving low film resistance should be used.

However, the level of pigmentation that gave maximum film resistance was much higher than that normally used in paints for electrodeposition and, at P/B ratios below 1/1, the resistances were much lower and showed much less variation between pigments.

The following figures are extreme values for the film resistances in ohm ft^{-2}:

Set 1	*Yellow oxide*	*Mica*
Maximum film resistance	30 (P/B: 2.6/1)	12 (P/B: 2.3/1)
Film resistance at P/B 1/1	13	8
Film resistance at P/B 0.5/1	10	5.5

Set 2	*Hansa Yellow*	*Corax L*	*Red oxide*
Maximum film resistance	34 (PVC 43)	7 (PVC 40)	14 (PVC 42)
Film resistance at 10% PVC	4.4	4.7	8

Set 3	*$TiO_2(1)$*	*$TiO_2(2)$*	*$TiO_2(3)$*	*$TiO_2(4)(5)$*
Maximum film resistance	50	38	22	2.5
Film resistance at P/B 1/1	4.5	3.5	3.0	2.5

There did not appear to be any correlation between the chemical nature of the pigment or extender and the film resistance, although the low resistances of films pigmented with a carbon black were attributed to the conducting nature of carbon black in an aqueous suspension and/or the very high oil absorption of the pigment.

Further work[10] using a resin of relatively high film resistance confirmed their previous findings of wide variation in maximum film resistance when deposited at constant current. However, using constant voltage conditions resulted in much smaller differences between $TiO_2(1)$ and $TiO_2(4)$ mentioned previously, even at high PVC's:

	Maximum film resistance (ohms ft^{-2})	
	$TiO_2(1)$	*$TiO_2(4)$*
40 volts for 2 minutes	120	102
60 volts for 2 minutes	165	120
1 amp/sq. ft. for 2 minutes	85	25

Fry and Curtis[11], continued this work using lower PVC's in a resin giving relatively low film resistance and depositing at 60 volts for 2 minutes. They found an appreciable spread of results for eight different grades of titanium dioxide; e.g. at a P/B of 0.5/1 the film resistance per ft^2 varied from 14 ohms to 25 ohms. They claimed that this would result in an appreciable difference in film thickness, since the film thickness is dependent upon the number of coulombs, and a larger current will flow at lower film resistances. Unfortunately, no film weights were given and it is possible that the higher film resistance may have been due to a greater film weight deposited after 2 minutes.

Holzinger[5] examined a large range of titanium dioxide pigments and concluded that the film resistance was dependent upon the resin used, whilst choice of pigment had little significance.

General considerations

Obviously, as most systems are alkaline, alkali resisting pigments must be used. Pigments containing carboxylic groups such as lithol rubine, Permanent Red 2B, phloxine, rhodamine, must be avoided[12].

As electrodeposition is carried out at a low non-volatile content, most workers mention the need for finely dispersed pigments. Ellinger[13] states that no difficulties should generally be encountered using high quality pigments of adequate insolubility, alkali and heat resistance and a particle size of around 0.5 micron. However, she mentions that selective precipitation of certain red and yellow oxides and yellow chrome pigments on to the cathode has occurred during overnight storage.

Tasker and Taylor[2], however, reported that satisfactory results were obtained from red oxide of iron (both micronised and unmicronised), carbon black, lead silicochromate, strontium chromate, barytes and Norwegian talc, the only stipulation being that the pigments should be fully wetted before the paint is diluted to the low solids required for electrodeposition, and that finely divided pigments are preferred, owing to their slower rate of settling at low viscosities. They did state, however, that difficulty had been experienced in obtaining a high gloss white finish pigmented with titanium dioxide, although satisfactory tinted primers based on titanium dioxide had been obtained. They published formulations for two different primers and a black gloss finish all pigmented in a conventional manner, but results for other deep coloured gloss finishes were not reported.

With regard to the electrical properties of pigments Kays[12] lists the coulombic yield for a range of white and coloured pigments. These were obtained for 20 per cent dispersions of pigment in water containing Calgon. These show a wide variation, from zero for a beaded carbon black to 0.281 for Tioxide R-CR. However, as he points out, these results are a guide to a pigment's ability to migrate to the anode and do not relate to the pigment plus vehicle.

Brintzinger, Haug and Sachs[14] studied the electrophoresis of pigments dispersed in organic solvents, which gave a knowledge of pigment charge and resistance, but again this was in the absence of binder.

Pigments for primers

Although zinc chromate cannot be used since its high solubility causes the precipitation of some water soluble resins, other chromates, such as lead silico chromate, strontium chromate and barium chromate, have been widely used and typical formulations quoted[2, 6, 15]. The toxicity of these pigments has been questioned[6] as chromates may have an irritant effect on the skin and lead compounds in some cases are prohibited.

Chromates are also suspect with respect to preferential settlement and possible instability in certain systems.

Austin, Schmidt and Odem[16] reported that basic lead silicochromate was the best of those tested, giving a smooth film, whilst strontium chromate, although giving excellent rust inhibiting properties in water soluble dip primers, was not satisfactory for electrodeposition.

Clarke and Asten[17] also report that, whereas a primer pigmented with lead silicochromate gave a good film, strontium chromate did not deposit satisfactorily.

The effect of replacing 5, 10 and 20 per cent respectively of red oxide anti-corrosive pigment in a typical red oxide electrodeposition primer was evaluated by Tawn[18]. The anti-corrosive pigments used were strontium chromate, lead chromate and lead silicochromate. Panels were exposed to salt spray and humidity testing. Addition of 5-10 per cent lead chromate gave the best anti-corrosive properties although the film gloss was reduced when compared with that of the primer containing only red oxide. Films containing strontium chromate had a rough flocculent texture.

Tasker and Taylor[6] state that zinc phosphate had shown anti-corrosive properties and could be used as an equal weight replacement for chromate. Organic phosphates, sodium, lead and zinc benzoate and quaternary amine compounds are said to have given promising results with the added advantage of having no tinctorial properties.

The chromates are generally used in conjunction with red oxide pigments. Synthetic red oxides are claimed to give the best properties[16] and although good results have been obtained with both micronised and unmicronised pigments[2], good dispersion is essential.

Austin *et al.*[16] stated that, although carbon blacks could give unusual wrinkle effects, dependent upon PVC, voltage and other factors not understood, titanium dioxide plus small quantities of black gave satisfactory films. This appears to be the opinion of most workers, e.g. non-flotation of grey primer previously mentioned.

Bono and Pagani[19] state that the wetting power of the resin and the oil absorption and dispersibility of the pigment have a marked influence on the choice of total non-volatile content best suitable for obtaining maximum performance.

Clarke and Asten[17] suggested that lithopone could be used to advantage in resins of high resistance. They showed that, although a water suspension of lithopone had a lower specific resistance than a titanium dioxide suspension, the specific resistances of paints pigmented with each pigment were very similar and about identical to the specific resistance of the resin solution.

Extenders

Strauch[20] reported work on the use of various extenders in red oxide/alkyd primers. He worked at a total PVC of 16 per cent replacing 50 per cent (by volume) of red oxide by various extenders. Deposition was at 15 per cent non-volatile content using 50 volts for 2 minutes.

It was found that Millicarb and Dolomite gave the smoothest films with the highest sheen. Millicarb also gave the best blister resistance and hence the least rusting in the salt spray test. It is possibly significant that the paints giving the smoothest film also had the lowest resistance (in the bath). To determine whether this lower resistance was due to the presence of soluble salts, the resistance of a 15 per cent suspension (in water) of each extender was determined before and after thorough washing of the pigment. Results showed a better correlation between film smoothness and lowest resistance *after* washing than with resistance before washing, i.e. presence of insoluble salts was apparently unimportant with regard to smoothness of film deposited.

Determination of pH values also showed Millicarb and Dolomite to have slightly higher values than the other extenders and the red oxide.

Robinson and Tear[23] showed that the addition of Laponite reduced the pigment content in the film, thus producing a glossy film and also increased the weight of film deposited. The settling in the bath was reduced and the salt spray resistance improved. Addition of Laponite increased the conductivity in the bath, but if the conductance was increased by addition of electrolyte to the bath, the film weight was decreased slightly.

Replacing the alkyd used by an epoxy ester gave similar results, but using a second alkyd resulted in an increase in pigment content in the film.

Pigment for gloss finish

Frangen,[21] in 1968, stated that the area of surfaces painted by electrodeposition amounted to 375 000m^2 per day, of which two thirds consisted of primers and one third lacquers and enamels. Approximately 20 per cent consisted of one-coat finishes.

As electrodeposition is confined to application on to a conducting surface, it is natural that early work was mainly concerned with primers. Development of gloss finish was also retarded, as many of the resins originally used discoloured to varying degrees and, even with the advent of better coloured resins, such as acrylics, discolouration frequently occurs owing to the presence of iron in the film which arises from dissolution of the anode.

Nevertheless a certain amount of work on gloss finishes has been reported.

Holzinger[5] tested one titanium dioxide manufacturer's range of pigments and concluded that the resin plays the decisive part with respect to the electrical properties. A number of examples were given, a few of which are shown below. The specific resistance of the pigments evaluated varied from 3,000ohm cm^{-1} (for an uncoated pigment) to 20,000ohm cm^{-1} (for a fully coated grade). However, when each pigment was dispersed in the same resin, the specific resistance of the paint was 1,100ohm cm^{-1}, irrespective of which pigment was used. Further, using eleven different resins the specific resistances varied from 150ohm cm^{-1} to 2,000ohm cm^{-1}, although the majority were of the order of 500ohm cm^{-1}.

The film resistance showed no differences caused by choice of grade of titanium dioxide, but wide variations were found between resins. It was also reported that using conductive pigment such as carbon black reduced the film resistance to such an extent that electrodeposition of a second paint was possible, but if the pigmentation was reduced to the normal level for carbon black (P/B 0.05/1) the effect on film resistance was not very great.

The film weight deposited depended upon the density of the pigment used, higher density pigments giving greater film weight. However, no significant effect on coulomb efficiency caused by choice of grade of titanium dioxide was noted, but choice of resin did have a relatively large effect. It is interesting to note that when film thicknesses were related to weight of film deposited, using paints pigmented with titanium dioxide, the extremes of film thickness, at the same weight, were obtained with the same pigment but in two different resins.

The choice of titanium dioxide did not noticeably affect the throwing power, although choice of resin had a large effect.

Although the grade of titanium dioxide had relatively little effect on quantitative aspects such as coulombic efficiency, film thickness, throwing power, and film resistance, the choice of pigment did have a significant effect on film properties such as uniformity, smoothness, porosity, gloss, colour, and durability, when the quality of the pigment, as with conventional painting processes, became noticeable to the fullest extent.

The suitability of a particular grade of pigment in giving a film of satisfactory quality depended to a large extent on the resin employed. The higher the resistance of the resin the greater the number of pigments that produced acceptable finishes. In higher resistance resins, almost all rutile grades could be used, although the high opacity, high gloss, premium grades were preferred for one-coat finishes because of their exceptional optical properties. In low resistance resins, certain grades were reported to be "sensitive" and the choice was slightly more restricted.

Landon and Ashton[8] evaluated a large range of pigments and found that the order of film gloss agreed with the order expected from the same range of pigments in water-soluble acrylic finishes applied by conventional methods, although the values were generally lower. The visual appearance and gloss were best when the high opacity, high gloss, premium grades were used. They found that the coulomb yield at a given P/B was identical whichever grade of pigment was tested.

As previously stated, satisfactory tints were obtained with four different coloured pigments, but two peculiarities were noted:

polishing the surface of the stoved film always gave a paler colour, which suggested slight flooding of the coloured pigment whilst in the oven;

the gloss of the tinted film was always slightly higher than that of the white base, the increase being greater at 1 per cent tinter than that at 2 per cent.

Landon[22] repeated his earlier work using a different resin and testing at a P/B of 0.4/1, depositing at constant current.

Again, he found that the best film properties, particularly gloss, were obtained by using the high opacity, high gloss, pigments although in this instance a pigment primarily designed for use in matt and eggshell emulsion paints also gave good gloss.

Changing the substrate from untreated steel to zinc coated steel resulted in a drop in gloss with eight pigments, but in an increase in two instances. While this altered the order of merit slightly, the high quality premium grade pigments generally gave the best results.

Rechmann[22] showed that, in one particular resin system, the type of coating given to the titanium dioxide pigment was important, particularly the ratio of alumina to silica, and he introduced a term designated the *V* value

$$= \log_{10} \frac{Al_2O_3}{SiO_2}$$

For satisfactory films it was necessary to use pigment of low positive *V* values. High numerical values (positive and negative) resulted in pigment flocculation and hence poor results. However, in a second resin system, satisfactory films with good gloss were obtained with pigments having a wide range of *V* values, and only pigments of extremely high *V* values were unsatisfactory.

In a third resin (an alkyd based on castor oil), unsatisfactory results were obtained with all the pigments, owing to heavy settling giving extremely uneven paint films. Addition of MF resins gave improved results and films of moderate gloss were obtained with pigments of moderate to high positive *V* values.

Effect of varying P/B ratio

With regard to film quality, it is generally necessary to use much lower pigmentation levels than in "conventional" paint systems, although several workers have reported obtaining satisfactory films at fairly high P/B ratios.

As the P/B ratio is increased, the coulombic efficiency generally increases, resulting in a greater film weight and also greater film resistance, which in turn usually lead to greater throwing power.

Owing to the higher density of the pigments compared with the binder, it could probably be expected that the film weight would increase but generally the film thickness obtained also increases.

Similarly, if the film thickness increases it would be reasonable to expect that the film resistance would increase, but it has been reported[5] that the increase in film resistance with increased pigment content varies to a greater extent than with increasing film thickness i.e. the pigment is also contributing to the film resistance.

It is probable that the high resistance at higher pigment levels is responsible for the poor film quality.

Landon and Ashton[8] using constant current conditions, found that when the voltage increased above 90 volts, gas evolution occurred, resulting in a very poor film. At P/B ratios above 0.5/1 the film resistance, and hence the voltage, increased so rapidly that it was impossible to obtain a satisfactory film, and at P/B ratios of 0.75/1 and 1/1 it was possible to rub pigment from the surface of the stoved film. At P/B 0.5/1 the film had a slight sheen whilst at P/B 0.25/1 the 45° gloss was 60 per cent. It should be explained that the resin used in this work had not been specifically designed for electrodeposition, but was selected for its non-yellowing properties.

Landon and Ashton also reported an increase in coulombic yield as the P/B ratio increased although at P/B's 0.1/1 to 0.5/1 the differences were marginal. They concluded that, for this resin, the maximum P/B was 0.5/1 for satisfactory films, and that much lower pigment levels must be used for the production of glossy films.

Later work by Landon[22] using a different resin showed that 45° gloss readings between 70 per cent and 80 per cent could be obtained at P/B values of 0.4/1.

Holzinger[5] using P/B ratios of 0.5/1, 1/1, 2/1, 3/1, showed that film resistance increased and film quality decreased with increasing pigmentation and concluded that a P/B ratio of 0.5/1 should not be exceeded if smooth dense films are to be produced. At P/B ratios of 1/1 and above, rough, porous films were produced, the pores being in the form of craters with a more pronounced wall the higher the pigmentation.

He suggested that the higher resistance resulted in higher current density or higher voltage being necessary for deposition and this promoted attack on the anode, so that electrolysis occurred in addition to electrophoresis, resulting in formation of oxygen. No paint can be deposited at this point and the paint film around this point is deformed by the gas bubble into a crater. In addition films of higher pigment content will be less elastic, thus favouring crater formation.

Holzinger also showed that film resistance was dependent upon the rate of deposition, the film resistance being greater the slower the rate of deposition, even though the final film weights and final film thicknesses (and the number of coulombs passed) were identical.

Thus it is imperative, when determining the effect of pigmentation (or other variables) on film resistance, to ensure that deposition rates are constant. The coulombic efficiency was found to increase linearly with increasing P/B ratio and examination of the figures showed that approximately the same amount of resin was deposited per coulomb at all four P/B ratios used, the increase in film weight being due to increased pigment.

Rechmann[23] also stated that, above a P/B ratio of 0.5/1, the film gloss was poor whilst at lower pigmentations inadequate hiding was obtained.

Tasker and Taylor[6] showed Talysurf profiles of red oxide primers at P/B ratios of 0.5/1 and 1.5/1, the former giving a smooth film and the latter an extremely rough film.

They also showed[2] that the weight of resin deposited was constant irrespective of the P/B level and that the weight of film deposited increased with increasing P/B ratio.

Salt spray tests[9] on films of varying P/B showed that optimum results were obtained at P/B ratios of 2/1 with both red oxide and titanium dioxide. This value of 2/1 is well below the P/B giving maximum resistance in conventional applications.

Koral, Blank and Falzone[25] showed that in a two component resin system of maleinised oil and amino cross-linking agent, the migration of the amino resin decreased with increasing pigment and it was preferable to keep the P/B ratio below 0.5/1.

They showed that, in the absence of an anionic polymer, the amino resin would not migrate to the anode and also that the rate of migration of the maleinised oil was independent of both amino compound and pigment. They postulated that the amino compound migrated owing to the formation of an associated complex with the ionised polymer. When pigment was present the maleinised oil was preferentially adsorbed by the pigment and at P/B ratios above 0.5/1 there was insufficient ionised polymer left to associate with all the amino resin.

Pigmentation in the film

Analysis of the deposited film invariably shows that the P/B ratio in the film varies from that in the bath.

Holzinger[5] found that the pigment content was always higher than that in the bath but the extent of the increase varied with both pigment and resin. With one resin and a bath P/B of 0.5/1, the film P/B varied from 0.6/1 to 1.3/1 dependent upon the pigment whilst with a second resin the film P/B ratios were generally of the order of 0.6/1 whilst a third resin gave intermediate values.

Further examinations of one resin and one pigment showed that, at bath P/B's of 0.5/1, 1/1, 2/1 and 3/1, the increase in pigment in the film was constant at about 20 per cent.

Landon and Ashton[8] showed that, for thin films, the film pigmentation was less than that in the bath, but it was greater in thick films.

Figures given by Rechmann[23] showed that the film pigmentation was greater than that in the bath, but the percentage increase decreased with increasing P/B ratio.

P/B ratio in bath	Ratio $\frac{TiO_2 \text{ film}}{TiO_2 \text{ bath}}$
1.24/1	1.15
0.5/1	1.15
0.29/1	1.2
0.13/1	1.4

Tasker and Taylor[2] stated that the P/B ratio in the film was equal to that in the bath.

Robinson and Tear[23] investigated this phenomena, using five different grades of titanium dioxide, and came to the following conclusions concerning the ratio $\frac{TiO_2 \text{ film}}{TiO_2 \text{ bath}}$:

It was dependent upon both grade of titanium dioxide and the resin,

It was reasonably constant over a wide range of applied voltages for four grades, but a fifth grade showed an increase with increasing applied voltage, reached a maximum and then decreased,

It increased with increasing pH; this was attributed to free OH^- ions being absorbed on pigment surface, thus increasing its mobility;

Although increasing the temperature increased the weight deposited, the ratio remained constant (maximum gloss was obtained at 19-22°C and above 30°C the film was spongy),

It was independent of the bath PVC,

It was independent of substrate although total weight deposited and film gloss varied to a large degree.

Nevertheless, it was found that, if the bath PVC was kept constant but the non-volatile content varied, then the film PVC decreased with increasing resin solids, and eventually became less than the value of the PVC in the bath. However the non-volatile content at which this occurred was higher than that at which satisfactory films could be obtained.

No reason for the increased pigment in the film was put forward, but differences in the iso-electric point was suggested for the differences between pigments.

In their work, Koral *et al.*[25] found that the preferential migration of pigment increased with increasing pigmentation and also with increasing amounts of amino cross-linking agent, even though this latter compound would not itself migrate in the absence of an anionic polymer.

Martin[7] conducted a test starting with a PVC of 38.7 per cent and total solids content of 10.3 per cent, and carried out electrodeposition until the bath solids dropped to 3.15 per cent. Initially the film PVC was higher than that in the bath, but it decreased linearly with time. When the bath solids had dropped to about 5.5 per cent, the film PVC was approximately equal to the bath PVC, but as the solid content dropped further the film PVC continued to decrease resulting in the bath PVC increasing.

Effect of degree of dispersion

Tasker and Taylor showed that film resistance increased as the degree of dispersion was improved by increasing the number of passes through a roll mill[9] and also by increasing the length of time of ballmilling[10]. When comparing two grades of red oxide, a higher film resistance was obtained with the grade having a finer particle size. Similar results were obtained with two grades of silica extenders.

Martin[7] compared electrodeposited films of paint prepared by three-roll milling and by ballmilling. The paints prepared by three-roll milling gave films identical to the standard, but ballmilling resulted in flocculation and hence a poor film. He attributed the flocculation to colloidal shock at the "let down" stage.

Several workers stress the importance of good dispersion, but this is mainly to prevent settlement at the low-viscosities used.

Effect of surfactant

Landon and Ashton[8] showed that the gloss could be improved by the addition of sodium hexametaphosphate (Na.HMP) approximately 0.15 per cent on weight of pigment being the optimum amount. The improvement was independent of whether the Na.HMP was added to the millbase or to the final paint. The improvement was more noticeable in a paint of low gloss than in one of higher gloss. Electrical properties such as coulombic yield or film resistance were not affected. The authors state in their discussion that, as the improvement is only slight when using a premium grade pigment, and in view of the probable difficulties of formulation control during exhaustion of the bath, it is doubtless better to avoid such additions if possible.

Addition of ammonium polyacrylates (1 per cent on weight of paint) did not affect gloss or coulombic yield, but reduced the gradient of the voltage/time curve, which should make it possible to apply thicker film.

Finn and Mell[1] state that, if a pigment is initially dispersed in an unsuitable surfactant, it is possible to have a system in which the resin is deposited as a clear transparent film from a pigmented dispersion.

Martin[7] showed that when flocculation was obtained, when dispersing by ballmilling, owing to colloidal shock at the "let down" stage, selection of surfactant with the correct HLB value could reduce the flocculation but not completely prevent it.

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Pollution*

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Summary

The author discusses the incidence of pollution in the area of the Greater London Council and the problems it poses with particular reference to atmospheric pollution, river pollution, refuse disposal, radioactive waste disposal, and noise. The policies adopted to meet these problems are described.

Keywords

Miscellaneous terms
pollution

La pollution de l'environnement

Résumé

L'auteur discute l'incidence de pollution de l'environnement dans l'enceinte du Greater London Council, et à la fois les problémes qu'elle souléve à l'égard particulier de la pollution atmosphérique et fluviale, le débarrassement des ordures menagères et des déchets radioactifs, la propagation de bruit nuisible. On décrit la politique adoptée afin de faire face à ces problèmes.

Umweltbesudelung

Zusammenfassung

Der Autor spricht über das Auftreten von Pollution im Bereich des Stadtgebietes von Grosslondon und die Probleme, welche dadurch insbesondere durch Verunreinigung, Verschmutzung von Flüssen, Abfallbeseitigung, Entfernung von radioaktiven Abfällen, sowie Geräuschen entstehen. Er beschreibt die Richtlinien, welche zur Lösung dieser Probleme gesetzt wurden.

Загрязнение

Резюме

Автор обсуждает сферу действия загрязнения в районе лондонского окружного муниципалитета и задачи связанные с этим вопросом, уделяя особое внимание вопросам атмосферного загрязнения, загрязнения рек, мусоросжигания, удаления радиоактивных отбросов и шума. Описываются мероприятия принятые для борьбы с этими задачами.

Pollution is a very topical subject today but it is no new phenomenon, since the very processes of life itself produce the elements of pollution. Neither is anti-pollution legislation a very new phenomenon. Most people will have read that in the fourteenth century a man was hanged for causing smoke in London by burning sea coal, and modern legislation on water pollution can be said to date back to 1848 and on clean air to 1863.

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Nevertheless, the great upsurge in population and the technological advances in recent times has resulted in more urgent pollution problems, and the modest success attained in some fields in advanced countries during the 1950's has had a snowballing effect as varying interests have joined together. In fact, pollution has a much wider meaning now than a few years ago and it is perhaps as well to see what the word can now signify.

First are those discharges into the environment which clearly cause a public health hazard, e.g. raw sewage into a drinking water source. In general, governments are usually ready to take drastic steps to curb such pollution. Second are those discharges into the environment which cause a public nuisance or are otherwise detrimental to the environment, living or otherwise, but do not appear to have a direct effect on the health of man. Examples are gaseous pollution in moderate amounts, pesticide pollution, etc. Here governments normally are willing to act drastically only if little economic sacrifice is involved. However, many environmentally interested people would argue that if a pollutant harms the living environment it will eventually harm man himself.

For instance, the Tokyo Metropolitan Government, which is perhaps dealing with the worst pollution in the world, claims that it has been handicapped in dealing with this by the Japanese Government's view that unless pollution clearly endangers the health of citizens it should be overlooked in the interest of sound economic growth of the national economy. The Tokyo Metropolitan Government complains in frustration, "the destruction of landscapes, the withering of trees, the disappearance of fish and wild birds—these are the warning signs that precede the invasion of pollution upon human health itself. Man is among the toughest of living creatures, but like other creatures he is susceptible to the effects of a deteriorating environment. Hence it becomes necessary to halt environmental deterioration before it wreaks havoc on animal and plant life and on human health. If this means some factories must close down, it cannot be helped".

Some environmentalists see the situation as even more alarming. Their argument may be put as follows. All living things, including man, are dependent on the cyclical processes followed by the four elements that make up the major portion of living things: carbon, oxygen, hydrogen and nitrogen. All these cycles operate by the action of living things: green plants, animals and, not least, myriads of micro-organisms. If sufficient of these forms of life are destroyed, it will have a catastrophic effect on man himself. Many consider that man is recklessly destroying the living systems which support him, e.g., by modern industry, modern farming methods, by contamination of rivers and oceans, by our increasing world population and in many other ways. In other words, the earth should no longer be regarded as man's preserve as such but as nature's. Some environmentalists consider that modern technology has so stressed the vulnerable points in the web of processes in the living environment that there is little leeway left in the system and catastrophe is looming. It is difficult for governments to take much action to reduce the pollution covered by this view, as it would strike hard at modern industrial and farming methods and cause great hardship in itself.

In the past, noise was not usually considered as a form of pollution, but now it is well accepted as such. People who live near motorways, trunk roads or airports will know that authorities are not willing to forgo the economic advantages such facilities bring, action usually being limited to palliatives to avoid the worst effects.

Another aspect of pollution which has been broadly accepted as such only fairly recently is visual pollution. Bad architecture, bad town planning, derelict land, etc., is now regarded as a form of pollution. Some people consider man the greatest pollution on earth and want to introduce population control under the subject pollution. Yet others consider that pollution is a form of dissipation of natural resources and consider that conservation of resources should also be considered under pollution.

This introductory survey shows that pollution now covers a very wide range of topics and no attempt can be made to cover the whole field. This treatment will be restricted to the GLC view on topics within its own field of interest. As this is primarily an association concerned with paint, this subject will be introduced from time to time.

Of course, anti-pollution legislation is the business of national government in this country, but this does not prevent the GLC acting as a pressure group when it finds problems in its own area. Moreover, local authorities, including the GLC, often have the responsibilities of operating or enforcing state legislation.

Atmospheric pollution

London is a very large, densely-populated area, although without much of the heavy industry that characterises the industrial north, and prevention of undue pollution of its air is of major importance. The principal pollutants are smoke and sulphur dioxide from domestic and industrial premises, but electricity generating stations emit very large quantities of sulphur dioxide at a high level and road vehicles omit smaller quantities of smoke and fumes which are unpleasant in confined streets carrying intensive traffic. It is generally accepted that it was a major London pollution disaster, the smog of 1952, which gave impetus to the passing of the Clean Air Act of 1956. Not that the Clean Air Act was an entirely logical outcome of the smog. In the smog, about 4,000 bronchial sufferers died before their time and many other people may have been affected. Whether it was the smoke or the sulphur dioxide or both which caused the trouble was not clear, but it was easier to clean up smoke, so only the emission of smoke was controlled.

The Clean Air Acts of 1956 and 1968 have made three main contributions—

Dark smoke (not greater than 40 per cent blackness) must not be emitted from industrial chimneys or any part of industrial or trade premises.

Local authorities (in the London area, not the GLC, but the London boroughs) have been enabled to create smokeless zones where only authorised smokeless fuel may be burnt or specifically exempt smoke-free fireplaces used.

Local authorities (in the London area both GLC and borough councils) must be informed whenever it is proposed to install new industrial furnaces and the furnace must "so far as is practicable be capable of operating without emitting any smoke at all".

Apart from the planning aspect just mentioned, the GLC has no statutory responsibilities for the control of air pollution. Control and enforcement under the Clean Air Act in the London area are exercised by the London borough councils and for certain special industries by the Alkali Inspectorate. The Greater London Council, however, does assist in these fields with continuous measurement of smoke and sulphur dioxide, advice to the borough councils and some modest research.

The reduction of smoke in the London air since the Clean Air Act has been remarkable, decreases being noted every year since the winter of 1958-9, apart from last winter when the shortage of smokeless fuel caused the suspension of a number of Smoke Control Orders. In the winter of 1958-9 the average smoke content of the air of Central London was 309 $\mu g\ m^{-3}$. 11 years later, during the winter of 1969-70, the average content was 66 $\mu g\ m^{-3}$ a reduction to one-fifth.

Since the durability of external paint is often held to be proportional to the sunlight it receives, this should lead to a decrease in the life of exterior paint. However, most paint does not achieve its maximum life due to faults of preparation and the substrate generally and it is doubtful if this cleaner air is reducing the life of exterior paint to any great extent.

The sulphur dioxide content of the air was ignored by the Clean Air Act. Until about 1965, there was no clear trend either up or down at ground level, but since 1965 there has been a steady reduction of sulphur dioxide at ground level. The figure of 192 $\mu g\ m^{-3}$ for Central London in the winter of 1969-70 was less than two-thirds of that in the years 1958 to 1965. There does not seem to be much decrease in the amount of sulphur emitted—it has probably increased—but planning consents for industrial chimneys and the co-operation of the Central Electricity Generating Board, which emits large quantities of sulphur dioxide from its power stations, has resulted in a high stack policy whereby the uncooled flue gases are issued at great height, often 500 feet or more above ground level. This has the effect of distributing the gases over a wide area and thus reducing the concentration in the worst areas. The position, therefore, has improved in London, although the levels of SO_2 are still high. Further substantial reductions could be achieved if the use of fuels with a low sulphur content was made mandatory in all densely-populated areas, at least in buildings with chimneys below a certain height. This control could be extended to other areas if adequate supplies became available.

In this respect, it is interesting to note that the Corporation of the City of London is at present promoting a bill in Parliament to limit the sulphur content of fuel burnt within the City of London.

Although the effect of sulphur dioxide, in the quantities present, on human health has not been clearly established, there is not much doubt that it has some effect on the environment, particularly buildings of limestone, concrete and the like. The GLC since the war has put up many concrete buildings with the idea that this would give a permanent self-finish. However, in less than ten years, most look very shabby and this appears at least partly due to acidic attack and erosion. The result of this has been a renewed interest in masonry finishes to protect and decorate the concrete, and there is now an approved list of such materials. The effect of sulphur dioxide can also lead to faster rusting of steel and greater difficulties in preparation for painting, since the "salt" component of rust is often the active principle leading to failure of paint when it is applied over residual rust.

The amount of air pollution arising from road vehicles is relatively small, compared with the total emitted from all sources, and it consists mainly of carbon monoxide, hydrocarbons, aldehydes, smoke, oxides of sulphur, oxides of nitrogen, and lead. Emission is, however, at street level and this must be borne in mind before dismissing it as negligible.

HM Factory Inspectorate regards up to 50ppm of carbon monoxide as safe for daily eight-hour exposure by factory workers, but some people, for example bronchitis sufferers, may be unable to tolerate such a concentration. Less stringent standards are acceptable where exposure is of limited duration but smaller concentrations can slow a person's reactions. Measurements made by the Scientific Adviser in London streets indicate that a concentration of 50ppm is rarely exceeded for more than five minutes at any one time. The maximum hourly concentrations in heavy traffic are usually 10-20ppm. Therefore the concentrations present are unlikely to be a direct health hazard.

The highest concentration of smoke (usually associated with diesel engines) measured by the Scientific Adviser was $850\mu g\ m^{-3}$ for ten minutes in heavy traffic under calm atmospheric conditions. The 24 hour average concentration in Inner London on a typical winter's day is about $100\mu g\ m^{-3}$. There is no standard limit for smoke but concentrations of this order are not generally considered harmful, although they can be unpleasant.

Measurements of lead in York Road, Lambeth, for three periods of several weeks have indicated an average concentration of lead of $1.1\mu g\ m^{-3}$, the highest 24 hour average being $3.7\mu g\ m^{-3}$. The Medical Research Council have measured $3.2\mu g\ m^{-3}$ in Fleet Street. At present these concentrations are not considered a danger to health.

The concentrations of aldehydes and hydrocarbons in London air have not been studied, but are considered to be too low to be a hazard to health, although they may and do contribute an unpleasant smell. Sulphur oxides are very low and so are nitrogen oxides. Under certain conditions of strong sunlight, oxides of nitrogen can react with hydrocarbons to form unpleasant lachrymatory substances. In still conditions, these can give rise to the so-called photochemical smog. Incidence of such smog is considered unlikely in this country because of the climatic conditions, but some authorities consider we may be in for an unpleasant surprise.

The conclusion would appear to be that the exhaust gases from motor vehicles in London are not at present harmful, especially as any concentration is usually quickly dispersed by the wind.

However, the GLC do not appear to be entirely satisfied. For instance, many members and officers of the GLC are concerned by the smoke and unpleasant odour which often occurs, particularly from diesel engines. London Transport buses are required to operate at 90 per cent of the smoke point to minimise this nuisance.

There is also the question of lead. As is well known, lead is a cumulative poison and paint has borne a large share of the blame for cases of lead poisoning in children in recent years. So much so that its use has been drastically curtailed, not only in this country but also in many others. The US has enacted legislation intended to remove all existing lead paint from surfaces, although perhaps typically they are not too sure yet how they are going to do it. Although the author generally supports this reduction in the use of lead paint and is quite sure that many cases of lead poisoning in children are due to the chewing of paint containing lead, he believes that the role of lead paint may have been exaggerated in the past and tended to mask other sources. There are very many sources of lead in the environment, food, water and atmosphere all contributing their share. It has been claimed, apparently with some justification, that the margin between the average amount of lead ingested and the safe level is relatively small and that a small but significant proportion of the population does exceed the safe level. This may be particularly serious for young children, both because of their smaller body weight and because their developing brains and nervous systems are more vulnerable to attack. Therefore, many people consider that children and indeed adults can suffer lead poisoning without eating paint or other similar unusual food.

Where, then, does the lead come from? Although petrol contains two to three grams of lead per gallon, actual levels measured in London streets are of a low order. A recent Medical Research Council report considers that only 8 per cent of the lead the average Briton takes up each year comes from motor vehicle fumes, the rest coming from food and water. The position does not appear entirely satisfactory and further work is required to clarify the position. The main question is, how does lead get into food and water? For instance, is it deposited from the stacks of lead industries? Or is it partly a gradual accumulation of lead emitted from car exhausts? Or is it due partly to lead arsenic sprays used as pesticides? Or to other sources?

The GLC has stated, "It is certain that substantial quantities of lead are discharged into the atmosphere by cars, that this is additional to other sources, that the levels are likely to increase and that it is a cumulative poison. Research in this field is properly the province of the Government and the motor industry, who should be urged to intensify their studies into the levels of toxicity of lead and the effects of its prolonged dispersal into the atmosphere."

The GLC has also urged the Government to do a number of other things, e.g., to adopt EEC standards for carbon monoxide and hydrocarbon emission on cars. This would reduce the carbon monoxide emissions by about one-third and hydrocarbon emissions by 20 per cent. The council has also urged the Government to adopt US standards, to have car exhausts made of less corrodible material, to require that ventilating intakes should not be low down, and that exhaust emissions at least at idling speeds should be included in the annual MOT test.

What action is the Government taking? Diesel engine vehicles are the main emitters of smoke and the Government is framing legislation which will require such vehicles to conform to stricter standards. They are also developing instruments for checking smoke emission from goods vehicles during the annual maintenance test. Government regulations recently introduced require new cars to be fitted with a crank case positive ventilation device, which would reduce such emissions by up to 25 per cent. The Government have also announced that it is its policy to move towards adopting the broad EEC standards on the limitation of carbon monoxide and hydrocarbons, to join in moves to cut down emissions of lead by approximately one half, to promote long-term research and to keep the problems under review.

Part of this research is to make a one-month survey of the total pollutants from all vehicles at a road-side site in Reading, and to measure the relationship between traffic density, traffic composition and the breakdown in air of carbon oxides, hydrocarbons, nitrogen, lead and other trace elements. Monitoring is also going on in London in Fleet Street and outside St. Bartholomew's Hospital for airborne lead, hydrocarbons and sulphur dioxide. This is rather a limited range of pollutants, of course, and the oxidants and nitrogen oxides, at least, should have been included as it is unsafe to assume that photochemical smog cannot occur here. Monitoring is also going on concerning the uptake of lead by soils and crops in the vicinity of busy roads. Investigations are also being made of the effect of exhaust fumes on people.

Thus the Government is taking much useful action and the position is not too unsatisfactory. The author considers that a pilot monitoring system is required in London for carbon monoxide, nitrogen oxides, hydrocarbon, smoke, lead, oxidants, etc., so as to establish trends.

River pollution

The GLC has direct responsibilities in this field:

as the enforcement authority under the Rivers (Prevention of Pollution) Acts for most of the rivers and streams in Greater London (but excluding the two most important rivers, the Thames and the Lea),

as the Land Drainage Authority for some 420 square miles in and adjoining Greater London (i.e., the land drained by the rivers and streams for which it is the enforcement authority),

and, most important, as the Authority responsible for sewage disposal in the 625 square miles of the Greater London sewage area and thus the greatest guardian against the pollution of water courses in the area. The most important water course is the tidal Thames. The pollution of the portion of this river running through the London area is very largely due to sewage and its present relatively satisfactory condition is mostly due to the policy of the GLC and its predecessors in completely rebuilding its major sewage works. At this stage some account can be given of the essential features of a sewage works.

The process of sewage treatment basically is one of speeding up the natural processes by which wastes of the animal kingdom are broken down for re-use. This does not mean, as has been recently implied, that the methods are no better than those in use at the turn of the century. It is true that the same naturally-occurring micro-organisms are used in the processes, but modern plant can treat sewage using only about one per cent of the area required at the end of the last century and moreover at a cost per capita per week of the postage stamp for a letter. The basic stages of sewage treatment are as follows. Sewage is first treated to remove large solids, rags, etc., which are shredded in disintegrators and returned to the incoming sewage flow. Grit, which would otherwise silt up later treatment stages, apart from causing excessive wear on pumps, is next removed. Suspended solids are settled out in primary sedimentation tanks in the form of raw sludge, the liquid portion being given biological treatment either on percolating filters, as in small works, or in an activated sludge process. In both cases, the principle is to bring settled sludge into contact with specific micro-organisms (occurring in the activated sludge or as a film on the percolating filter) which in presence of air break down carbon-containing substances to carbon dioxide and water, and nitrogen-containing substances to ammonia and ultimately to nitrates. The effluent, after biological treatment and separation from the activated sludge, has been purified of most of its original polluted materials and can be discharged to a river.

Raw sludge, which is rather unpleasant, is fermented in the absence of air to produce a mixed gas containing 70 per cent methane and 30 per cent carbon dioxide, which is used as fuel to provide all the power required to operate the works leaving some to spare, which is fed to the National Grid.

The remaining digested sludge is far less offensive and virtually free from pathogens and parasites, and is disposed of either at sea by sludge vessels or by drying it for use on the land as a soil conditioner.

To revert to the Thames, until the early 19th century, the river is believed to have been in very good condition, as only surface water drains discharged into it. Disposal of domestic soil water was by means of cess pits. The introduction of the water closet in the early 19th century began to throw an impossible load on the cess-pits and it was soon made permissible to connect them to the street drains discharging into the Thames. This, allied to the increasing population, led to a rapid deterioration of the river and between 1835 and 1854 three great cholera epidemics struck London.

Public alarm was such that legislation was passed creating, among other things, a Metropolitan Board of Works responsible for constructing works to prevent the sewage entering the river within the metropolitan area and instead to convey it and to discharge it downstream beyond the metropolitan boundary. Large intercepting sewers running roughly parallel to the river were constructed which would convey their contents to Beckton on the north side of the Thames and Crossness on the south side. Although at first no treatment was given, settlement of sludge was soon introduced, the sludge being disposed of at sea. Treatment of the effluent by the activated sludge biological process was started at Beckton in 1934 and by 1940 about one-third of the flow received such treatment.

All this time, owing to the rapid expansion of Greater London, a number of relatively small streams discharging into the upper reaches of the tidal Thames had been conveying increasing quantities of effluents of deteriorated quality from some 28 separate sewage works. The consequence of this was a progressive deterioration in the condition of the water in the upper reaches of the Thames, with the result that the Middlesex County Council Act was passed in 1931. This gave to the Middlesex County Council powers to construct a scheme of main sewers throughout the area, a purification works at Isleworth and to close down all the 28 small works. The new works was completed in 1935 and its effect was soon evident in a marked improvement in the condition of the water in the upper reaches of the tidal Thames.

In the 1950's, owing to the growth of population and industry, the tidal Thames was so polluted in the reaches downstream of Greenwich that the river stank in the dry summer months and no fish life, other than very resistant eels, could survive anywhere in the London section. As soon as possible after the War, work was started on the new Beckton purification plant and this began to come into commission in 1959. It was designed to treat a further 60 to 70 million gallons a day, so that as soon as it was fully commissioned, half the total flow received at this works was receiving biological purification. In 1963, a completely new purification plant was brought into commission at Crossness, giving full biological treatment. During the past seven years putrescent conditions have been unknown. At this stage, of the 600 million gallons of sewage dealt with by the GLC per day, 500 million gallons was receiving full treatment.

The reduction of the pollution load has resulted in the gradual return of fish to the tidal reaches, and fish-eating birds, such as the common tern, can now been seen in the lower reaches.

It is also worthy of note that, in the early spring of 1971, two sea trout were taken from the river, one at Charlton and one at Teddington, and that two dolphins managed to swim upstream to Richmond. Public interest in the cleaner river has been stimulated by an annual angling competition instigated in 1968 by Sir Desmond Plummer, Leader of the GLC.

Whilst there is ample reason for pride in the improvement of the river, there is no room for complacency, and those responsible for its management feel that there is insufficient margin of safety, especially in conditions of very low flow.

Reconstruction is being carried out at Beckton Works, where by 1974 the whole of the sewage flow will be treated, to produce a high quality effluent, and provision has been made to deal with increased flows likely to arise over the next 30 years or so.

However, there are further dangers which may threaten the river. Specifically, the increased use of pesticides such as BHC, DDT, Aldrin and Dieldrin, has given some concern, as these substances are very stable chemical compounds which decompose at an infinitely slow rate and therefore tend to concentrate in living tissue. Not only can they become concentrated in the flesh of fish, but they can be re-absorbed in the flesh of fish-eating birds. Should the concentration of these substances be allowed to increase in fresh or marine waters, they could become a serious hazard, not only to fish and birds but also to human life. At present GLC effluents discharged into rivers contain concentrations varying between 0.1 to 1.5 parts of pesticides in 1,000 million parts of water. The river itself contains not more than 0.5 parts in this volume.

Another group of substances used mainly in the electrical industry but sometimes in paint, and not in themselves especially toxic, are the so-called poly-chlorinated biphenyls. Like pesticides, they are very stable substances and can be concentrated in fish by absorption from river or sea water. The concentration of PCB is 0.1 to 0.3 parts in 1,000 million parts of water in effluents and 0.1 to 0.5 parts in 1,000 million parts in the river.

There are also various toxic metals. In 1959, in the region of Minamata Bay in Japan, some 111 people were affected by what was at first thought to be a contagious disease, but was subsequently found to be poisoning as a result of eating fish from Minamata Bay. The trouble was caused by a discharge from a large chemical plant of an effluent containing mercury. Mercury in the form of its salts is not perhaps very toxic, but certain micro-organisms can convert these into methyl mercury which greatly increases the toxicity. It was this compound that was responsible for the Minamata disease. Unfortunately, information about this incident was not made available outside Japan. A further outbreak occurred at Niigata, also in Japan, in 1965, when 120 people were poisoned and five died. It was only in the following year that details of this hazard reached Europe and America. Subsequently, in March 1970, Canadian officials seized about eight tons of fish taken from Lake St. Claire and pronounced it unfit for human consumption because of its mercury content. This prompted the Canadian and US Governments to tighten the control of the mercury contamination in effluents discharged to the Great Lakes. A standard of not more than 5 parts of mercury in 1,000 million parts of water was imposed by the Federal Government.

As with pesticides and PCB, the GLC is keeping a close watch on the mercury content of its effluents and sludge. The concentration of mercury in most GLC effluents is usually below two parts in 1,000 million parts of effluent. In the effluent from Beckton it is a little higher, this being due to the higher solids content of the effluent from this works, but after 1974 the level should fall to that in other effluents. The concentration in the river itself does not exceed 0.5 parts in 1,000 million parts.

It is confidently expected that, by 1980, the Thames will be a river which at all times of the year is healthy and capable of supporting a variety of fish life over large stretches. Consideration for further improvements is only likely to result if greater amenities are anticipated in its use. This would require considerable expenditure and the accrued advantages would have to be weighed carefully against the cost.

Refuse disposal

The GLC took over the full responsibility for refuse disposal in the Greater London area in 1967. Not refuse collection, which is still the responsibility of the borough councils, but the actual satisfactory disposal of the refuse.

The small and obsolete plants and depots taken over by the GLC from its predecessors are being replaced with larger and more efficient plants, serving a wider area. At the present time, the total quantity of refuse requiring disposal is about 2,700,000 tons per year, originating from an area of about 625 square miles.

At the present time, most of London's refuse is disposed of by tipping on land which in many cases would otherwise remain useless.

Tipping could be a source of considerable nuisance. Flies, rodents, smell, offensive appearance, for a start, and it can result in pollution of water supplies. Therefore it is essential to operate controlled tipping, which in its essential features involves:

the selection of a suitable site, preferably one which will be improved by having its level raised;

preliminary measures to avoid surface or ground water pollution by run off or leaching;

provision of good access to and the total enclosure of the site;

prior definition of the ultimate use of the site;

deposit of the refuse in layers of limited depth and daily covering of all fresh refuse with soil or similar material.

It might be added that all public or private tips need planning permission from a body on which river boards, water undertakings, etc., are represented.

There are many examples in Britain of many types of land which have been satisfactorily recovered in this way, but it is becoming more difficult to achieve good land reclamation with untreated refuse because of voids caused by consumer durables, plastic containers, rubber tyres, etc. Temporary environmental degradation by wind borne litter (plastic bags, paper, etc.) is also becoming difficult to avoid.

These problems can be overcome, at a cost, by suitable pre-treatment, although few local authorities do so yet. The most favoured pre-treatment at the moment is pulverising.

Pulverisation of town refuse can be obtained almost instantaneously in a hammer mill or after an hour or so of tumbling in a slowly revolving drum with a little water. The former uses much power but there are few rejects. The latter uses little power but there are more rejects. The GLC has only small capacity for pulverising at the moment, but is in the process of building a large plant at Cringle Dock, Battersea, together with a barge transfer station intended to treat refuse for disposal on marshland in the Thames Estuary.

The benefits of pulverisation are:

land reclaimed is superior because of uniformity and lack of voids;

insect, rodent and fire risks are greatly reduced, if not eliminated;

the refuse loses its offensive appearance;

the space ultimately occupied by a given weight of pulverised refuse is only about two-thirds that of a similar weight of crude refuse;

covering of pulverised refuse is probably not essential, although some operators prefer to do so both to improve the appearance and to avoid possible odours which can occur in hot damp weather.

Use of pulverising increases the cost of refuse disposal by up to three times. Toxic substances cannot be tipped indiscriminately. There are various possible procedures, but if tipping is resorted to this must be to special sites where no environmental hazard is considered possible.

Another method of disposing of refuse is by incineration. Until recently, only a very small proportion of GLC refuse was disposed of this way, but the 1,333 tons per day incinerator at Edmonton in North London will soon be fully operational, so that this will be dealing with half a million tons per year, or about 18 per cent of the total.

This plant is of special interest in that it is unique in the UK by virtue of its size and because it generates about 30 megawatts of electricity, which is sold to the Eastern Electricity Board. In addition to electricity, the plant will produce about 150 tons per day of scrap metal, 260 tons per day of clinker and 75 tons of fly ash, all of which are saleable.

The GLC has gone to considerable lengths to ensure that the amount of pollution created by the plant is minimal. Electrostatic precipitators have been incorporated for dust and grit removal and the chimney is 100 metres high to ensure good dispersal of the products of combustion.

A few years ago, the GLC planned to build several more incinerators so that most refuse will be disposed of this way. However, it seems doubtful if these will be built in the near future, as incinerator costs have become uneconomic.

Radioactive waste disposal

Radioactive isotopes have been used now for many years in a great variety of operations ranging from power stations to luminous signs. Radioactive wastes arising from these uses could easily lead to hazards for the population if suitable disposal methods were not available.

Some environmentalists consider radioactivity potentially the most lethal of pollutants, as it cannot be neutralised. A radio-active isomer decays at its own specific rate and if its half-life is, for example, 100,000 years, it will only have lost half its activity in that time; there is little one can do but hide it away somewhere safe. Whether anywhere is absolutely safe is another matter—there are earthquakes, etc.

At any rate, the GLC has to follow Government policy and is concerned only with low activity materials, where the principle is to ensure that disposal does not result in an undue rise in the level of radioactivity in the environment.

In brief, the Radioactive Substances Act 1960 requires all users of radioactive materials to be registered with the Department of the Environment. When the user wishes to dispose of waste, authorisation of the Department of the Environment is required, which specifies the site. Any substantially radioactive waste is disposed through the National Disposal Service operated by Harwell. However, there are over 600 registered users of relatively low activity material in Greater London, many having authorisation to dispose of liquid wastes to the drainage system and solid wastes to the refuse system. Authorisations are passed to the GLC by the DOE and both the liquid and solid disposals are monitored by the GLC to see that no hazard is caused. The GLC also operates a limited programme on radioactive fall-out to obtain reference data for London.

Noise

The first and probably the largest noise survey anywhere was undertaken in London in 1961. It consisted of noise measurements over 24 hours at 540 points spaced out at equal intervals in the central part of the city. A social survey associated with the measurements indicated that 56 per cent of the population was disturbed by noise, and that traffic noise was by far the greatest single source of annoyance. Since then, the problem of traffic noise has greatly increased, both because the actual volume of traffic has grown substantially and because traffic has been diverted on to many previously quiet roads.

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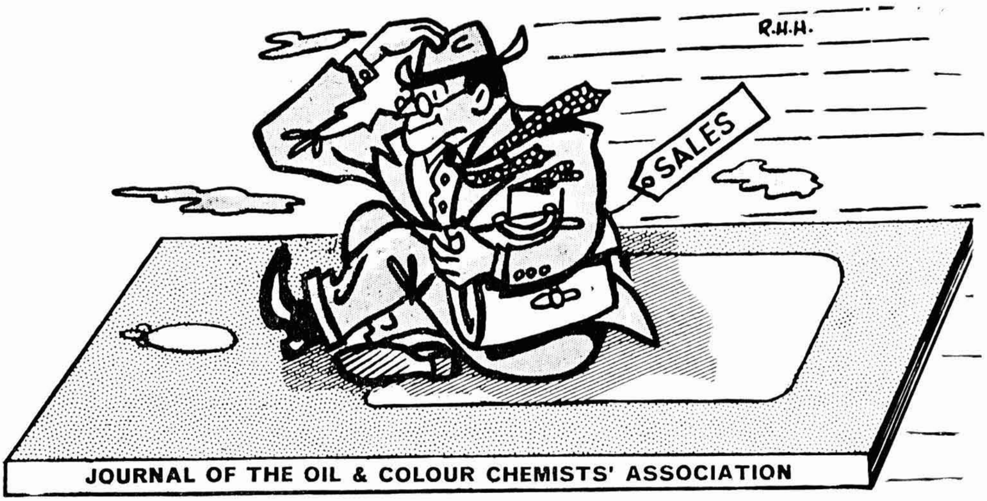

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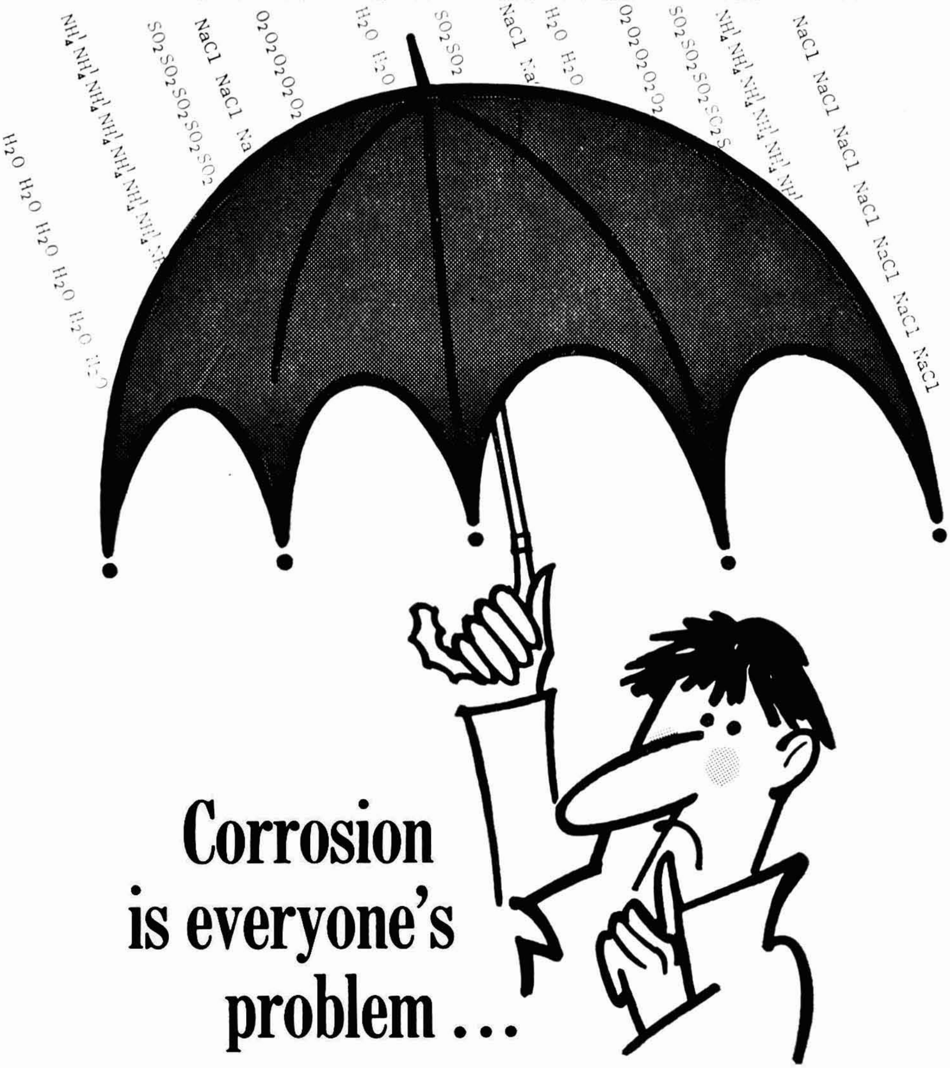
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S 170	71	0,98	650	17	200	for all types of black finishes
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Special Black 15	84	0,96	250	25	100	for highest quality offset and letterpress inks
Special Black 4 *	80	0,86	300	25	180	in finishes applied by dipping or electrophoresis, high-grade flexo and special gravure inks and duplicating inks
Special Black 4 A	80	0,86	230	25	180	for high-grade printing inks, carbon paper and typewriter ribbons
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Carbon Black LTD	81	0,66	360	35	80	
Printex® V **	83	0,95	400	25	110	for industrial and decorative paints, gravure, flexo and rotary news inks
Printex® 140 V *	84	0,91	360	29	96	for decorative paints, carbon paper, gravure, flexo and rotary new inks
Printex® 400	84	1,01	330	25	95	for letterpress and offset inks of good colour
Printex® 30 *	90	0,91	400	27	78	for rotary news inks
Printex® 300 ***	90	1,00	360	27	78	for gravure and inexpensive letterpress and offset inks
Printex® A *	94	0,73	300	41	46	for gravure inks
Printex® G *	98	0,64	250	51	31	for tinting paints, and in gravure inks and one-time carbon papers
Lamp Black 100	93	0,66	400	51	48	for tinting paints and in matt printing inks
Lamp Black 101 *	102	0,21	280	95	21	for tinting paints, with high resistance to flotation and pigment separation

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The annual change in noise levels has been assessed by taking measurements regularly from the 180 metre high Post Office tower. The first measurement, in 1963, showed that a single measuring point at a great height gave a very similar pattern to the average of the 540 points measured at ground level, and a ready means was thus available of monitoring annual changes in the noise climate. The main pattern has been that, although there has been little change in the day-time levels of noise during the working week, the quiet period at night has become shorter and also less quiet. Weekend noise levels have also increased. Investigations of traffic noise have shown, as expected, that heavy commercial vehicles are the main culprits and that in fact under urban conditions the percentage of heavy vehicles is a more important parameter in determining the noise than is the total volume of traffic. These results again emphasise that the most effective way of reducing urban noise is first by limiting the noise of heavy commercial vehicles and secondly by banning them from residential roads, except where access is required.

The Government, following the recommendations of the Wilson Committee, has now laid down constructional regulations to control vehicle noise. The maximum noise of a vehicle is measured under a test procedure laid down in BS 3425 which basically measures the noise at full throttle. For instance, the heavy goods vehicle or bus constructed after 1 April 1970 must not exceed 89 dBA and a car 85 dBA. By 1973, these figures will be down to 86 dBA for a heavy vehicle or bus with an engine of under 200bhp and 80 dBA for a car. The Government's long-term aim is to reduce the levels for lorries to 80 dBA and for cars to 75 dBA. These proposals for new vehicles go further than anything that has been proposed in any other European country. The Government also intend to include a noise check in the present annual checks of heavy vehicle maintenance and thereby to ensure that bad maintenance does not allow a vehicle to become noisy as it ages.

The Greater London Council also has as its official policy the aim of achieving the recommendations set out in the 1963 Wilson Report on noise, for all new housing developments. The report suggested that 50 dBA by day and 35 dBA by night should not be exceeded for more than 10 per cent of the time inside dwellings. As far as is practicable, all planning takes account of these recommendations, by the relative position of roads and housing, by the layout of housing estates, the internal planning of buildings and, where necessary, by the use of sound insulation at the facades.

A comparatively recent problem is the effect on the environment of urban motorways. Several motorways already exist in the London conurbation and more are planned. On the principle that prevention is better, and also much easier, than cure, all proposals for new motorways and other major roads, as well as of new housing developments, are now studied so that as far as possible any environmental conflict between noise-producing and noise-sensitive areas are avoided. By means of careful planning at an early stage, motorways may lead to an improvement of an area taken as a whole, as they draw traffic away from residential streets not designed to carry heavy traffic. By restricting the highest noise levels to a narrow strip of land alongside the motorways, the maximum available resources can then be used to protect properties in the vicinity of the motorway. A method of protecting dwellings in such cases is by means of a specially designed noise barrier which may give reductions of the order of 10 dBA.

Apart from road traffic, London's other major noise nuisance is due to aircraft. The major airport, Heathrow, is very badly situated as regards noise, since it is close to the western suburbs and, with a prevailing south-westerly wind, over 70 per cent of all approaching aircraft have to pass low over these suburbs. To mitigate the effect of noise as far as possible, all aircraft taking off are obliged to climb according to prescribed noise abatement procedures and follow minimum noise routing so designed as to affect as few people as possible. Maximum noise levels permitted for aircraft taking off are 110 PNdB by day and 102 PNdB by night at the nearest built-up areas. To assist people living close to the airport within the boundaries of the 55 NN I contour a grant scheme is operated by the British Airports Authority, according to which residents may receive £150 or three-fifths of the cost of sound insulation treatment, whichever is less. It is hoped that with the promised advent of quieter aircraft, especially following the introduction of aircraft noise certification in January 1972, the aircraft noise problem will at least be held in check, even though the numbers of movements will continue to increase.

There is now the possibility that vertical take-off and landing aircraft and short take-off and landing aircraft may be developed successfully and used for relatively short-haul inter-city travel. Different types of these aircraft are being developed and may be used to provide a travel network in Europe. If such a network were introduced, it is probable that its extension to cover major cities in Great Britain would be considered.

These types of aircraft have the great time-saving advantage that their terminals could be near the city centre. If successful, they would replace the short-haul aircraft at present in use, with a possible resultant fall in the total number of aircraft using London (Heathrow) Airport. Terminals would be required to be situated in an area, possibly about half a mile or more in diameter, where relatively high noise levels could be accepted. Noise reaching the ground underneath the flight path might be attenuated to an acceptable degree if the flight of the aircraft exceeded 2,000 feet. The question of whether these could be used in any position in London is still under active high-level consideration and the results cannot be anticipated.

Acknowledgments

This paper is published with the permission of Dr B. R. Brown, Scientific Adviser to the Greater London Council, but the views expressed are those of the author, and not necessarily those of the Council.

[*Received 13 November 1971*

Next month's issue

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

- **"The design of resins for electrodeposition,"** *by H. R. Crawford*
- **"Developments in marine paint,"** *by K. S. Ford*
- **"Equipment aspects and quality control of electropainting plants,"** *by R. L. Nicolay*

Correspondence

SIR—In the last paragraph of Mr Tawn's letter in your March issue of the *Journal* appears the question "Is he hinting that we should publish in languages other than English?" I have reread my original letters (1971, *54*, 795 and 992) and it seems almost inconceivable that such a question should have arisen. The whole tenor of my enquiry relates to the possibility of increasing the proportion of contributions from this country, and asks whether the Association should not have a policy directed towards this end.

Mr Tawn's somewhat facile explanation of the prominence of papers from Dutch and Australian sources generates more questions than it answers, but we need not go into them at this stage of the argument.

The crux of the matter may lie in Mr Tawn's statement that the Hon. Editor can only publish what he receives. Does the Hon. Editor at present specifically invite papers from selected British scientists and technologists who are known to be working in particularly interesting fields of investigation? If this has been tried and found to be unproductive, then why not make it a rule of membership that senior people shall be required to submit papers to the Hon. Editor—say at least one paper every three years—it being understood that the organisation for whom the member is working will be engaged on some form of industrial development or research.

Of course there will be problems arising from such a requirement of membership, but not altogether insuperable ones, it may be suggested, and if British members are to play a more significant role in what after all is an essentially British journal, then surely it cannot be ruled out of court without serious consideration?

It is quite possible that no one would have any objections if every published paper originated from overseas, and if this is true then that is the end of the matter, but I suspect that many would prefer that Council introduced some measure of control, if a practical way can be found.

Yours faithfully,
F. ARMITAGE

195 Clarence Gate Gdns.
London NW1,
26 March 1972.

SIR—I had thought that Mr Armitage was calling for a form of proportionate representation in your published papers and was tempted to ask whether this should be based on a country's OCCA membership, *JOCCA* readership, number of paint firms, GNP or what? On reading his penultimate paragraph, however, I find I was mistaken: he preaches chauvinism, pure and simple.

I would agree that *JOCCA*, like its sponsoring body, was of British origin, but OCCA is now international and *JOCCA* is internationally read. For this, if for no other reason, your Publications Committee would be irresponsible jingoists did they not advocate acceptance of a goodly leavening of papers from abroad.

The idea of inviting papers has, I believe, been considered before and you may well feel that it should be considered again. In the past the practice was rejected as invidious and likely to lead to more problems than it solved. These, however, fade into insignificance beside the problems raised by Mr Armitage's proposed rule of membership. Who are the "senior members" to whom the rule would apply? What happens to them if they fail to comply? What of the "senior member" who is not engaged in R & D; a managing director for instance? Is a "senior member" to be castigated if his employers forbid publication? Would the rule apply to Associate Members, who by definition are substantially non-technical, and, if not, why discriminate against senior technical men who, I submit, are the backbone of the Association?

I suppose I would be classified as a "senior member," and I would much rather encourage the younger members of my staff to publish in their own names than hog your pages for my own doubtful glory. The pity of it is that they are so difficult to encourage. But if I did succeed, would Mr Armitage damn me to demotion, expulsion or some other, equally horrid, fate?

Yours faithfully,
A. R. H. TAWN.

34 Crest View Drive,
Petts Wood,
Kent, BR5 1BY.

Review

PROGRESS IN ORGANIC COATINGS VOL. 1, NO. 1, MARCH 1972

Lausanne: Elsevier Sequoia SA (Subscription 131.75 Swiss Francs per annum, postage paid)

The Managing Editor of this new publication is W. Funke (Germany), the Consulting Editors are P. Fink-Jensen (Denmark) and A. R. H. Tawn (Great Britain) and there is an Editorial Board of distinguished scientists of world wide repute. This team in itself is an indication of the quality of the reviews likely to appear in the new journal.

The publication is described as "An international review journal," and it is to appear quarterly. It is understood that it will be for reviews and that original papers will not be published.

This first number contains four reviews:

"New polymers for coatings for the '70's," by J. W. Prane

"Polymer reactions on powder surfaces," by R. Kronen, M. Schneider and K. Hamann

"The measurement of adhesion," by T. R. Bullett and J. L. Prosser

"Solvent evaporation from paint films," by T. Yoshida

The reviews give the backgrounds of the subjects studied with some indication of the practical implications involved and link these with the more detailed and precise aspects of the subjects. The length of each review is in the range of 20-30 pages, and the subjects are adequately treated; however their length does not permit an exhaustive study and whilst the list of references given is not complete, it is ample to indicate sources of further study.

It is believed that this Journal fills a gap which has existed in the literature of organic coatings and that it should become of great value to serious workers in this field.

HON. EDITOR

Student Review

Paint Technology Manuals. Part Seven: Works practice

Chapter IV. Paint manufacture

Before commencing upon this subject, it is convenient to break down the way in which the various aspects are to be treated. Accordingly, a synopsis of the chapter is given below.

Pigment dispersion	
Production methods	four general processes
Mixing machinery	fixed tanks (a) horizontal (b) vertical change-pan mixers edge runners high-speed mixers portable mixers
Paint milling machinery	
Group 1	machines for which premixing is essential: triple-roll mills single-roll or bar mills rotating surface mills—colloid mills sand mills
Group 2	complete dispersion mills: ball mills attritor mills kady mills high speed impeller mixers Cowles, Torrance
Tinting and colour matching	
Straining and filling	
Warehouse and despatch	
Typical lay-outs	Grouping of machines method of drive
Machinery maintenance	

Pigment dispersion

The dispersion of the pigment in the film-forming medium is the basic operation in the manufacture of paint. The manufacture of resins and media has been considered in earlier parts of these reviews, but although they are frequently made by paint manufacturers, they may be regarded as raw materials or intermediates for the actual paint manufacture.

This part of the manuals is not the proper place to explain the reasons why a pigment is necessary in a paint, since the concern here is mainly with the equipment necessary in the factory to carry out the incorporation of pigment and give some consideration to the methods of operation.

Descriptions of various aspects of pigmentation have been given in earlier parts of these manuals. Some useful references are:

Part 1 "Non-convertible Coatings" Chapter 4 p. 99 Pigments suitable for lacquers and some description of grinding methods.

Part 3 "Convertible Coatings" Chapter 12, p. 185 (2nd edition, p. 217) General summary of factors governing pigmentation and the mechanics of dispersion.

Part 5 "Testing of Paints" Chapter 2, p. 12 Measurement of the fineness of grind.

Part 6 "Pigments, Dyestuffs and Lakes" This part describes the range of pigments and extenders available for use in paint manufacture. Attention is drawn to Chapter 1, p. 1, for a general description of the structure of pigments and to Chapter 3 p. 90 for a further discussion of the use of the fineness of grind gauges.

This review and the following two articles will be concerned with the machinery used in the dispersion of pigment on a factory scale. A fairly wide range of types of equipment is available to the manufacturer; the choice of the plant installed in a factory and the selection of that used for a particular operation depends upon many factors, amongst which may be mentioned:

the volume of paint to be produced,

the degree of dispersion of the pigment necessary for the type of paint being made,

the choice between a labour intensive method, such as a triple-roll mill which is capable of rapid production of small volumes, and a method which is slow but requires a minimum of labour and which can be left to run without attention overnight, e.g. a ball mill,

whether a base paint which can be subsequently tinted to the required shade is to be made or whether the paint is being made directly in the colour required subject to final adjustment,

the actual colour required, e.g. a black or dark shade may be made in a steel ball mill, which would cause discoloration in a white or pale shade,

the difficulty of dispersing the pigment(s) present and whether or not true "grinding" is necessary,

the stability of the medium to the forces exerted by the machine chosen, e.g. whether an emulsion would be coagulated by the shear forces applied,

the volatility and inflammability of the solvents present,

the economics of the process or series of processes involved in relation to the quantity required,

the colour required in relation to what has been previously made in the machine and what colour is to follow it, that is, as much cleaning down should be avoided as possible, since this can be a difficult and expensive operation with some types of machine;

the same consideration as above may arise when changing from one type of medium to another, for example from a water based to a solvent based medium,

what plant is actually available at the factory and free from other commitments, including tinting mixers and even filling machines.

In addition to the choice of plant for the dispersion operation, the method of making the final paint can be varied. For example, suppose a pale green colour is to be produced, then basically three methods can be used:

(a) the formulation to make the final colour is dispersed in the plant chosen which should, if successfully prepared, need only a slight final adjustment of colour.

(b) the paint is made from a white base and
  (1) tinted to shade by the addition of a concentrated paste of the coloured pigment(s) OR
  (2) tinted with a finished paint(s) of the same general type as the base, but made with coloured pigments.

b (1) and b (2) may be considered as the two extremes and there are a number of intermediate processes possible e.g. a pigment concentrate of lower consistency than a paste but of higher pigment concentration than a finished paint may be used.

Both the methods under (b) have their difficulties: the paste method involves considerable mixing to ensure that the relatively small amount of paste is uniformly distributed throughout the bulk of the paint. However, as the amount of paste added is small, no further addition of driers should be necessary, even if the paste itself does not contain them.

The ready mixed paint method is probably easier for colour matching purposes, since the shade produced is not so sensitive to the quantity added. The driers needed may give problems because, if driers are added to the "tinters," they will skin on storage unless great precautions are taken and will lead to a "bitty" final paint. On the other hand, if the tinters are made without driers, and a significant amount of them has to be added to the base paint, an addition of driers has to be made to the final paint. The amount to be added needs to be calculated from the volume of tinters used, followed by the measurement and mixing in of a small amount of driers.

When the batch of paint is completed it is followed by a filling out operation, which will be described in a later review.

The dispersion process

The first part of the series of operations described above may now be considered more closely. It is not necessary in this review to discuss in detail the subjects given under the above references to earlier parts of these manuals, but some brief account of what occurs during "dispersion" may be useful. Most modern pigments are manufactured to have an ultimate particle or crystal size which is small enough to need no further reduction during paint manufacture.

Strictly, a process which reduces the size of the particles present should be described as "grinding" or "milling" and since, in general, no such reduction occurs during paint manufacture, the use of these terms is incorrect and the processes considered in what follows are more accurately to be described as "dispersion." However, the term grinding is very widely used in the industry and it is likely to be a long time before its use is eradicated.

A good description of the importance of adequate dispersion has been given by Hoogerbeets in a Student Review (*JOCCA* 1971, **54,** 1162). This paper was specifically applicable to the dispersion of titanium dioxide, but the principles involved are relevant in general.

To disperse pigments and extenders in a paint medium appears, at first sight, a simple process but it is in fact often a difficult one.

It must be borne in mind that, although the ultimate pigment particles may be very fine, they are invariably encountered as aggregates or air-agglomerates of many single particles held together by strong surface forces. The particles may be covered with a firmly adherent layer of gas, usually air, or moisture. In its simplest terms, pigment dispersion aims at removing this adsorbed layer, separating the aggregates into their ultimate fine particles and surrounding each with a layer of medium in such a manner that re-aggregation does not occur. It should be stressed that there is usually no question of reducing the ultimate particle size.

Simple mixing with oil or medium seldom breaks down the aggregates, and some form of dispersion is required. As noted above, this is referred to as grinding, and requires a considerable expenditure of energy. The entrapped air is displaced, and if the liquid "wets" or covers the pigment, surface air and moisture are displaced and replaced by the medium or some component of it. The pigment aggregates are broken down mechanically into the primary particles or smaller aggregates and these in turn are wetted by the medium.

Wetting is an essential part of the dispersion process. There must be some component of the medium able to form a kind of protective envelope round the individual particles, so that the latter do not come together again and re-aggregate or flocculate when the shearing force is removed. The pigment is then said to be dispersed and a series of properties required in paint possible of achievement.

Pigments differ in the ease with which they may be incorporated into a medium; some, like antimony oxide, are easy to incorporate, while others, like carbon black and Prussian blue, are difficult. Much attention has been paid to treating pigment particles by micronising (see Paint Technology Manuals Part Six, p. 319) or by other processes to facilitate their incorporation into the medium. Similarly, grinding aids or special substances (wetting agents) may be added to the medium to accelerate the dispersion process. The essential factor is that, whether from the medium itself or from the wetting agent, chemical groups must be present which are capable of adsorbing on to the pigment surface. The gradual improvement in pigment quality has been accompanied by the simultaneous development of new types of dispersion equipment.

Likewise, much attention has been paid to the formulation of the mill base and to the milling operation, so that over the last decade the dispersion operation has been speeded up to a remarkable degree.

Many students obtain their first introduction to pigment dispersion by rubbing a sample of pigment and linseed oil out on a plate with the aid of a palette knife. The smearing action of the palette knife moving over the plate, together with the pressure exerted, brings about the mechanical action usually described as "shear" which arises when surfaces are pressed together and are moving at different speeds. Shear plays an important part in pigment dispersion and can be illustrated by one of the earliest methods of pigment dispersion, that of the plate and muller. This can be regarded as operating in the three stages described below.

Premixing phase: The weight of the muller is not allowed to operate but the motion mixes the liquid and pigment, displacing some of the entrapped air.

Reduction of aggregates phase: The weight of the muller is allowed to operate, but the speed of operation is kept low. The resistance to motion gradually decreases until a more or less lubricated condition exists between the plate and muller. Aggregates are broken down, accompanied by wetting of the exposed pigment surfaces.

Completion of wetting and stabilisation: The rate of shear is increased and the full weight of the muller is allowed to operate together with manually applied pressure. This action is continued until the pigment particles are thoroughly wetted by the medium and do not re-aggregate when the shearing force is removed.

It must be explained that these three phases are by no means sharply defined, as each merges into the next. In practice, however, some milling machines, e.g. triple-roll mills, are unable to deal adequately with a pigment and medium which have not been pre-mixed into a more or less homogeneous paste form, and for this reason it is convenient to distinguish between the pre-mix stage and the milling stage. In other types of equipment, e.g. ball mills, all phases of dispersion can take place in the same machine.

In the plate and muller apparatus, the stages are all obtained by moving one surface over another with a film of material between them. The result is a shearing action within the film, and this action provides one basic mechanism of the paint milling operation.

The relative velocity of the surfaces: The shear in the film increases as the relative velocity of the surfaces is increased. Shear effect, and therefore dispersing action, is nil if there is no relative motion between the two surfaces.

The dimensions of the gap: The greater the gap between the surfaces the lower the shear action. This point can be illustrated by recalling that each surface has a molecular layer of medium adhering to it; as the gap increases the relative movement of the intervening parallel molecular layers becomes less and less, provided that the speed of the plates remains constant.

Duration of shear: In the operation of the plate and muller, the result of any shearing process must increase with time. The effects of these three factors are summarised in the equation:

$$\text{Effect varies as } \frac{\text{relative velocities} \times \text{duration of shear}}{\text{size of gap}}$$

Production methods

Production methods for pigment dispersion can be divided into the four general processes shown below.

(1) A process in which a stiff paste is produced in a heavy duty mixer, and then milled on a triple-roll mill. Preparation of the paint is completed by thinning in a separate mixer.

Raw materials ⟶ heavy duty paste mixer ⟶ triple-roll mill

(2) A similar process to (1), except that a lower consistency paste is produced in the mixer and this is ground on a single-roll mill before the final thinning procedure.

Raw materials ⟶ heavy duty paste mixer ⟶ single-roll mill

(3) A more fluid pre-mix is produced in a high speed impeller mixer, and final dispersion is carried out in a sand or bead mill.

Raw materials ⟶ high speed impeller mixer ⟶ sand or bead mill

(4) The complete dispersing operation, producing a fluid dispersion, is carried out in one machine. Where conventional pigments are involved this will be a ball mill, an attritor mill, or a high speed impeller mixer; but when surface treated, readily dispersible, pigments are used, a cavitation mixer will often suffice.

$$\text{Raw materials} \begin{array}{l} \nearrow \text{ ball mill} \\ \searrow \text{ high speed impeller mixer} \end{array}$$

In all processes, the composition of the pigment and medium mixture plays an important part in the efficiency of the dispersion process—it being economically desirable to have the pigment content as high as possible—and this will be controlled in the first instance by the oil absorption of the pigment. In processes (1) and (2), the main dispersing process is intense shear, and for this to operate effectively the vehicle must be of a high viscosity and the grinding mixture must contain the minimum of solvent. This combination of high pigment content and viscous low-solvent medium produces an almost plastic mass, which will adhere to the rolls and is ideal for the development of mechanical shear by the roller mill. On the other hand, processes (3) and (4) operate at much lower grinding consistency and, while the pigment content should still be as high as possible, a higher proportion of solvent will be present, which will aid the wetting action; shear forces are less evident and attrition also plays a part. The non-volatile content of the medium should be formulated to be sufficient to produce a stable mill base, which can then be made into the completed paint as required by further additions of medium, thinners and driers. If this is not possible, great care must be taken to stabilise the mill base by careful addition of medium immediately after the milling operation. A too-rapid addition of medium or thinners can cause re-aggregation of the dispersed pigment particles (so-called colloidal shock). This will be discussed later under ball mills.

The wide variation in the physical properties of pigments and in the wetting ability of media means that the optimum pigment: non-volatile binder: solvent ratio must be worked out by experiment for each pigment and for each type of equipment. The presence of wetting agents, such as metallic soaps, can greatly influence not only ease of dispersion, but also the pigment content of the mill base.

Manufacturing equipment

Processes (1), (2) and (3) require premixing machinery and all may require a thinning operation which is again a mixing process.

Mixing machinery

Many types of mixers are in use and the following will be considered:

fixed mixing tanks—horizontal
                                   vertical
change pan mixers
edge-runners
high speed mixers
portable mixers

Fixed mixing tanks

As these are built into a fixed position, their contents must be brought to and carried away from them. In the case of thinning tanks, they are often built in large sizes, up to 4,500-9,000 litres. In view of these factors, their siting must be carefully considered with regard to ease of both filling and emptying.

Horizontal mixers: These usually consist of a U-shaped vessel fitted with a lid which allows access to the whole of the tank. The shaft which drives the mixing blades is preferably supported on bearings outside the vessel at each end, so that only a small proportion of the stresses set up are borne by the tank body. To prevent leakage along the shaft, the ends of the tanks are fitted with glands. The driving mechanism consists of a motor coupled directly to a worm reduction gear which drives the mixing shaft through a flexible coupling. The outlet is at the bottom of the vessel and, when the mixer is used for premixing pigment and medium, this outlet is controlled by a valve followed by a short length of vertical pipe or, preferably, of inclined gutter, so arranged as to be easily removed for cleaning.

These mixers handle materials which vary in consistency from heavy pastes to relatively fluid mixes, although their use for the latter type is now rare. To obtain the maximum efficiency, the material, at some period in its treatment, should be in a relatively viscous condition. For this reason, the mixers should be rigidly constructed so as to prevent bending of shafts or blades. The glands are of the utmost importance and must be easily adjusted or repacked and contain sufficient packing to prevent the percolation of paint along the shaft. A paint containing a solvent which does pass along the shaft will reduce the lubrication of the packing and so cause scouring and undue wear of the bearings.

The blades may have various shapes, such as arrow-head or half arrow-head, and are adjusted on the shaft so that the area swept by the revolution of any blade is usually slightly overlapped by the area swept by the next blade. The clearance between the bottom of the tank and the blades should be as small as possible, and this also applies to the clearance between the end blades and the end of the vessel. The rate of revolution of the shaft is usually low, e.g. about 30 revolutions per minute, or even less. There must be an arrangement whereby, if the lid is opened when in operation, the motor is immediately switched off. If the motor is belt-driven, the lid should be locked closed when the belt shifting device is pushed over to the drive position.

These mixers are usually used for premixing paste for subsequent grinding in triple-roll or bar mills. Generally, a quantity of medium is fed into the mixer, followed by the pigment and extenders as required. Mixing continues, during which time the viscosity is maintained sufficiently high to break down as many pigment aggregates as possible; at the same time much air is forced out of the batch and, owing to the shearing action, considerable wetting ensues. The operator should examine the machine periodically to see that all the batch is kept in motion, and any stagnant portions should be scraped into the moving mass of the batch. Some thinning may be necessary, depending on the plant to be used subsequently; in this case additional medium is added slowly to produce the required consistency and mixing is continued until homogeneity is achieved. In order to feed the subsequent plant with material which requires the minimum amount of additional milling, this premixing operation should not be hurried. It is usual to provide two mixers to keep the second-stage mill fully occupied.

Z-blade mixers (see Chapter 3): These comprise a horizontal trough in which are two powerful contra-rotating Z-shaped blades which intermesh deeply and which rotate at different speeds. The base of the trough is contoured to coincide closely with the blades. For efficient operation, the charge must be of heavy consistency, so that a very high degree of shear is imparted by the blades, breaking down aggregates and ensuring thorough wetting. The shear effect can be further increased by completely enclosing the charge by a hydraulically controlled cover. Pigment dispersions in high viscosity cellulose nitrate solutions are often made in this type of machine.

Provision is made for the trough to pivot round the driving shaft so that the contents can be discharged by tipping. Although access to the whole interior of the vessel can then be obtained, cleaning prior to use for another colour is not easy, as it is difficult to remove completely traces of colour from some parts of the machine.

Particular care is necessary when loading the mixer. The liquid is put in first, and it is an advantage if the pigment can be added while the machine is running. This can be done by feeding the pigment through a grill in the cover, but never with the cover removed; the mixer, in fact, should always be fitted with a device which stops the machine if the cover is opened, as with conventional horizontal mixers.

The pigment should be added slowly, allowing each addition to be absorbed into the medium before the next portion is added. When all the pigment has been added, the mill is stopped, scraped down and then run again until dispersion is complete. Further reduction with medium to the consistency required for the next stage must be slow, otherwise a lumpy paste will result. With some pigments of high oil absorption, particularly organic pigments, the initial dispersion frequently results in rapid thickening; this must be corrected by slow addition of medium.

Vertical mixers: These are usually used as thinning mixers and consist of a cylindrical tank whose height is 2 to 2½ times its diameter. A central shaft is driven either from the top or bottom of the vessel; in the first case the blades are arranged either at the bottom only or at various distances up the shaft. The details of the design depend on the material to be handled. For instance, if the material to be thinned has high viscosity, the blades should be arranged to scrape the bottom and sides; if the viscosity is relatively low, a single well-designed blade at the bottom of the tank will produce vortex-like motion in the charge up the side of the tank and back into the rapidly moving area around the blades. If, however, the final viscosity of the charge is not to be low, a shaft having a number of propeller type blades fixed over its length is necessary, and the tank should be fitted with a number of baffles between them to stop rotation of the charge as a whole. Again, the shaft is best driven through a worm gear coupled directly to the shaft of the mixer. It should operate at fairly low speeds, of the order of 40-120 r.p.m., depending on the size of the vessel. The drive for the worm gear is preferably provided by a directly coupled motor, or by belt with fixed and loose pulleys. On very large thinning and tinting tanks, there is a tendency for splashes to form drips on the top plate and these eventually lengthen into stalactites. This tendency can be obviated by a light blade attached to the shaft with a small clearance between it and the top plate.

In order to obtain complete drainage when emptying, it is advisable to provide the tank with an inwardly dished bottom, and to fix the outlets as near as possible to the joint between the side and bottom.

The tank can be suspended from a higher floor or structure, or may be supported by a structure from the floor below. Access is necessary for inspection and the introduction of medium, thinners, tinters and driers. Cleaning may be difficult if arrangements are not made to facilitate it. At least two manholes should be provided in the bottom of the tank to allow scraping and removal of the material from the tank.

This type of equipment is very widely used for mixing, tinting and thinning of the finished product prior to the filling out operation. It is not effective for handling dry pigment for pre-mixing operations. A disadvantage is that flow takes place mainly in a horizontal plane, so that when additions of thinners or stainers are made, it may take a considerable time for uniformity to be obtained.

The second type of vertical mixer is that in which there is some form of turbine agitation; the liquid is drawn into the centre of a fairly high speed impeller and is centrifugally pumped away from the edge. This method has the advantage that the equipment is usually of much lighter construction, since a gearbox is not generally required, and the circulation is mainly in a vertical direction, thus giving more rapid uniformity of mix. It is also suitable for the incorporation of solids, since considerable shearing forces exist on the periphery of the impeller and these will assist the breakdown of lumps and aggregates as well as promoting wetting. The disadvantages are that the power requirements are usually higher and, especially in large vessels, difficulty may be experienced if high viscosities and/or thixotropy are encountered.

Change pan mixers

The advantage of this type of mixer is that the pan can be mobile, e.g. fitted with wheels or with lugs for lifting by fork lift; when in position the pan is supported by the floor or base of the mixing machine. Many types are available, as shown below.

Heavy duty: With this type of machine, e.g. Keenomix, the container is clamped to the frame of the machine and the mixer comprises two contra-rotating blades which also sweep round the pan by means of a planetary action. Normally, there is also a scraper blade to clear the material from the sides of the container and a dust hood. To obtain good results with this type of equipment, it is necessary to carry out the operation at a very heavy consistency, following the general procedure detailed under Z-blade mixers, and the letdown to a paste of milling consistency must be done very slowly with small additions of medium in order to avoid lumping. After the operation, the mixing head is raised in order to permit removal of the pan, which is generally mounted on wheels. This type of equipment is normally only used in the premixing of pigments and media prior to roller milling.

Light duty: There are very many machines of this type, in which there is an agitator blade or paddle, mounted on a shaft which rotates at a moderate speed. Provision is made for the paddle to be raised both for removal of the container and also in order to vary the height of the blade during the mixing operation. This type of machine is tending to be superseded by high speed equipment.

High torque dispersers: A modern version of the heavy duty paste mixer is exemplified by the Mastermix High Torque Disperser. This machine consists of a vertical shaft on which is mounted an open type of propeller agitator or "Trifoil" blade; it is arranged either with gearing so that speeds may be changed, or, as with the machine illustrated (Fig. 14), with a variable high speed drive. Speeds can vary from 0–400rpm. Container clamping must be absolutely rigid and this is effected by hydraulic means.

With a mixture of very stout consistency, the machine develops intense shear and provides a quick and versatile method of premixing for triple-rolls and other machines. Charging procedure follows the general pattern noted under Z-blade mixers.

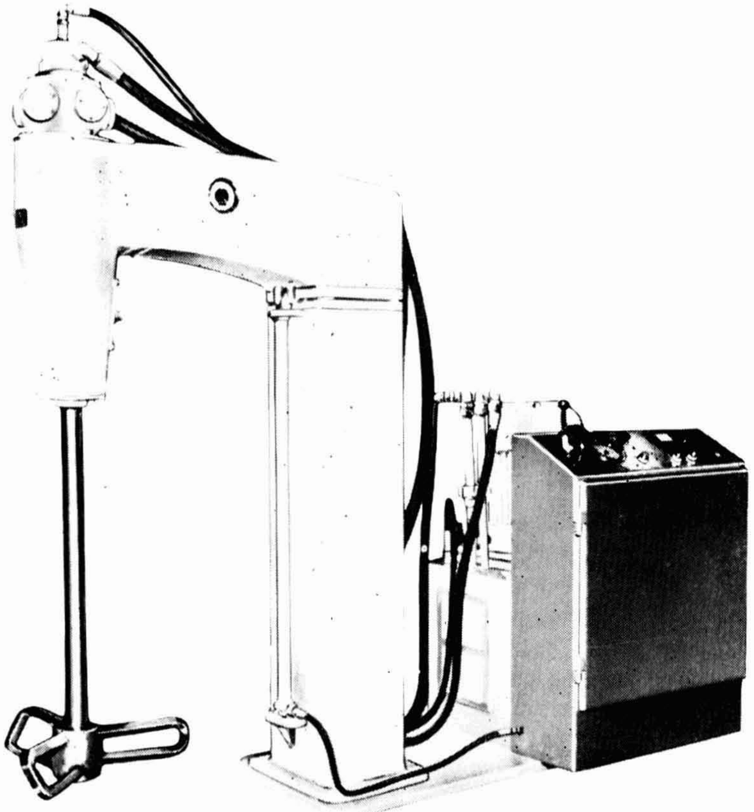

Fig. 14. High torque disperser (courtesy of Mastermix Engineering Co. Ltd.)

Edge runners or pan mills

These mills have been used extensively as pre-mixers, and are also used as finishing mills for products where only a moderate degree of pigment dispersion is required, e.g. oil based fillers, putty and some water paints.

On examining the action of this type of mill, it will be seen that some aggregates may escape any action at the low rates of shear operating, and it must be followed by further milling to complete dispersion. Its use as a pre-mixer is now rare, as it occupies considerable space, output is low, and labour costs high.

The machine illustrated in Fig. 15 consists of a shallow pan, accurately machined so that the clearance between the scrapers and the sides and bottom of the pan remains constant and small. A vertically driven shaft in the centre of the machine rotates an arm at right angles to a heavy roll capable of rotating on it. The roll is also driven either by teeth on it engaging with a fixed gear bolted to the centre of the pan, or by a series of gears driven through a hollow shaft surrounding the centre shaft that revolves the roll arm. The arm is rotated faster than the normal rolling speed of the roll and the result is to produce a shearing action between the pan and the roll, first by the difference between the

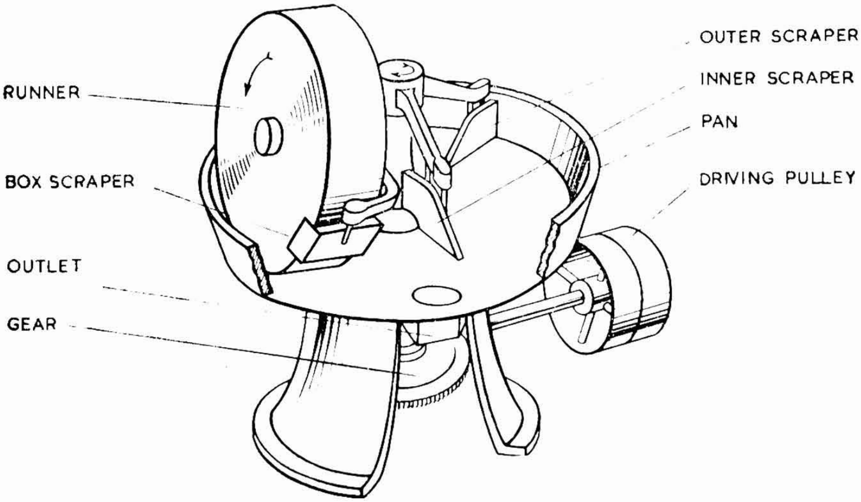

Fig. 15. Edge runner or pan mill

speed of the surface of the pan and that of the roll surface, and secondly by the twisting of the roll on the surface of the pan when following its circular path. Two scrapers are attached to the rotating arm; one in front of the roll turns the charge from the outer edge of the pan into the path of the roll, and the other follows the roll, turning the charge from the inner edge of the pan into the path of the roll, during its next rotation. Complications in the design are introduced by the necessity of allowing the roll to ride over agglomerations of pigment on the pan bottom during the early part of the milling operation. The driven can be a direct motor type or by fast and loose pulleys.

The method of operation of the mill is to load it with part of the liquid medium and to add slowly the solid components of the batch. Small amounts of liquid are added as required to produce a stiff paste, until the milling operation is complete. It is important to keep the paste stiff at this stage. Thinning is effected by slowly adding the necessary liquid media. Edge runners were largely used in the manufacture of water based distempers, where fine dispersion was unnecessary, but with the disappearance of this type of product their use is declining.

High speed mixers

Shrouded head: There are many machines of this type available, such as Greaves, Silverson and Ultramix, which are used for many different manufacturing operations. The basic design is a small bladed impeller running at high speeds, which acts in the same way as a centrifugal pump: the material is drawn into this impeller and expelled through a series of slots or holes in a fixed stator which surrounds it. Intense shearing and mixing forces are set up by this action and the machines are used for many diverse operations, such as tinting, pre-mixing, cold cutting of resins and actual dispersion of selected pigments. They are best used in low viscosity systems, as when either high viscosity or thixotropy are encountered they are usually found to be somewhat ineffective. Typical of this type of high speed mixer is the Silverson machine illustrated in Fig. 16, together with a mobile hydraulic floor stand.

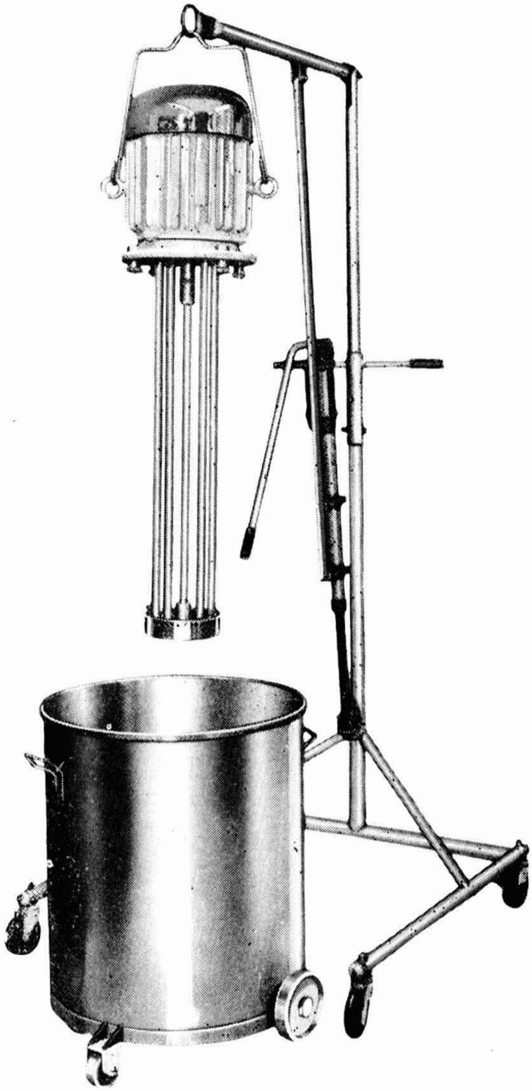

Fig. 16. Silverson High Speed Mixer with mobile hydraulic floor stand

The Silverson machine is supplied with a number of interchangeable working heads designed to deal efficiently with such processes as mixing, dissolving, emulsifying and pigment dispersion. The disintegrating head is recommended for the latter purpose. For example, a 50 gallon mill base in a suitably sized container would require a 10hp high speed Silverson mixer fitted with a draught deflector plate and flame proof motor. The draught deflector plate deflects the draught from the motor fan upwards to avoid disturbing the dry pigment.

A downthrust propeller is fitted on the shaft carrying the working head, about six inches below the surface of the medium when loaded into the container. The function of the downthrust propeller is to pull the pigment quickly below the surface of the medium; it also pulls the mix away from the periphery of the vessel towards the rotating shaft. The required amount of medium is fed into the container; the medium may have a non-volatile content of 30–60 per cent, varying with the binder and the pigment to be dispersed, and is adjusted to have as high viscosity as possible consistent with adequate flow at the operating temperature. The head is positioned about 12 inches above the bottom of the container and the machine run for a few minutes to warm up the medium and reduce its viscosity. The pigment is fed in as quickly as it is drawn into and wetted by the medium. When all the pigment has been added, the machine is stopped and the sides of the vessel and the shaft of the mixer are cleaned down with a brush wetted with solvent. The mixer is then run for 10 to 20 minutes and the progress of dispersion followed with a fineness-of-grind gauge. When dispersion is complete, further resin solution and solvent are added to complete the mix.

The whole operation of loading, dispersion, completion and cleaning can be completed in about 60–90 minutes, thus providing a rapid, flexible and

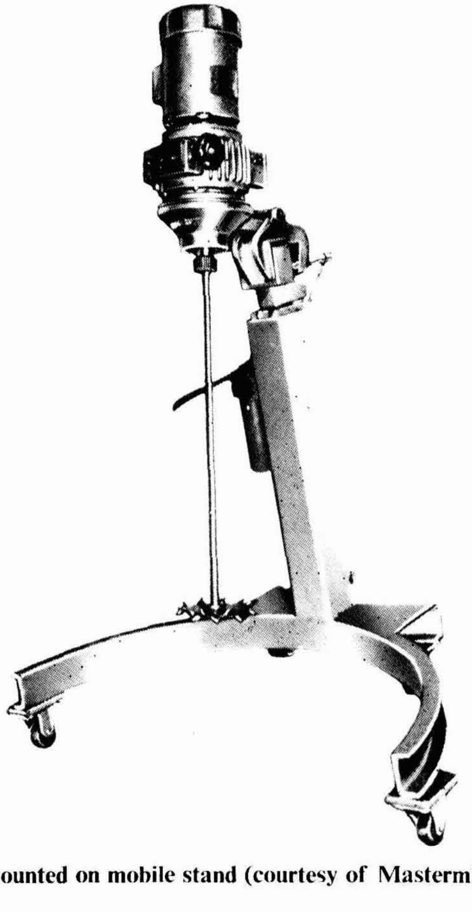

Fig. 17. Portable mixer mounted on mobile stand (courtesy of Mastermix Engineering Co. Ltd.)

economic method of paint production applicable to easily dispersible pigments, such as certain grades of titanium dioxide, micronised pigments and the specially produced easily dispersible pigment-dyestuffs now available.

Saw tooth turbine or cavitation mixers: These are frequently used for mixing operations in all types of material, from the preparation of heavy pastes to the tinting of finished paint. Detailed consideration will be given to this equipment in the section on paint milling machinery.

Portable mixers

Portable mixers contain a drive unit, usually operated by an electric motor, although pneumatic motors are sometimes used, which can be attached to a container or suitable support by means of a clamping arrangement. They are provided with a shaft fitted with either propellers or turbines, provision usually being made for easy removal of the shaft by means of some form of quick release coupling. High, low and variable speed units are available, modern practice tending to favour the high and variable speed types. Properly used, they can be very versatile since, by means of change of shaft and/or impellers, a wide variation in size and type of product can be handled, and there is therefore a tendency for this type of equipment (Fig. 17), to supersede the traditional change-pan mixer.

No text has been printed on this page in order that reprints of the extracts from Part Seven of the Paint Technology Manuals may be run-on at the time of printing this issue of the Journal. It is intended at the end of the year to collate and bind these extracts and to offer them for sale. Registered students of the Association will be able to purchase one copy each at a considerably reduced rate.

Midlands Paint Students' Association*

Cost effectiveness in automobile painting

The first meeting of the 25th year of the association was held on 10 February 1972. It took the form of a lecture presented by Mr J. Humphreys of Pinchin Johnson Associates Ltd entitled "Cost effectiveness in automobile painting".

The lecturer started by explaining the high fixed cost of a car body paint shop. He showed that this cost was shared by the number of units produced and that, when production was increased up to a maximum, the cost per unit decreased markedly. He then explained how production could be maximised by shift working, staggering lunch hours and abolishing tea breaks, the extra floating relief men required being more than compensated for by the increased production. Much maintenance and cleaning could also be carried out during production: a rejected car body cost about £1.70 to repair, whereas a gap in the track cost £10.00.

By these means production could be increased by 20 bodies per shift or 10,000 per year—at a saving of 40p per body. If production was maximised at 160,000 per year this amounted to £60,000.

Mr Humphreys then itemised variable costs per car, highlighting expensive processes such as electro primer, surfacer, wet sanding and repair, or "hospital," treatment. He discussed each process in turn, showing where waste occurred and when cost savings could be made without reducing quality.

He claimed that more warranty complaints were made against resprayed areas on a car than on bodies passed first time with surface defects. Respray areas were also much more likely to deteriorate during service.

The lecturer concluded by looking briefly at possible future trends and then undertook to answer a variety of questions which were put to him.

D.B.

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*Editor's Note: Although the Midlands Paint Students' Association is not connected directly with OCCA, many OCCA Members have come up through its ranks. In order to encourage the students, in accordance with OCCA's policy of involvement in education in the industry which led to the institution of the Professional Grade, and in order to strengthen the ties between the two Associations, it has been decided that the proceedings of the Students' Association will be published in *JOCCA* from time to time. This is the first to appear, and it is hoped that more will follow in the near future.

MPSA meetings are held on the second Thursday of each month. For further details contact the Hon. Secretary, Mr D. Ballett, Pinchin Johnson Paints, PO Box 359, Rotton Park Street, Birmingham 16.

Information Received

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

A new eight-page brochure now available from **Dow Corning** illustrates the user benefits, durability and long-term economics of the use of silicone based maintenance paints. A wide range of examples is recorded emphasising these paints' better protection against weather and corrosion.

A new oil modified polyurethane alkyd suitable for rapid-drying enamels requiring high standards of durability, toughness and colour retention is announced by the Surface Coating Resins Division of **Synthetic Resins Limited.** To be marketed under the trade name *Beckurane 502*, the new resin is recommended for use in formulating enamels and varnishes for household, machinery and marine applications and is particularly suitable for floor varnishes and the coating of kitchen furniture. Having infinite tolerance to white spirit and good compatibility with long and medium oil length alkyds, it is claimed that *Beckurane 502* can also be used effectively to upgrade the drying and hardening properties of conventional decorative paints and varnishes.

Ault & Wiborg Industrial Finishes Ltd. has published a new leaflet covering the systems and substrates applicable to *Peridite* solvent free epoxy coating. The leaflet describes the properties of *Peridite* and defines the typical fields of application and the various methods by which this can be achieved.

A new resin has been added to the **Cray Valley Products Ltd.** range which is claimed to be a completely new concept in resin technology. *Synolac 99W* is a structured alkyd, having the combined advantages of conventional and thixotropic alkyds. It is claimed to show significant advantages over existing Newtonian decorative media in terms of application and brush transfer, with no pigment settlement and no thixotropic gel formation even at low temperatures. Unlike thixotropic alkyds, *Synolac 99W* does not require storage at elevated temperatures, but should be treated and handled as a conventional long oil alkyd.

It has recently been announced that the **English China Clays** group of companies has acquired the assets of the **Queensgate Whiting Company Ltd.,** and the fine whitings made by Queensgate will now be marketed by English China Clays Sales Co. Ltd.

A new film starring *Magicote* and entitled "In a class of its own", has been released by **Berger Paints.** For distribution to housewife and dealer audiences, it tells the story of a classroom, in which a boisterous class of schoolchildren learn a very practical lesson in the use of colour. With the help of their teacher, a visiting professional painter and *Magicote* paints, the children transform their classroom from a drab, depressing room into a world full of colour. The 16mm film is in colour and lasts for 20 minutes. Produced by **Illustra Films,** copies are available for showing to group audiences on request from Berger Paints Services.

Bayer Leverkusen has developed a new type of antifoaming agent, known as *Antifoam DNE*, which will complement the range of organic and *Baysilone* antifoams for the most varied fields of application. This new product is chiefly intended for the processing of solutions containing surfactants, though it has many other uses, among which aqueous plastics dispersions in the paper, paints and adhesive industries rate as particularly important. *Antifoam DNE* has also proved successful when working with media containing wetting agents and emulsifiers in the metal and chemical industries, as well as in sewage processing.

Xyladecor, a decorative, water repellent wood preserving stain, is now being made under licence in Britain at the **Carson/Hadfield** paint plant at Mitcham, Surrey. Formerly, this product was imported direct from West Germany. *Xyladecor* itself provides protection against wood-rotting fungi, wood-boring insects, mould and blue stain. Because it does not form a surface coating, it cannot crack or blister. It costs less than the normal paint systems and thus reduces maintenance costs.

A major reorganisation of **Sanderson's** wallcoverings manufacturing and merchanting operations has recently been announced by the company. It is planned to transfer these sections of the company's activities to better facilities at Uxbridge, Christchurch and Gosport during the next twelve months following substantial losses incurred at Perivale over the past few years. Between now and April 1973, the manufacture of all Sanderson vinyls, gravure printed wallpapers and laminates is to be transferred from Perivale to the Christchurch factory of **Shand Kydd Limited,** a Sanderson company, which is already well established in this field. The manufacture of Shand Kydd wallcoverings will continue as at present. In addition, the *Crown* wallcoverings factory at Gosport is now part of Sanderson and during the ensuing twelve months the production of all Sanderson surface printed, flock printed and duplex wallcoverings currently carried out at Perivale will be transferred to this factory which will then cease to issue any further Crown collections. During the same period, Sanderson's merchant activities and the company's headquarters are to move from Perivale and will be accommodated in space available at the Uxbridge site of Sanderson Fabrics. The Perivale design studio is to be relocated at Gosport and the Sanderson, Crown and Shand Kydd wallcoverings export department will be centralised at Christchurch. The large majority of people currently employed on Sanderson's Perivale merchanting activities are to be offered jobs at Uxbridge and it is also the company's intention to offer alternative employment to other Perivale personnel wherever possible at Uxbridge, Christchurch and Gosport.

Elcometer Instruments Ltd. has announced that it has been appointed agent in the UK for the *Taber Abraser*. Manufactured by **Teledyne Taber** of New York, the *Model 503 Abraser* is a durable precision built test instrument designed to evaluate the resistance of surfaces to rubbing abrasion. Its range of application includes tests of painted, lacquered, electroplated and plastic coated surfaces as well as textile fabrics (ranging from sheer silks to heavy upholstery), metals, leather, rubber and linoleum. Tests performed on the *Taber Abraser* have been accepted as standard by the automotive, aircraft, chemical, textile, paint and other major industries both in the USA and other countries.

Elcometer has also been appointed exclusive agents in the UK for **Deltron Instruments** of Sydney, Australia, who specialise in the manufacture of moisture meters.

In recognition of significant developments, **Kollmorgen's Color Systems Division** has been awarded the US Government Patent covering the automatic correction of spectrophotometer 100 per cent line by digital or computer storage of correction factors. This feature has been embodied in all the recent Kollmorgen spectrophotometer/computer system developments such as the *KCS-15/34*, *KCS-18/35* and *KCS-40*, enabling these systems to achieve the highest absolute accuracy obtainable in colour measurement.

A decision to proceed with construction of the first phase of a new multi-million dollar complex for the manufacture of *Freon* fluorocarbon products near Corpus Christi, Texas, has been announced by **Du Pont.** Plans call for construction in several stages, which will combine to be the world's largest fluorocarbon facility. The initial stage is designed to produce about 500 million pounds (250 million kilograms) of chemical intermediates annually. When completed, the plant will supply a full range of *Freon* fluorocarbons. The new plant will incorporate the most advanced technology for environmental control. Plans have been reviewed by the Texas Water Quality Board and were submitted to a public hearing in April.

Bakelite Xylonite Limited has published a new and comprehensive guide to its products and services. The entries are alphabetically indexed and keyed to the company's nine divisional sources. Full address details of all BXL factories and sales offices are included with an outline of the company's principal markets. Brief historical details and a selection of trade names are also featured. Copies are available from BXL on request.

The **Chemorphic Art Institute** has announced a new phase of its investigations into chemically evolved artistic works. The current programme combines metallic particles with specially modified polymer paint vehicles. An elegant effect is being achieved and has caught the attention of numerous commercial firms. A report has appeared in P/M Technology, published by the American Powder Metallurgy Institute, and copies are available from Chemorphic.

Two new technical bulletins have been issued recently by **Nopco Hess Ltd.** These are entitled "*Nopco Foamaster P* defoamer for polyvinyl alcohol" (Nopco Technical Bulletin PAD-19), and "*Foamaster T-2* defoamer for latex tint bases and paints" (Nopco Technical Bulletin PAD-3). Nopco has also introduced two new products, a defoamer claimed to provide efficient foam and froth control in all phases of synthetic latex manufacture, known as *Foamaster VL*, and a new highly concentrated alkyl naphthalene sulphonate, *Sellogen W*, an addition to the firm's line of highly stable anionic wetting agents. At the same time, Nopco has announced that its *Sellogen HR-90* wetting agent, formerly only in powder form, is now available in slurry form as well, for use in liquid systems. Nopco also manufactures *Sellogen HR*, available as a powder.

What is claimed to be the first ever non-drip polyurethane varnish has been developed for marketing by **Carson Paripan Limited.** Sold under the *Super Plus* brand name, this new varnish complements Carson's existing range of non-drip products. Carson's *Super Plus Polyurethane Varnish* has a high gloss finish and contains silicone for greater dirt resistance. It is claimed to be a tough, chip resistant varnish which is easy to apply. The new product is aimed mainly at the DIY market and can be used for all surfaces normally treated with standard varnish. It is available in 500ml cans only.

Bristol

Degradable polymers

A meeting of the Bristol Section was held at the Angel Hotel, Cardiff on Friday 25 February 1972. The speaker for the evening was Professor E. M. Evans of BP Chemicals International Limited, who spoke on "Degradable polymers."

Professor Evans began by stating that the interest in developing degradable polymers was primarily concerned with their potential use as packaging materials to replace polyethylene, polypropylene, polyvinyl chloride etc., which were very resistant to natural or biological degradation. It had been estimated that some 3,000 tons of plastic packaging material was discarded annually in the UK as litter. It was this litter that ecologists wished to be made completely degradable—collected waste could be used for land-filling or could be incinerated. Professor Evans then reviewed the current situation regarding degradable polymers in terms of attack by solar radiation combined with oxidation or attack by micro-organisms. Various workers had shown that polymers containing carbonyl groups were prone to attack by UV light leading ultimately to chain scission, particularly when hydrogen atoms were near the carbonyl group. Other groups could contribute towards degradation e.g. nitrile groups, ester groups etc. Various manufacturers were attempting to produce packaging materials containing such groups in the polymer structure. The use of additives that absorbed UV light, converting it to chemical energy which resulted in radical formation leading to polymer degradation, was also under investigation.

Biological degradation was concerned with attack by micro-organisms, which tended to be extremely specific in the choice of substrate that they might attack. Straight chain paraffins were preferred to branched chain structures and those containing ten carbon atoms were further preferred. Polymers containing chlorine tended to be resistant to this form of degradation.

Following this lecture, the possibility of toxic by-products arising from degradation and the adaptation of micro-organisms to new substrates were among questions that were considered. Finally a vote of thanks was proposed by Mr F. E. Ruddick and warmly supported by all present.

T.I.P.

Manchester

Future trends in the printing and communication industries for the seventies

A joint meeting with the North Western Branch of the Institute of Printing was held at the Royal Institution, Liverpool on Thursday 9 March.

Mr H. Sander of the Bonnier Group presented his lecture to some 80 members and guests.

Mr Sander based his lecture mainly on information from "Comprint 90" produced by the Battelle Memorial Institute.

Using slides of about 16 different tables showing rates of growth for gross national product, commercial printing, then on to the more detailed figures for printing inks usage in the USA and Europe, Mr Sander proceeded to analyse the effects of new techniques on the likely growth of printing inks.

Mentioning driography, solid state inks, colour scanners, inks for magnetic and optical scanners, electronic imagery, jet printing and direct lithography, he suggested that further development in these fields would require a tremendous amount of research work and therefore the ink industry, at least in Europe, would have to merge and co-operate with the big chemical firms in order to finance it. A really big change in the structure of the ink industry was therefore to be expected and at the end of the seventies only the big plants would survive, whilst increasing use of no-contact printing methods would eliminate part of the traditional ink industry.

In particular, jet printing, electrostatic printing, and cathode ray printing, were three interesting examples of no-contact printing methods with big potential for development.

Mr Sander also suggested that, in the 1980s, non-print methods of presenting information would increase their share of the communications industry market.

In conclusion it was stated that the graphic arts industry had had a normal rate of growth between 1960-1970, but real new technical developments within the industry during this period had been infinitesimal. During the seventies fast technological developments would apply here as for all other industries. This would be a great challenge to the industry to find its new role within the big complex of communications.

A lively question time followed and Mr F. Courtman proposed the vote of thanks which was enthusiastically received.

A.MCW.

Midlands

The changing structure of the paint industry

The 156th Meeting of the Midlands Section took place at the Birmingham Chamber of Commerce and Industry on Friday 18 February 1972, with 23 Members present.

The Chairman for the evening, Mr D. J. Morris (Past section chairman), introduced the speaker, Mr D. E. Eddowes, Editor of "Polymers, Paint and Colour Journal" who gave a lecture entitled "The changing structure of the paint industry."

Owing to a power cut the lecture was commenced in candle light until full power was restored after ten minutes.

Initially, Mr Eddowes discussed the build-up of the paint industry until the 1950's, with an emphasis on the period between the two world wars when consumer durables, and the car industry, rapidly expanded.

The early 1960's saw the industry rationalising, Bergers with Jenson and Nicholson being a typical example. There were acquisitions such as Pinchin Johnson and Associates by Courtaulds, and then the merger of PJA with International Paints Ltd., in 1968.

A list of the top twelve companies in the UK was shown, illustrating their turnover and profitability as closely as it was ascertainable. Mr Eddowes explained the table in some length discussing the various growth rates, and comparing them with European Economic Community.

The insight the lecturer gave into the surface coatings industry in Japan was most illuminating. The industry began in 1884 when Komeisha Co. (now Nippon Paint Co.) commenced manufacture of paste and ready mixed oil paints in Tokyo. By 1924, the parent bodies of seven companies had been formed, and these now formed the basis of the three largest companies in Japan.

Although some 27 major coating manufacturers accounted for 60 per cent of the USA's paint industry, it was believed that, altogether, there were some 1,500 concerns within the industry. Sherwin Williams stood out as the largest. The USA paint sales for 1970 were totalled at 2,753 million dollars.

With regard to the future, it was felt that large groups would dominate the mass market, but specialised fields would remain the preserve of the small, more flexible, companies.

The interest and complexity of the subject was shown by the number of questions from the floor, which helped to promote further discussion. The Chairman finally closed the meeting by calling upon the Honorary Secretary, Mr D. E. Hopper, to give the vote of thanks.

D.E.H.

Newton Friend Lecture: antique silver

The 157th meeting of the Midlands Section was held on Friday 17 March 1972 at the Birmingham Chamber of Commerce, with the Chairman, Mr H. J. Griffiths, in the chair. This was the annual J. Newton Friend Lecture to which the ladies were invited as guests. The Section was honoured to receive Mrs Newton Friend for the evening.

The speaker on this occasion was Mr I. Tarratt, FGA, Chairman of George Tarratt Limited (Goldsmiths) of Leicester. Mr Tarratt presented a fascinating lecture on the subject of antique silver, dealing in particular with the period from 1660 to 1810. This period, covering the time from the restoration of the monarchy to the start of the Victorian era, was described as the greatest period for design in English history.

This country was unique in having a very high purity standard for silver, set by a statute as long ago as the year 1300; the standard of 925/1000 silver by weight was required for all silver sold in the UK.

Mr Tarratt covered the effect on designs and quality of changes in the political climate, of immigration of various nationalities into England and of the fashions set by the aristocracy of the times. He also mentioned the methods used by fraudulent antique dealers and the methods of detecting a fraud.

The lecture was well received, as was evidenced by the amount of questions from the floor. A vote of thanks was proposed by Mr D. W. Lovegrove and the Chairman closed the meeting.

R.J.K.

24-OCCA Technical Review

Lord Ironside opening the exhibition, watched by (left to right) Mr F. Cooper (Chairman, Exhibition Committee), the President, Mr A. W. Blenkinsop, and Mr R. H. Hamblin (Director & Secretary)

24-OCCA overcomes difficulties

The Twenty-Fourth Annual Technical Exhibition of the Oil and Colour Chemists' Association (24-OCCA) was held at the Empire Hall, Olympia, London, from 17-21 April 1972 and, despite many difficulties, was of such benefit to exhibitors, who were drawn from 12 overseas countries, that many have already stated that they will be exhibiting at the Silver Jubilee Exhibition (25-OCCA) in May 1973.

The opening day coincided with the work-to-rule on the railways which, coupled with the problems of finding car parking space in London and a work-to-rule on a national airline, made travelling to the Exhibition extremely hazardous. These conditions persisted throughout the week and the total attendance was naturally lower than previously, there being 8,500 recorded at the turnstiles. Nevertheless, visitors from 33 overseas countries were represented in the Visitors' Book at the Information Centre: Australia, Austria, Belgium, Brazil, Canada, China, Czechoslovakia, Denmark, Finland, France, Germany, Greece, Holland, Hungary, Iraq, Ireland, Italy, Japan, Kuwait, Malta, Mexico, Morocco, New Zealand, Norway, Poland, Portugal, South Africa, Spain, Sweden, Switzerland, Turkey, United States of America and Yugoslavia.

Exhibition Luncheon

On the opening day, the Exhibition Luncheon was held at the Savoy Hotel, prior to the opening ceremony by the Guest of Honour, Lord Ironside, Vice-President of the Parliamentary and Scientific Committee. A large number of members, exhibitors and visitors gathered for the occasion, but once again the Association had to contend with a problem, since it was unfortunate that the date of the Parliamentary and

Scientific Committee's Annual Luncheon, which is normally held in February and attracts a number of representatives from scientific societies, was recently changed so that it clashed with the Association's Luncheon.

In his Address of Welcome, the President of the Association, Mr A. W. Blenkinsop, pointed out that, owing to the restricted dates available at Olympia, only ten months had elapsed since 23-OCCA in June 1971 and it had been expected that some firms might, in this shorter-than-usual time, have experienced problems in complying with the regulations of this unique annual display of technical developments by technical personnel for technical visitors. The Exhibition Committee was, therefore, gratified by the way in which they had found support, not only from exhibitors at 23-OCCA but from 14 companies which had not shown at previous OCCA Exhibitions.

For future years, the same situation is unlikely to occur, since the Committee wishes it to be widely known that, following the Silver Jubilee Exhibition in May 1973 (25-OCCA), the Empire Hall, Olympia, has been booked for April 1974 (26-OCCA) and April 1975 (27-OCCA). Full details of next year's Exhibition will be sent to those already on the Association's list of exhibitors, but any organisation wishing to have details of the first Exhibition after Great Britain is expected to become a member of the European Economic Community should write immediately to the Director & Secretary of OCCA.

In his reply to the Address of Welcome, Lord Ironside congratulated the Association on its achievements and referred to the importance of the application of advanced technology to solving industrial problems. His speech, which contained points of direct concern and interest to the surface coating industries for whom the Annual Exhibitions are arranged, was received with acclamation by those present. After performing the Opening Ceremony, Lord Ironside made a tour of the Stands at the Exhibition, accompanied by the President, the Chairman of the Exhibition Committee, Mr F. Cooper, and the Director & Secretary, Mr R. H. Hamblin.

The Exhibition

Like many other exhibitions, OCCA suffered from the present economic difficulties affecting the chemical industry both at home and abroad, and nothing demonstrates more clearly the strength of the Exhibition and the necessity of maintaining the high standard of this annual event than the way in which it was able to overcome one problem after another on this occasion.

Visually, the Exhibition presented an attractive picture. The red and blue of the facias made for a colourful display, and the stand designers successfully produced interiors that matched or co-ordinated with the colours to produce a bright, cheerful show.

On the technical front, there was much of interest. The 14 companies that had not shown previously naturally had new materials and information for the visitor, and in some cases injected an entirely novel line of thinking into the technology of the coatings industries. A further increase in the number of in-store tinting machines shown, a trend noted last year, may point to things to come in the decorative field.

Most of the more familiar exhibitors introduced new products, or further technical data on established lines. A general appreciation of the current state of awareness of ecological problems in the industries was apparent, and several products and modifications designed to combat pollution were on view. Ingredients for newer types of formulations, particularly powder coatings and thixotropic paints, were prominent, many of these being additives, which had a higher proportional representation than is often the case.

An endorsement of the technical quality of the exhibition—perhaps allied to a slight change of emphasis—may be seen in the fact that several seasoned exhibitors reported an increase in the number of enquiries received on the stand compared with past years—and this in spite of the fact that overall attendance was slightly lower. The change of emphasis is due to the fact that the Association made special efforts to increase the publicity sent to people in industries on the periphery of its major fields, notably to the plastics, rubber and dyeing industries. It is felt that this brought in a large number of new visitors who were perhaps a little less aware of the technology than regular attenders, and who took full advantage of the technical back-up supplied by personnel on the stands.

Technical Education

The theme of the Technical Education Stand was pigments, and plaques described the chemistry and structure of eight of the most important pigment categories. Samples of pigments in each category were displayed. Several parties of sixth formers from nearby schools attended 24-OCCA, and their interest in the paint industry was certainly aroused by the stand and the lectures given to each party by Mr G. H. Hutchinson. Staff from the various technical colleges in the London area manned the stand, and were able to advise on suitable courses for students wishing to enter the industries.

A useful adjunct was the display showing the progressions and entrance requirements of the Professional Grade, which appeared on the Information Centre.

The theme of the Technical Education Stand was pigments

Research Associations

Under the title "Service to industry—today and tomorrow", the PAINT RESEARCH ASSOCIATION showed the results of a number of research contracts undertaken by the PRA for national and international bodies. A number of instruments had been developed as a result of this work, including a wood porosity meter that can be used on site to identify wood with a porosity too high for exterior use, a paint levelling blade that enabled the flow of brushmarks to be assessed quantitatively, and a fungal test cabinet for assessing the resistance of paint films to fungal attacks. Other interesting contracts described included work on the use of sugar as a resin intermediate, sponsored by the International Sugar Research Foundation, and investigations of flame sprayed zinc and zinc rich coatings for protection of structural steelwork.

Technical journals and services

The three journals other than JOCCA that serve the paint industry, PAINT MANUFACTURE, PIGMENT & RESIN TECHNOLOGY AND POLYMERS, PAINT & COLOUR JOURNAL, were again represented. The two latter have recently changed their names from Paint Technology and Paint, Oil and Colour Journal respectively; in changing, PPCJ has gone from weekly to fortnightly publication.

THE SOCIETY OF DYERS AND COLOURISTS showed the third edition of its Colour Index, a comprehensive work classifying all commercially available homogeneous dyes and pigments, with application and fastness properties, chemical constitutions and methods of preparation. The third edition was published earlier this year.

The METRICATION BOARD was present as a service to visitors, particularly in view of the recommended metrication of the paint industry. Leaflets describing the agreed recommended metric containers to be used were available, as was printed information on all aspects of the metric system. Advice was available from trained personnel on any problem not covered by the leaflets.

Extenders

Special Extender SE, a new natural mineral extender composed of a mixture of hydrated magnesium silicate combined with calcium magnesium carbonate, was introduced by BROMHEAD & DENISON LTD. Only known to exist in Austria, the mineral is mined and processed by TALKUMWERKE NAINTSCH, and supplied in standard, micro and super grades. Having a plate-like crystal structure, the extender is claimed to impart improved weather and scrub resistance in emulsion paints, as well as having good whiteness, hiding power and brightening capacity. Its low water soluble content was stressed as an advantage in anticorrosive finishes.

CROXTON & GARRY LTD showed its range of finely ground and classified calcium carbonates, including a number of new grades. The use of the new finer grades, Omyalite 90 and Hydrocarb 90 and 90T (coated) in emulsion paints was recommended, particularly for replacement of TiO_2 in high PVC formulations. The Florida exposure of typical such formulations was on show.

A new brilliant white crystalline calcite, Omya D2, was recommended for brilliant white emulsion paints. A series of polymer-based textured wall finishes containing a range of controlled particle size Omya fillers was prominent.

A comparison of various extenders in highly pigmented zinc dust chlorinated rubber paints was made by AMALGAMATED OXIDES LTD, giving the results of three years' exposure. A fine silica gave almost perfect behaviour at a volume replacement of the zinc dust of up to 50 per cent.

STEETLEY LTD, Berk Mineral Products Division, had a complete range of sizes and colours of dolomite extenders. The range of Aerosil silicate products was featured by DEGUSSA.

Lithopone received some attention on the SACHTLEBEN CHEMIE GmbH stand, under the aegis of the INTERNATIONAL LITHOPONE ASSOCIATION. Up-to-date cost data on the economics of using Microcal ET, a silica extender, in emulsion paints were supplied by JOSEPH CROSFIELD & SONS LTD.

Solvents

Several additions to the range of ethoxol solvents were made by IMPERIAL CHEMICAL INDUSTRIES LTD, Petrochemicals Division. Other ethylene oxide derivatives from ICI included ethylene and diethylene glycols. Special importance was given to a development product, a methyl naphthalene for use as a dye carrier and as a speciality solvent for agricultural chemicals.

CARLESS CAPEL & LEONARD LTD highlighted the broad selection of solvents it offers by introducing a new aliphatic hydrocarbon, CAS 20/8, and pointing out the advantages that could be obtained in extension of wet-edge time when it was used in decorative paints. Deodorised Paraset 22, a new low odour nitro-paraffin, was also on display. The need for tightening specifications on solvents had been met by Carless in that benzene, xylene and toluene that comply with the recent British Standards are now produced. Aliphatic solvents that meet the requirements of US anti-pollution regulations are being developed.

The Association's Information Centre

Ester solvents appeared in the exhibit by REX CAMPBELL & CO LTD, special mention being given to methyl amyl acetate, which is claimed to be finding increasing use in lacquers. Ketone solvents under the Sida trade name were shown by PRODUITS

CHIMIQUES UGINE KUHLMANN, and BRITISH STEEL CORPORATION offered a number of aromatic solvent types.

Oils

A significant part of the AKZO CHEMIE NV stand was devoted to the broad spectrum of oils supplied by the company. Distilled tall oils, modified vegetable oils, dehydrated castor oils and wood oils were specially mentioned.

Unithane 640W and 641W, two novel urethane oils, were shown by CRAY VALLEY PRODUCTS LTD; suggested end uses include formulation of tough, chemically resistant, one-coat finishes for floors.

Pigments

Titanium dioxide manufacturers and suppliers were prominent, a number of new grades being exhibited. SACHTLEBEN AG showed a new, easily dispersible type, Hombitan R611D, and Hombitan R506, specially designed for aqueous systems. A new universal grade, Finntitan RRP, was featured by VUORIKEMIA OY, and displays showed the product's improved dispersing properties and exterior durability. Formulation details of other Vuorikemia pigments were also noted.

The new titanium dioxide plant of MONTEDISON SpA, details of which were given at OCCA-23, is now in production, and technical data on the seven types of rutile pigment offered were available on the company's stand.

New grades of Titafrance TiO_2 pigments, coded RL65, R67 and RL68, were part of the MORRIS ASHBY LTD exhibit.

Although not introducing any further grades, TIOXIDE INTERNATIONAL LTD exhibited a great deal of new information illustrating how the company keeps abreast of general advances in formulation, resin technology, and application techniques. Particular emphasis was given to powder coatings, and the criteria for correct dispersion and dispersion stability in the newer media—including water soluble types—outlined. A display illustrated formulation techniques in relation to pigment economy and milling method, and the new publication "Tioxide pigments in air-drying and gloss paints" was available.

LAPORTE INDUSTRIES LTD illustrated the properties of coated TiO_2 pigments in emulsion paint films. The differences in zeta potential of various pigment types in aqueous systems were demonstrated, and a correlation with the effect on the viscosity and can stability of such paints under normal storage conditions demonstrated.

Fluorescent and speciality pigments were also well represented. STERLING COLOUR COMPANY LTD demonstrated the many applications for its fluorescent products. A range of fluorescents was also shown by HERCULES POWDER CO LTD. Metallic pigments were prominent amongst the CROXTON & GARRY LTD display, particularly in epoxy formulations. The Midas Gold acrylic thermosetting metallic automobile finishes, newly introduced in the UK, were emphasised.

Iridescent interference pigments from Mearl Corporation were shown by CORNELIUS CHEMICALS LTD. Aluminium flake pigmented coatings were referred to by DURHAM RAW MATERIALS and, in particular, the use of this pigment to reduce the white reaction products formed when zinc dust containing products are exposed to salt laden atmospheres was demonstrated. Results of work with Zinc Dust 962, introduced at OCCA-23, in silicate media and in welding primers was also shown. Zinc dust pigmented coatings were also featured by MORRIS ASHBY LTD, and the impressive results of a three-year exposure test on zinc dust/silicate coatings was prominent. Of the silicate binders in this test sequence, ethyl silicates were shown to be the best for self-curing coatings, being more tolerant.

REX CAMPBELL & CO LTD made additions to the range of sparkle silver aluminium pastes introduced at OCCA-23, and displayed panels showing their advantages in automotive finishes. Sparkle Silver 3660, a new non-leafing grade for non-automotive uses, was given prominence.

A modified zinc molybdate, Moly-White 101, from Sherwin-Williams, was featured on the KINGSLEY & KEITH LTD stand, the anti-corrosive and non-toxic properties of this near-white pigment being demonstrated.

CABOT CARBON LTD, whose stand carried the claim that the company is the world's largest producer of carbon black, introduced new pigment grades, Monarch and Black Pearls 700 and 800, made by the furnace process and intended to replace the company's channel blacks. DEGUSSA also featured new grades: FW200 for paints, and Special Black 15 and Printex 400 for printing inks.

In the field of coloured pigments, several new products were on show. ALLIED CHEMICAL INTERNATIONAL SA featured two new types. Indofast Brilliant Red ER-8070 is a bright red perylene pigment. Having good acid and alkali resistance and excellent light fastness in full shade, ER 8070 is recommended as a lead-free substitute for molybdate orange in toy finishes, etc., showing ease of dispersion in most media. Perrindeau Violet EV is a very dark reddish shade violet, with good acid and alkali resistance and non-bleeding properties. Imparting a more transparent film, the pigment is recommended for use in metallic automotive finishes to give a wide range of deeper colour finishes; automotive paints containing the pigment have withstood two years' Florida exposure, and it has been selected for a number of automotive stylings in the USA for 1974. This company also had available information on two other new pigments, Quindo Violet ERV-8088 and S.P.Quindo Violet ER-8096. Both are beta-form linear quinacridone pigments recommended for the tinting of white bases; ERV-8088 is intended for use where humidity resistance is particularly required.

Easily dispersible pigments from Societe de Produits Chimiques et Matieres Colorantes de Mulhouse were exhibited by VICTOR BLAGDEN & CO. LTD, including two new benzidene yellows. New Rubine 4B toners for printing inks from the French company were also noted, together with alkali blues from Chemetron Corporation, particularly predispersed types. Claremont Polychemical Corporation was represented on this stand by its range of non-tarnishing bronze powders. Alkali blues from Sherwin Williams were featured by KINGSLEY & KEITH CHEMICALS LTD; this company also showed the range of inorganic and organic pigments from Dainippon Ink.

The Lutetia-ST range of easily dispersed pigments from Francolor was a part of the exhibit of PRODUITS CHIMIQUES UGINE KUHLMANN.

INTERNATIONAL COLLOIDS LTD emphasised its range of pigment dispersions in various media, in particular the new range of pigment pastes based on melamine/formaldehyde resins. The pigmentation level of Microsperse D1/24, a high jet furnace black dispersed in water, has been increased from 45 to 50 per cent, and savings in transport and handling costs were indicated. The use of the Intersperse 53 low mw polyethylene pigment chip range as a universal master batch for many resin systems was demonstrated.

A range of lead-free tinters in aqueous and non-aqueous vehicles was shown by DANIEL PRODUCTS COMPANY, the good weathering properties and durability of the range being outlined. The CAL/INK CHEMICAL CO. OF CANADA stand was based on its tinting systems for ester, oil, alkyd and other resin-based media. Particular prominence was given to a new system of lead-free tinters for emulsion and alkyd/oleoresinous decorative paints. Twelve colours are included, and a recommended range of 1,350 shades may be obtained by admixture. The maximum amount of colourant used in any mix is 12g/US gallon.


GRACE
Grace
GRACE
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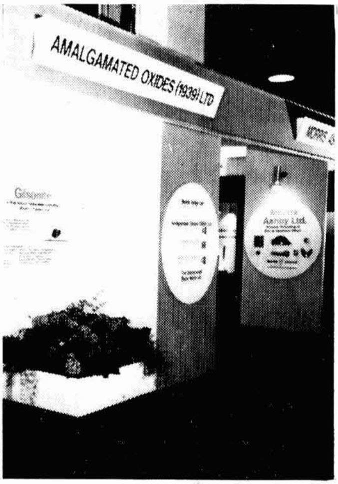
Competitive
Silicas
GRACE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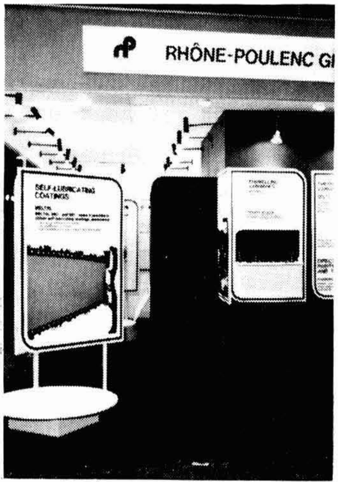
RHÔNE-POULENC G
SELF-LUBRICATING COATINGS


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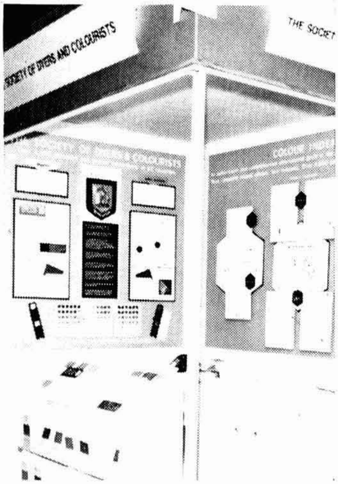
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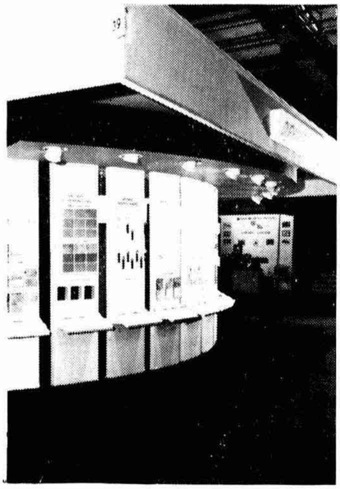
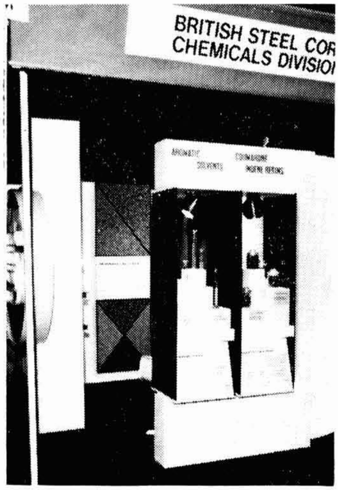



BRITISH STEEL COR
CHEMICALS DIVISIO
AROMATIC SOLVENTS
COUMARONE INDENE RESINS

Additives, driers, surfactants

As thixotropic paints achieve more acceptance in both the amateur and professional decorative fields, many exhibitors were showing thixotropy-promoting additives. GRACE GmbH introduced Sylodex, a fibrous particle silica thixotropic agent. Also on display was a new grade of Syloid silica matting agent numbered 165 and claimed to have improved dispersibility and flatting efficiency. Evidence was shown to prove that Syloid matted clear varnishes on wood gave improved durability compared with a control formulation, whereas other silicas reduced the varnish's performance.

The thixotropic properties of titanium chelates were underlined by TITANIUM INTERMEDIATES LTD; the range of systems in which these compounds can be incorporated has now been increased. Also featured was the use of titanium alkoxides, alone and in conjunction with siloxanes, for heat resistant paints. Using heat resistant pigments, a range of colours was produced which would withstand service temperatures of up to 500°C. The use of the alkoxides with siloxanes not only saves binder costs, but also allows the siloxanes to cure without stoving.

More data on the Rheox and Thixseal thixotropes introduced at OCCA-23 was supplied by BAKER CASTOR OIL COMPANY, which also gave prominence to Alfa-841, a polyurethane elastomeric additive intended to promote adhesion to difficult substrates, plasticised PVC for instance. Laponite swelling clays appeared on the LAPORTE INDUSTRIES LTD stand, their use as thixotropes being outlined. REX CAMPBELL & CO. LTD exhibited Crexathix R and Crexathix T, thixotropic agents for all non-aqueous formulations.

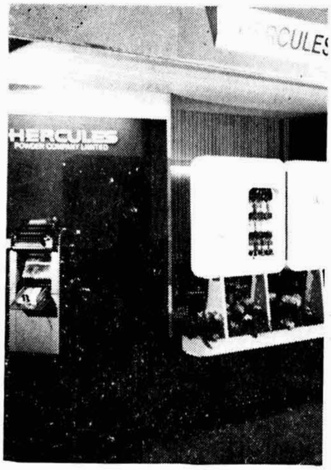
A new product from JOSEPH CROSFIELD & SONS LTD was Gasil 959, a silica additive which produces thixotropy, and also improves inter-coat adhesion in wood finishes such as two-pack polyurethanes, a useful property when the top coat is to be sanded. Crosfield presented new information on other Gasil products; Gasil TX-1 was shown to have high cost efficiency as a thixotropic agent in unsaturated polyester resins, and the use of Gasil A5 in powder coatings and textured finishes was indicated.

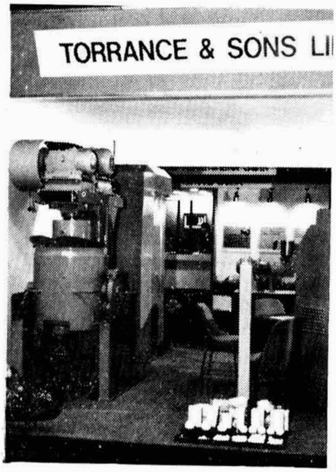
Silica additives featured also in the CABOT CARBON LIMITED display with the range of Cab-O-Sil products. Proposed uses for these sub-microscopic, chemically inert, fumed silicas included thixotropic paints, powder coatings (to impart improved flow) and as an emulsifying agent. CROXTON & GARRY LIMITED indicated similar applications for the range of silicas from Lowe, and chose Neosil A, an amorphous grade for coil coating primers and sealers imparting scratch and abrasion resistance, for special mention.

Biocidal additives were very much in evidence, and the ecological problems now associated with the mercurial types had obviously led to a great deal of work by the suppliers. LENNIG CHEMICALS LTD exhibited an experimental product, Microbiocide M8. This is a non-mercurial mildewicide, and two year Florida exposure panels were used to show its favourable performance compared with mercurial, lead, and zinc oxide compositions.

Technical advice on the use of Busan 11-M1, the modified barium metaborate from Buckman Laboratories Inc. introduced at OCCA-23, as a fungal control agent was supplied by VICTOR BLAGDEN & CO. LTD, the absence of toxicity of this compound being stressed. Organo-tin biocides were given some prominence amidst the SCHERING AG display, and also appeared on the CASA CHEMICALS LTD stand.

DURHAM RAW MATERIALS showed a new can preservative, as yet only at the experimental stage, intended to reduce bacteria-induced loss of viscosity in emulsion paints. Experimental work demonstrated its effectiveness. It is hoped that it will be commercially available in the near future. Nuodex 87, a non-toxic fungicide, was also featured; panels demonstrated its efficiency in anti-microbial washes on


HERCULES
HERCULES
POWDER COMPANY LIMITED


TORRANCE & SONS LTD.


REX CAMPBELL & CO LTD
M. P. HOUSE DINGWALL ROAD CROYDON CR9 3QU
SPARKLE ALUMINIUM
SILVER PIGMENTS


INTERNATIONAL COLLOIDS LIMITED


Georg M. Langer & Co
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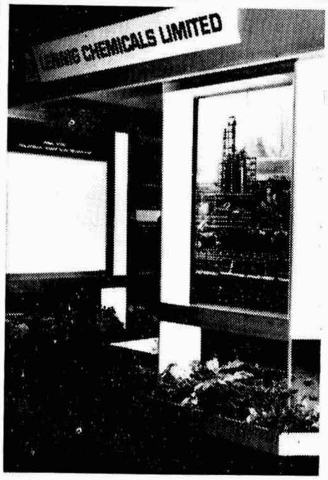
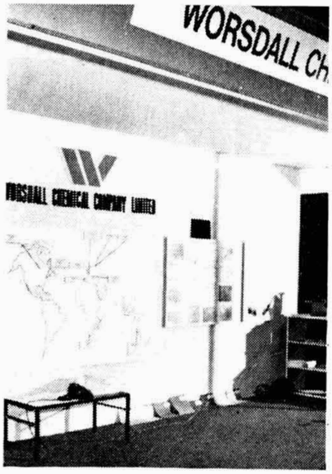
LANCO-REX


CHEMICALS LIMITED


WORSDALL CH
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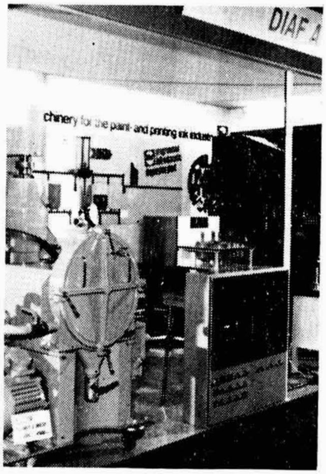

DIAF
chinery for the paint and printing ink industry

infected surfaces, and showed the effect of varying its concentration. Durham had several other additives on display, including Foamacure 142, a new anti-foaming agent for emulsion paints, zinc stearate DLG, a stir-in grade for sanding sealers which will not cause blooming under acid phosphate cured top-coats, and the Nicosyn range of synthetic acid based driers, for which cost advantages were claimed over driers based on the relatively scarce naphthenic acid.

Anti-foaming agents were selected for special mention amongst the range of additives from HENKEL & CIE GmbH. Five grades were shown, and the properties of three silicone-free types, Dehydron A, Dehydron C and VP-HD 1548, were contrasted with those of two silicone-containing products, Dehydron B and VP-BE 7182. A photograph taken at high magnification of the surface of a control panel showed the effect of microfoaming.

The efficiency of dispersing agents VP-HD 1705 and VP-HD 1706 in aqueous emulsion systems was underlined by a series of graphs illustrating experimental work; a stable consistency was achieved within a few days at a storage temperature of 50 C.

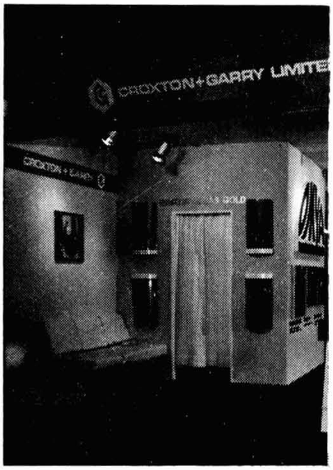
The Berk Mineral Products Division of THE STEETLEY COMPANY LTD had information on the uses of its wide range of additives. The use of the well-known Bentone range as additives in polyolefines and ABS to promote non-drip properties under heat was noted—of particular interest in reducing fire hazards in polypropylene. Strodex phosphate wetting agents were presented as anticorrosive agents; in general they are not biodegradable, and are very efficient in reducing corrosion, being stable to caustic soda concentrations of up to 5 per cent. The Raybo range of special additives was also shown.

A series of aliphatic and aromatic amine curing agents for epoxy resins appeared on the EMSER WERKE AG stand. This consisted of four products, two aliphatics, XH 89062 and XH 89074, and two aromatics, H 81003 and H 81005; a wide spread of curing speeds could be obtained by using this range, using the products either alone or in admixture. Epoxy curing agents were the major exhibit of ANCHOR CHEMICAL CO. LTD. Latest additions to the Ancamine range of aliphatic and aromatic curing agents were listed. Of particular interest was Ancamine MCA, a high reactivity product for low temperature or under-water curing; Ancamines LO and LOS, which can be used mixed in varying proportions to give a range of curing times from 40 minutes to 12 hours at room temperature, were also prominent.

Recent developments in the field of Casamid water dispersible epoxy resin hardeners were announced by CASA CHEMICALS LTD. The advantages of systems based on the new Casamid 360 over conventional solvent borne epoxy/polyamide paints were outlined; such formulations were recommended for marine, industrial maintenance, and concrete coatings.

Dapro 650S Sanding-Ayd was featured by DANIEL PRODUCTS COMPANY. A paste dispersion to improve the sanding properties of sanding sealers, the product was claimed to have advantages in use of allowing earlier sanding and reducing clogging of sandpaper when compared with coatings containing zinc stearate. Three new products were added to the Slip-Ayd series of polyethylene and polymerised wax dispersions. These were SL-18 and SL-140, for use in aqueous vehicles, and SL-18, for solvent-based formulations.

GEORG M. LANGER, exhibiting for the first time, introduced Lanco-Wax PP1362D, a micronised polypropylene wax that is claimed to reduce gloss and increase mar resistance and slip in wood finishes and industrial coatings; use in powder coatings was also indicated. Low molecular polyethylene dispersions, Lanco-Glidd WM and AH, are supplied in plasticiser and alkyd solutions, and are intended to modify the surface properties of films to improve water and mar resistance and slip.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CROXTON + GARRY


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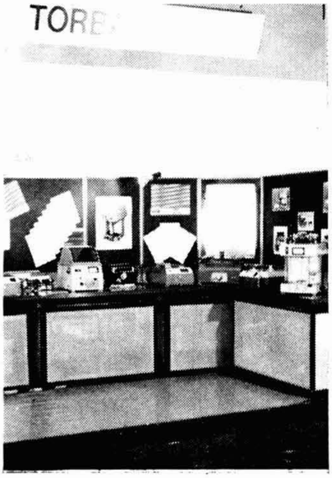
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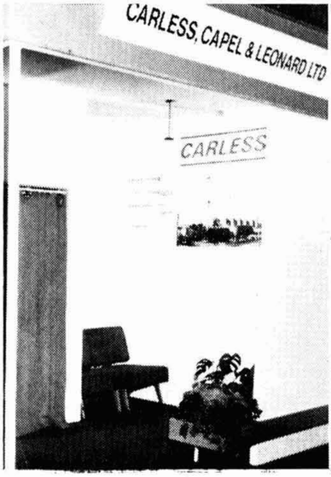
CARLESS, CAPEL & LEONARD LTD
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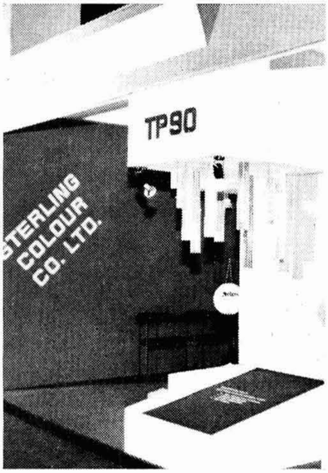
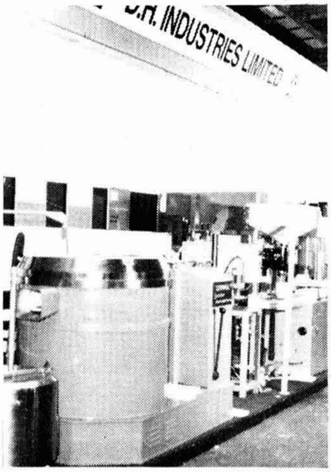
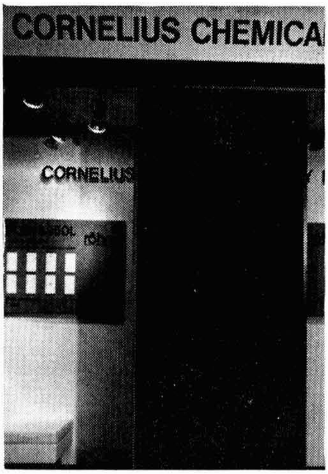

TP90
STERLING COLOUR CO. LTD.


ALLIED CHEMICAL INTERNATIONAL S.A.


D.H. INDUSTRIES LIMITED


CORNELIUS CHEMICA
CORNELIUS

Three novel low molecular weight polyethylene additives were introduced by ALLIED CHEMICAL INTERNATIONAL SA. AC9 is a harder grade aimed at improving rub resistance in printing inks. The other two new grades are for hot melt adhesives and hot melt coatings: AC430, a 30 per cent ethylene/vinyl acetate copolymer soluble in aromatic and aliphatic solvents, and AC580, an ethylene/acrylic acid copolymer. This company also featured the Polymist series of micronised resins for use in improving the abrasion resistance of printing inks. Of the series, Polymist AIZ, a micronised polyethylene wax, is an entirely new product, and three micronised PTFE grades were also novel. The lubrication properties of the PTFE's, which are in the particle size range 4-10 microns, were underlined. There was also a CTFE resin, Halar 500, but this new product is not yet readily available.

PTFE powders from Plastics Division were also prominent on the stand of IMPERIAL CHEMICAL INDUSTRIES LTD, and new applications taking advantage of the wear resistant and non-slip properties of the resins Fluon L169 and Fluon 170 were outlined.

Resins—Alkyd

A number of new developments in the alkyd field were noted. Synolac 99W is a new type of alkyd offered by CRAY VALLEY PRODUCTS LTD. A high-structured resin, it imparts a thick creamy consistency without any tendency to thixotropic gel formation, even at low temperatures, and could thus be described as being mid-way between the thixotropic and conventional alkyd types. Although high-structured, it is claimed to have excellent flow properties, and to be free from the brush marking tendencies of most structured alkyds. Blends with conventional alkyds to give a range of intermediate structures were indicated.

CdF CHIMIE demonstrated a "new generation" of alkyds for flat, non-penetrating, egg shell paints, including silk and half-gloss finishes, for use on plaster or wood. The company's established Gedeglyps and Sicagel ranges were also represented.

Alkyds were strongly represented on the WORSDALL CHEMICAL COMPANY LTD stand, in particular Estervars B504 and B505, two new master mixes intended for use alone or with other alkyd vehicles for ink formulations. A technical display showed the results of experimental work on the water and moisture resistance on a number of wood substrates of various resins from Esterchem Pty. Epex 60, a silicone safflower alkyd, showed good resistance on most woods, and was recommended for boat varnishes; a TMP epoxy linseed alkyd also showed excellent moisture resistance. Products from Pope Chemical Company exhibited on this stand included the Pyro-Gloss vehicle system for web offset inks, which consisted of two varnishes, VH-280, an ungelled type, and VH-266, the gelled form. The pigment is ground into the more liquid varnish, which has better wetting properties, and the gelled form is then added in appropriate quantities to give a buttery offset ink.

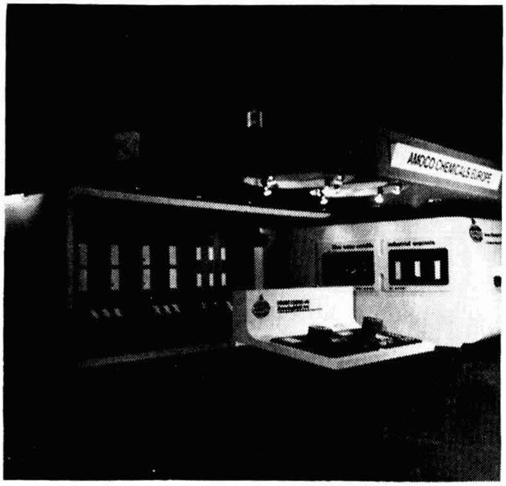
The VICTOR BLAGDEN & CO. LTD display included the Cargill range of resins. amongst which were new alkyd copolymers. Styrenated and vinyl toluenated dehydrated castor oil alkyds were particularly prominent, linseed and soya alkyds with similar modifications also being available.

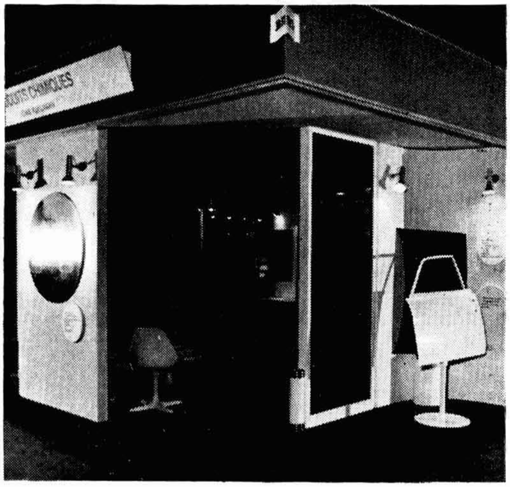
A range of alkyds was offered by PRODUITS CHIMIQUE UGINE KUHLMANN.

SCADO NV introduced Scandonal 46, a short oil alkyd resin for very quick air drying top coats and stoving primers and finishes, imparting good yellowing resistance.

Resins—Amino

BIP CHEMICALS LTD centred its stand on a new isobutylated etherified melamine/formaldehyde resin, L3673. This product has a very high reactivity, and is designed


AMOCO CHEMICALS EUROPE


DUITS CHIMIQUES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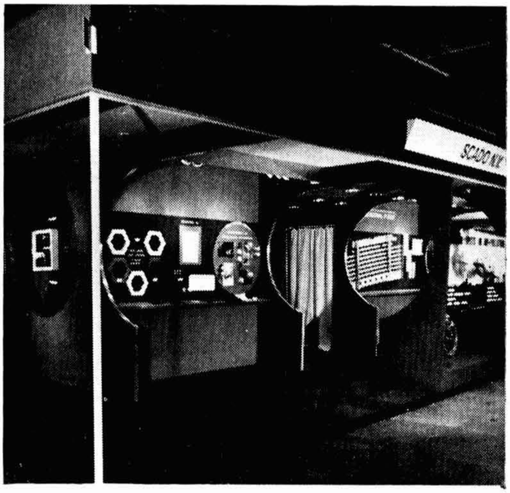
CABOT CARBON LIMITED
Cabot Performance Chemicals
NEW
CARBON BLACK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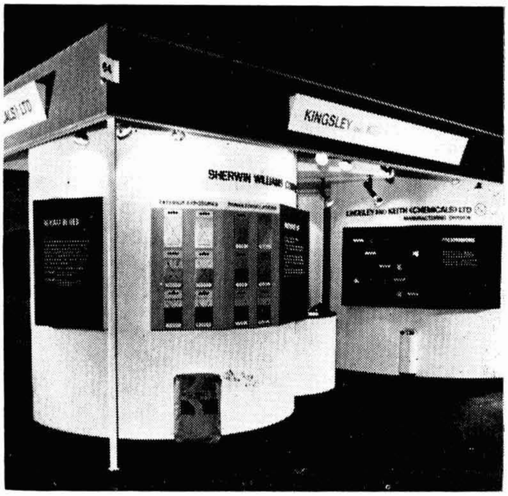
KINGSLEY
SHERWIN WILLIAMS
KINGSLEY AND KEITH (CHEMICALS) LTD

for fast cure and low bake finishes in conjunction with semi-drying oil alkyds. Displays demonstrated the high hardness obtained from uncatalysed curing at temperatures as low as 80°C. Scadonal P2007, a new alkyd/melamine combination for powder coatings, was featured by SCADO NV. The good durability of coatings incorporating P2007 was stressed, and levelled films of 30-120 microns dry thickness demonstrated.

The wide range of Cargill amino resins occupied a part of the VICTOR BLAGDEN & CO. LTD display; the high solids methylated and butylated melamine and methylated urea types were stressed. PRODUITS CHIMIQUES UGINE KUHLMANN also showed a comprehensive amino resin series, manufactured by Plastymer.

Resins—Polyamide

Versamid 758, a novel polyamide resin, was exhibited by CRAY VALLEY PRODUCTS LTD. Intended for incorporation in flexographic inks, Versamid 758 is claimed to offer improved deep freeze and water resistant properties when compared with previous types. Polyamides were given some publicity on the AKZO CHEMIE NV stand, and the comprehensive Versamid and Versaduct ranges of SCHERING AG featured prominently in the company's display; uses and formulations were indicated.

Resins—Unsaturated polyester

An interesting development in the field of unsaturated polyester resins was introduced by CdF CHIMIE. A new addition to the Norsodyne range is a polyester specifically developed for curing under β-radiation; examples of the high curing speeds obtainable were given. RHONE POULENC showed ranges of unsaturated polyesters from the division Redis-Rhone-Progil, trade named Rhodester and Stratyl.

Resins—epoxy

The main emphasis on the stand of EMSER WERKE AG was given to a novel unmodified liquid epoxy resin, Grilonit G16.05. Plaques demonstrated the advantages the new resin offers over conventional liquid epoxies by virtue of its lower viscosity and its non-crystallising nature. Liquid epoxy resins were also shown by SCHERING AG, although most stress was given to three additions to the company's epoxy range; Europox 716, Europox 703 and Europox 7002. WORSDALL CHEMICAL CO. LTD, a newly-formed company showing for the first time, offered a wide range of epoxy resins for paints and inks under the trade name Estopen. Worsdall also handles resins for a number of overseas companies, as indicated elsewhere in this review. Roller coating was the end use intended for Scadoform L34, an epoxy/phenolic precondensate from SCADO NV; sample panels demonstrated the advantageous properties it gives in this application.

Resins—Acrylic

Coil coating and electrodeposition were amongst the applications for which Roehm GmbH, one of the companies represented by CORNELIUS CHEMICAL CO. LTD, showed acrylic resins. Plex 4811 is a thermosetting acrylic for electrocoating, in particular for one-coat finishes on phosphated steel or aluminium where white or pale shades are required. Good corrosion resistance was claimed. For coil coating, Plexisol DV577 was exhibited. Outstanding adhesion, flexibility, and stain resistance are claimed for this thermosetting acrylic resin; it is said to conform to the present recommendations of the European Coil Coating Association. Also from Roehm was Plex 5350L, a hydroxylated acrylic for cross-linking at room temperature with polyisocyanates, especially where hard, durable, scratch resistant finishes are required. Further work on all these polymers, which were introduced at OCCA-23, was on display. CRAY VALLEY PRODUCTS LTD added three products to the Synocure range, all of which are hydroxy functional acrylic resins for room temperature curing with polyisocyanate cross-linking. The three resins are: Synocure 8675, a quick hardening version—Koenig hardness of 80 within 4 days—which has an eight-hour pot life, and is reported to impart excellent weathering properties and petrol resistance; Synocure 8685, a non-yellowing medium recommended for use on rigid and semi-rigid surfaces; and Synocure 8685, a fast drying polymer with long pot life, recommended for wood finishes.

Resins—emulsion

Featured by LENNIG CHEMICALS LTD were a number of emulsions in the Primal series. Florida exposure panels underlined the gloss and colour retention and freedom from dirt pick-up of coatings based on Primal acrylic emulsions AC388 and AC507, after three years' south facing exposure. Black and white top-coats of ACC507 over primers of AC388 were also compared favourably with similar paints based on an alkyd resin and an ethyl-vinyl acetate copolymer. Following the legislation on lead-containing paints, exposure panels were also used to show the stain resistance of films from Primal E-726; it is claimed that this lead-free emulsion can produce wood finishes of equivalent stain resistance to the lead-based types.

Plextol D540, a methacrylic dispersion from Roehm GmbH exhibited by CORNELIUS CHEMICAL CO. LTD, was the newest product from this company on display. Properties claimed for the emulsion, which is intended for interior and exterior emulsion paints, include high pigment binding power, outstanding weathering resistance, and lack of yellowing. Acrylic copolymer emulsions were included in the range from RHONE POULENC. Supplied by Redis-Rhone-Progil, the Rhodopas dispersions are seven in number: A, a pva type; AM, maleate/pva; AV, verstate/pva; AD, acrylic pva; SD, acrylic/styrene; XD, pvc; and XR, a special copolymer for textured paints.

CdF CHIMIE demonstrated the improvements obtained by the use of Lopox 120CB, an epoxy emulsion, in comparison with other available water dispersible grades; emulsion stability was particularly stressed.

Resins—Miscellaneous

IMPERIAL CHEMICAL INDUSTRIES LTD, which chose to concentrate on its resin and solvent products this year, showed further work on Imprez 100, the petroleum resin introduced as a development product at 23-OCCA; the resin is not yet in production, but it was announced that a new plant will become operational in mid-1973. Mond Division had a display on the use of its well-known Alloprene chlorinated rubbers in high-build films, and a display showed the effect of PVC and film thickness on the performance of chlorinated rubber traffic paints. An item which aroused much interest on this stand was a selection of photomicrographs, taken using the Nomarski differential interference contrast method, which indicated that the diffusion between layers in formulations based on chlorinated rubber imparted improved adhesion when compared with films in which diffusion did not occur, such as polyurethanes.

Adhesion was also a subject explored by EASTMAN CHEMICAL INTERNATIONAL, who demonstrated the use of chlorinated polyolefin 334-1 to improve the performance of primers on plastics substrates. Novel uses of cellulose acetate butyrate were also picked out; to give improved flow and quicker curing in powder coatings, and to allow higher blocking temperatures and impart reduced dirt pick-up and improved "feel" in polyurethane coatings for cloth.

The Cargill ranges of polyurethane resins, one and two-pack, including thixotropic oil-modified types, were referred to by VICTOR BLAGDEN & CO. LTD.

Amongst the wide range of polyvinyl resins from RHONE POULENC, including butyrals and formals, three were of particular interest. Rhodopas XR700E4 194M was given special prominence. It is a vinylidene chloride copolymer designed particularly for use in intumescent paints; technical displays showed its superior alkali and yellowing resistance which, together with good adhesion, recommend it for building paints, particularly for those on fresh concrete. A new grade of Rhovinal BSA, a polyvinyl butyral containing less than 1 per cent acetate, was introduced for wash primers and varnishes. Information on a new product, Rhodopas ACVX, was given but no data sheets or samples of this product are yet available.

Electrodeposition possibilities for the range of SMA styrene/maleic anhydride resins were exhibited by ARCO CHEMICAL COMPANY. The latest addition to the range, SMA5900, is a 100 per cent solids vehicle of low functionality, designed for highly corrosion resistant electro-coatings. The use of SMA5500 in low cost thermosetting paints for electrodeposition was outlined, modification with refined linseed oil or amino resins being recommended. Attention was also drawn to SMA1440H, a low molecular weight half ester for use as a primary dispersant in a tint base formulation for several types of universal colourants.

The BRITISH STEEL CORPORATION, CHEMICALS DIVISION, centred its exhibit on the special ranges of pitches for blending in epoxy and polyurethane systems. Two new pale resins, LMS150 and LMS4500, were offered, and their use in coloured finishes of similar properties to epoxy/coal tar types as well as in aggregate adhesives was outlined. BSC also showed its range of coumarone/indene resins, including a pale development product intended for road marking paint. Crex terpene resins were offered for the first time by REX CAMPBELL & CO. LTD; a dewaxed dammar for cellulose lacquers was also on view.

New developments in its range of hydrocarbon resins, including an interesting group of blended resins, were featured by HERCULES POWDER COMPANY LTD; printing inks and adhesives were indicated as possible end uses.

Chemical intermediates

AMOCO CHEMICALS EUROPE demonstrated the industrial applications of its isophthalic acid and trimellitic anhydride in various resins. A water-soluble oil-free alkyd based on IPA-99 was shown in appliance finishes, imparting good gloss and yellowing resistance, hardness and flexibility. Another novelty was a water-soluble gloss enamel based on tall oil fatty acid modified with isophthalic acid and trimellitic anhydride—this formulation was said to be capable of good performance on cold rolled steel without a primer. Powder coatings were also prominent on the stand; a version incorporating isophthalic acid and trimellitic anhydride was claimed to involve lower costs. Isophthalic acid was also offered by ARCO CHEMICAL COMPANY.

From the large range of intermediates and other products supplied by AKZO CHEMIE NV, polyols and DCO fatty acids received some attention; possible uses were suggested.

ANCHOR CHEMICAL COMPANY LTD included the range of Sartomer acrylate and methacrylate monomers in its exhibit.

Dantocol DHE, hydantoin glycol, was recommended for resin production by REX CAMPBELL & CO. LTD. Glycidyl methacrylate and glycidyl ethers from Nippon Oils & Fats appeared on the KINGSLEY & KEITH LTD stand.

Manufacturing equipment

MATREP SA, a French company exhibiting for the first time, showed its comprehensive services for the paint, printing ink and resin industries. Matrep can supply every type of manufacturing equipment: mixers, dispersers, resin plant, heating installations etc. Its speciality, however, is in supplying complete, fully automated, production plant—in the company's own words, to start with a bare site and finish with a complete factory with automatic control systems. Displays emphasised the company's expertise in bulk handling, storage, dosage, distribution of powders and liquids, and above all, automation of plant control. An item of particular interest was a pneumatic system of movement of powdered raw materials, especially pigments. Three systems are available, operating under high, medium or low pressure respectively, which can be geared to the product to be moved. By this method, the powder is moved automatically from storage silos to any one of a number of selected points throughout the factory under air pressure. A flow sheet was on view showing the system installed in a large paint factory; using this system with a central console, one man can control the entire flow of powder throughout the plant; measured quantities of any of a number of stored powders can be transported to any of the installed production units entirely automatically. Also of interest in view of the pollution difficulties involved in solvent disposal, was a solvent recycling plant claimed to be economical in use.

A pneumatic powder conveying system manufactured by Gattys-Bau GmbH was shown by DIAF A/S.

As mentioned earlier, there was an increase in the number of companies offering colourant dispersers for retail or warehouse use; all reported much interest, and it may be that more UK paint makers will follow the trend current in the US and Australia towards this method of retailing.

WINTER OSAKEYHTIO introduced the Wintermix system, unique in that the colourant is dispersed through a hole punched in the can lid by the dispersing machine; a plastic closure for the hole is supplied which seemed secure enough to withstand the agitation of the shaker for the system, which is claimed by Winter to be the world's fastest shaker, effecting complete mixture in 20-30 seconds. The Winter system employs eight white bases, three water based and five enamels. Paints matching the BS 2660 colours were demonstrated.

The Blendorama system was shown by A. STRAZDINS PTY LTD. Three models were on view: 21P12 is a rotary bench model for retail use, dispensing up to 50ml at a stroke, in increments of 0.5ml. 53P is a larger model for factory use, supplied in rotary or in-line versions; by a novel system of a pump within a pump, shots of up to 150ml can be dispensed accurately in increments of 0.2ml. 200P is similar to 53P, but larger, having a shot capacity of up to 600ml. Accuracy of ± 1 per cent is claimed for all the machines. The two larger types have a novel "5 × formula gauge," which allows a five gallon pail to be tinted using the 1 gallon formula.

CAL/INK CHEMICAL CO. OF CANADA LTD demonstrated the dispersing machinery of H. G. Fischer & Co., in conjunction with its own system of tinters.

In the field of mixing and milling machinery, a wide variety of equipment was on view. TORRANCE & SONS LTD featured its new 25hp hydraulically operated cavitation disperser with central console. The Mark V laboratory model was also displayed; it has been specially designed to offer better correlation between laboratory work and conditions in production. Other Torrance machines included the 30S and HC5 continuous attritors, and the 3½ in pilot model Microflow ink mill. PETER SILVER & SONS (ENGINEERS) LTD exhibited the Flow line/In line mixing unit, emphasising its resistance to clogging. By restricting the outlet from the pump, the recycling, and hence shearing action, of the unit can be increased; thus a variable control of the process is available. The Vortex range of laboratory mixers was also shown by this exhibitor.

A new continuous in-line mixer was given prominence by D. H. INDUSTRIES LTD. The Ross ISG mixer is perhaps unique in that it has no moving parts. A series of elements through which holes are bored is present in the pipeline, and they are so arranged as to produce the maximum turbulence as the fluid mix is pumped through.

Very efficient mixing is claimed; the unit can be installed easily into existing pipelines and requires little maintenance.

Another new machine from D. H. Industries was the Centrimill, manufactured by Sussmeyer, Oliver and Batlle. The Centrimill is a complete dispersion batch mill, and features variable speed operation in an impeller driven from beneath the mixing bowl; a special gland is used which is claimed to eliminate leakage, and a specially developed discharge arrangement gives maximum product discharge. Also from the same manufacturer were two new hydraulic mixers, Hydrosolver HS, a high speed cavitation disperser with the hydraulic system built into the headstock, and the Hydrosolver LS, a low speed version. From Paul Vollrath, a new paste and heavy duty mixer, Dissolver model VDXV5 was featured, its plough stream device for directing the mix back into the mixer blades being emphasised. D. H. Industries also exhibited a new automatic lid dispensing unit from J. De Vree & Co., using the non-nesting and pileable lids manufactured by the Clover Can Company. The unit was shown integrated into a conveyorised filling, lid pressing and batch number marking system.

A paste mixer capable of dealing with very high viscosities, type LFBH 20, was exhibited by DIAF A/S. This company also featured the Rota-Flow mill type 56R, a bead mill for continuous dispersion and grinding of premixes, with a pot of 32 litre capacity. A 50hp dissolver, type FFBH 50n, fitted with carousel and sidescraper, was also on view.

G. J. ERLICH LIMITED showed a continuous grinding machine from the Molteni range, and mixers for operation under vacuum were also noted. A number of laboratory size units was featured, and correlation with full scale production indicated. Vibratory filter screens from Vibromac were also displayed.

The Boulton vibro energy air suspended strainer was prominent in the WILLIAM BOULTON LTD display. Advantages in increased throughput with less wear over conventional cam driven vibrators were outlined. Another item on this stand was the OP PO mill, a ball mill shaker that uses an ingenious concept of balancing thrust.

MASTERMIX ENGINEERING CO. LTD selected the Batch Mastermill from its wide range of manufacturing equipment for special attention. The Mastermill consists of a rotating grinding chamber containing ballotini; a patent on this system has been applied for. Complete dispersion of full paints may be obtained, even when difficult pigments are to be used.

A life of 20 years was claimed by WINN & COALES (DENSO) LTD for the laboratory model of its Colwin disintegrator/grinder, which was shown reducing polyethylene chips to a fine suspension in water. Details of the full range of mixers, which vary from the laboratory four pint size to a 300 gallon machine, were given. Improvements in the rotor head have led to the new Multi-Shear rotor and stator, which offers significant reductions in batch times. Another new development was a new bearing design which is claimed to reduce maintenance.

A new version of its triple roll mill was demonstrated by MARCHANT BROTHERS LTD. Modifications include automatic thermostatic control of the water cooling system, and four point hydraulic control of the roll. From MASCHINENFABRIK HEIDENAU VEB came the Heidenau power grinder 192.B, designed for continuous grinding and dispersion, and now fitted with a novel open screen filter. Continuous adjustable outputs of up to 750 litres per hour are claimed. Information on the many other Marchant and Heidenau machines, including the pan cleaner and roller coating machine introduced at 23-OCCA, was offered.

WINKWORTH MACHINERY LTD represented its range of paste and powder blenders with a stainless steel two gallon heavy duty 2-blade mixer, fitted with a jacket for steam heating or water cooling.

A range of centrifugal pumps from the Albany Engineering Company Ltd. was included in the WORSDALL CHEMICAL COMPANY LTD. exhibit. Pumps suitable for capacities up to 800 gallons per minute and heads up to 400 feet are available. An interesting adjunct to this exhibit was a specially printed leaflet intended for students, giving an explanation of the basic terms involved in pumps and pumping, and quoting a number of conversion factors.

Exhibiting for the first time, BOWATER INDUSTRIAL PACKAGING LTD. introduced a range of non-returnable fibre-steel drums for liquid, semi liquid and paste products. The Liquipack type, in sizes up to 210 litres, is fitted with a double inert polyethylene lining and pilferproof lever action closure. The Leverpack can be supplied with internal linings of polyethylene, polyethylene coated aluminium foil, or other materials; sizes up to 270 litres are available. The Pattern III range, made from steel reinforced kraft with an integral polyethylene lining, was on view. Bowater have recently reached agreement with Mauser-Werke AG of Germany to handle Mauser drums in the UK; details of these drums were on display.

ELCOMETER INSTRUMENTS LIMITED showed the American Sprayon aerosol can filling apparatus.

Testing equipment

Colour measuring instruments were well represented, and coupling to digital computers was again prominent. INSTRUMENTAL COLOUR SYSTEMS LTD. showed its PCC-2000 system, a joint venture between ICS, Digico Ltd., who supplied the Micro 16P Minicomputer, and Pretema AG, who supplied the spectrophotometer, a Pretema FS-3A filter type. The computer can be programmed to supply a pigment mix to match a sample in 45 seconds, selecting against criteria of least metameric acceptable match, cheapest acceptable match, or a balance between the two. Shade correction, tinting factors or colour match prediction can all be undertaken with the same speed. The model on display was programmed to answer problems of the textile industry; the colour difference between a yellowed white paint and a freshly painted panel was measured in NBS units (Schofield modified Judd) within one minute on a demonstration on visitors' samples. ICS also displayed a Harrison-Shirley Digital Colorimeter, with direct read-out of tristimulus values X, Y, Z, chromaticity coordinates x, y, z and tristimulus ratios $\frac{X}{Y}, \frac{Y}{Y}, \frac{Z}{Y}$.

A computer-linked system was also demonstrated by KOLLMORGEN COLOR SYSTEMS, comprising the new KCS-18 Automatic Color-Eye and the KCS-35 PCC F computer. Combinatorial colour programmes can be used to suggest matches for samples, or the colorist can, at his own discretion, accept a suggested batch correction or determine a more satisfactory match in terms of cost or pigment in a matter of seconds. The KCS-18 itself is a versatile automatic dual-beam colorimeter abridged spectrophotometer which is capable of measuring fluorescence. Other items from the Kollmorgen catalogue included the Macbeth Super Skylight BX-848/A examination cabinet, and a portable solid state densitometer, Macbeth RD-505.

HUNTER ASSOCIATES LABORATORY showed its tristimulus colorimeters and colour difference meters, recording on Hunterlab's own L, a, b, scale. A circumferential viewing method is employed in the colorimeter, rendering easy measurements on textured finishes, which are often difficult on conventional instruments owing to the high scatter. An in-line colorimeter for continuous monitoring of coil coatings and paper stock was an interesting addition to the range. A glossmeter with viewing angles of 20°, 60° and 85°, particularly useful for low gloss coatings, was also shown.

THE LENETA COMPANY displayed a variety of paint test charts, both opacity types and scrub resistance charts. A drawdown type Anti Sag Meter was demonstrated.

The main exhibit on the RK CHEMICAL COMPANY stand was a series of Printing Proofers designed with interchangeable heads. The structure of these instruments allows two or more inks to be applied simultaneously to give a greater ease of comparison.

Also displayed was the well known RK range of wire wound metering rods for laboratory and plant application of coatings; wire thicknesses of 0.002 to 0.060 inches diameter are supplied. RESEARCH EQUIPMENT LTD. introduced a new type of coating bar consisting of a ground, profiled rod. Advantages in ease of cleaning are claimed over wire wound types; several film thicknesses were shown. A simple and convenient liquid density meter of the float type, used in conjunction with a balance was another innovation, and REL displayed the new ISO design of efflux viscometer, introduced recently and described in this Journal (McKelvie *JOCCA* 1970, **52**, 95). A viscometer to this design was also prominent in the SHEEN INSTRUMENTS (SALES) LTD. stand, which featured instruments to British, American and Continental specifications.

Viscometers were the basis of the FERRANTI LIMITED exhibit, in particular the portable coaxial cylinder viscometer and the Ferranti-Shirley cone and plate viscometer. The latest development is a new design of spring attachment for stress relaxation measurements in lower viscosity fluids. This technique is useful for measuring the flow properties of paints at low shear rates, and for work on thixotropic paints, which can be sheared at high shear rates immediately before stress-time measurements are taken.

A novel exhibit by DIAF A/S was a falling rod viscometer fitted with an automatic timer accurate to 0.01 second.

Continuing development of its range of film thickness measuring instruments was demonstrated by ELCOMETER INSTRUMENTS LTD. The latest model is the Eddytector, for measuring the film thickness of films on non-ferrous metal substrates; the Twintector may be used for both ferrous and non-ferrous metals by switching from magnetic to Eddy current measurements. A new magnetic gauge for measurement of film thickness underwater was given prominence.

MICROSCAL LTD. showed the results of work carried out with its range of instruments. Techniques using the Flow Microcalorimeter to distinguish between physical and chemical adsorption were demonstrated. Also featured was the Spinning Riffler, its use in sampling from bulk powders being outlined.

A wide variety of balances, covering weights from 7kg to 0.0001g, was displayed by the TORSION BALANCE CO. (GB) LTD., the advantages of longer life and greater accuracy imparted by the torsional system being stressed.

Acknowledgments

The Honorary Editor wishes to thank the following Members of the Association who gave so much of their time to assist in the reporting of the Exhibition:

K. Baxter, R. M. D. Barratt, J. M. Burke, M. Camina, R. G. Carr, F. W. Cole, Dr V. T. Crowl, J. Green, H. J. Griffiths, Dr H. R. Hamburg, K. J. Hedgecock, R. F. Hill, H. A. Hipwood, A. G. Holt, D. E. Hopper, R. J. King, A. Laws, A. McWilliam, J. E. Mitchell, J. L. Prosser, F. B. Redman, J. A. Saunders, D. J. Silsby, J. T. Tooke-Kirby, W. G. Topham, G. E. Westwood, F. B. Windsor, and the Assistant Editor (R. Wood), who collated the reports and wrote this review.

Professional Grade for Ordinary Members

Since the list of admissions to the Professional Grade was published in the May issue of the *Journal* the following Ordinary Members have also been accepted:

Fellows

Munn, Raymond Henry Edward (*London*)
Rechmann, Heinz (*General overseas*)

Associates

Adams, Terry Ernest (*London*)
Chippington, Kenneth Alan (*Bristol*)
Gibson, John Carrington (*Hull*)
Hughes, Gilbert William (*Manchester*)

These acceptances now represent a total number of 206 Ordinary Members who have been admitted to the various grades.

All members wishing to apply for the Grade are reminded that sponsors will not be required for their applications before October 1972.

OCCA Biennial Conference

towards 2000

eastbourne 19~23 june 1973

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 presented 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.*

News of Members

Mr K. J. Day, an Ordinary Member attached to the London Section, and a Fellow in the Professional Grade, has gone into practice as an independent consultant in protective coatings. Mr Day, who was previously Managing Director of BIE (Anti-Corrosion) Ltd., will join the panel of corrosion consultants, and will be available to the BIE Group in this capacity.

Mr D. H. Deacon, an Associate Member attached to the Thames Valley Section, has succeeded Mr Day as Managing Director of BIE (Anti-Corrosion) Ltd.

FSPT Mattiello Lecture

The Federation of Societies for Paint Technology has announced that Dr H. K. Raaschou Nielsen, Director of the Scandinavian Paint and Printing Ink Research Institute, and an Ordinary Member attached to the General Overseas Section, will present the Joseph J. Mattiello Memorial Lecture at the Federation's 50th Anniversary Annual Meeting. The title of his lecture will be "Cooperation, national and international—do we realise its potentialities?". Full details of the Annual Meeting, which is to take place at the Chalfonte-Haddon Hall, Atlantic City, from 24-28 October 1972, have also been released by the FSPT.

Silver Jubilee of Czech Research Institute

The Research Institute of Synthetic Resins and Lacquers (VUSPL) of Pardubice, Czechoslovakia, has recently celebrated 25 years of work in the field of resins and plastics. The VUSPL, which has grown from 15 employees to a staff of nearly 300, including 80 graduates, was the subject of an article in a special issue of "Czechoslovak Special Trade," devoted to the vast chemical complex that comprises the ZPCH Pardubice Trust. OCCA has long enjoyed good relations with VUSPL, and it is hoped to publish a number of papers by authors from the Institute in this *Journal* in the near future.

Forthcoming Events

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

Wednesday 7 June

Oil and Colour Chemists' Association: Annual General Meeting, to be held at Wax Chandlers' Hall, Gresham Street, London EC2, at 6.30 p.m.

Saturday 17 June

Newcastle Section: British Titan Cup, to be held at the Brancepeth Castle Golf Club. Tickets from H. Fuller.

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

ASHFORD, JOHN WILLIAM, Lorilleux & Bolton Ltd., Ashley Road, Tottenham, London, N17. *(London)*

BESELER SISNIEGA, CARLOS FEDERICO, Gardex, SA Apartado 19, Silla, Valencia, Spain. *(Overseas)*

BROWN, FRANK JAMES, 9 Lomond Road, Grangemouth, Stirlingshire, Scotland. *(Scottish)*

BUCKLEY, MICHAEL KEVIN, 46 Arthur Road, Erdington, Birmingham, 23. *(Midlands)*

BULLEN, NEIL, LRIC, 12 Moorside Avenue, Blackburn, Lancashire BB1 2BA. *(Manchester)*

CHAMBERS, ANTHONY, 55 Grantock Road, Walthamstow, London, E17. *(London)*

CHEW, CHONG BIAN, 15 Ellison Place, Pakuranga, New Zealand. *(Auckland)*

COLAU, PATRICK RENE, PhD, MSc, 41 Philips Avenue, Farnworth, Bolton, Lancashire BL4 9BJ. *(Manchester)*

CRAWFORTH, CHARLES GEOFFREY, BSc, DPhil, 31 Sandilands Road, Baguley, Manchester, 23. *(Manchester)*

DICKENSON, CHRISTOPHER JOHN, BSc, c/o Dulux (NZ) Ltd., PO Box 30366, Lower Hutt, New Zealand. *(Wellington)*

DUNDERDALE, JOHN, BSc, PhD, Laporte Industries Ltd., Organic and Pigments Division, Stallingborough, Lincs. *(Hull)*

FAMUYIWA, ISRAEL OLUSEGUN, 41 Brondesbury Villas, London, NW6. *(London)*

HAMILTON, ALEXANDER, BSc, 63 Whitton Drive, Giffnock, Glasgow G46 6EF, Scotland. *(Scottish)*

JEFFRIES, DENIS JOHN, 34 Water Lane, Totton, Southampton, SO4 3DN. *(London—Southern Branch)*

LEMMON, TERENCE BRIAN, ARIC, 15 Townsend Crescent, Morpeth, Northumberland. *(Newcastle)*

LITTLEFIELD, ROBIN CHRISTOPHER, 3 Welbeck Close, Cove, Farnborough, Hampshire. *(London)*

MCDERMOTT, PETER, c/o ICI Ltd., Dyestuffs Division, 4, Blytheswood Square, Glasgow, Scotland. *(Scottish)*

MCINNES, PETER BRADFORD, BSc, 7 Rangiora Street, Lower Hutt, New Zealand. *(Wellington)*

MACROSSON, WILLIAM DAVID KEITH, BSc, PhD, 65 Woodside Drive, Waterfoot, Eaglesham, Renfrewshire. *(Scottish)*

MARCELO, GODOFREDO L., BSc, c/o F. E. Zuellig Inc., PO Box 604, Manila, Philippines. *(General Overseas)*

ROSSITER, RAYMOND FREDERICK, BSc, PhD, 428 Outwood Common Road, Billericay, Essex. *(Hull)*

ROWLANDS, JOHN HOWARD, BA, 62 Elmstead Avenue, Wembley, Middx. *(London)*

SCHWAR, MICHAEL JOHN RICHARD, BSc, PhD, DIC, MINSTP, Paint Research Association, Waldegrave Road, Teddington, Middx. *(London)*

SAULI, EDOARDO, Via Guala 114, Torino 10135, Italy. *(General Overseas)*

SCHOLFIELD, DAVID, LRIC, 19 Knowsley Street, Bury, Lancs. *(Manchester)*

SHEIKH, SAEED M., BSc, 81/0, Block 2, PECH Society, Karachi 29, Pakistan. *(General Overseas)*

SMITH, DAVID, 47 Old Coach Road, Kelsall, Tarporley, Cheshire. *(Manchester)*

STEVENSON, BRIAN GERALD, 2 Woodlawn Grove, Kingswinford, Brierley Hill, Staffs, DY6 9QE. *(Midlands)*

STONE, NEVILLE MORRIS, Polymers (NZ) Ltd., Salesyard Road, Otahuhu, New Zealand. *(Auckland)*

TAINTON, PETER VICTOR, 12 Valley View, Cletton, Somerset. *(Bristol)*

THOM, CONRAD, 12 Princess Way, Euxton, Nr. Chorley, Lancs. *(Manchester)*

WEBB, ROY KENNETH, BSc, Phillips Petroleum (UK) Ltd., Portland House, Stag Place, London, SW1. *(London)*

WILLIAMS, CHRISTOPHER HUGH, LRIC, 45 Oxenhill Road, Kemsing, Sevenoaks, Kent. *(London)*

ZAKARIA, MOHAMMED BELAL, BSc, No. 3, Ringway, Stainsby Hill Estate, Stockton on Tees, Teesside TS17 9DT. *(Newcastle)*

Associate Member

BISHOP, PETER CHRISTOPHER WILLIAM, 27 Dene Hollow, Birmingham B13 0EG. *(Midlands)*

Registered Students

ACETO, ELISEO, 171 Coedmore Road, Bellair, Durban, South Africa. *(South African)*

ALDWORTH, MICHAEL DELL, 155 Kensington Drive, Durban-North, Natal, South Africa. *(South African)*

BAULD, ROBINA HAY, 17 Leeside Road, Glasgow, Scotland G21 1XL. *(Scottish)*

BLAIR, JOHN, 5 Tobago Place, Westwood, East Kilbride, Lanarkshire. *(Scottish)*

GEE, PETER, 45 Eldercroft Road, Timperley, Cheshire. *(Manchester)*

HALL, STEPHEN JOHN, 1 Cherry Grove, Mangotsfield, Bristol BS17 3DS. *(Bristol)*

MCKENZIE, JAMES, 4 Wardhouse Road, Paisley, Renfrewshire, Scotland PA2 8RQ. *(Scottish)*

NADAULD, CLIVE, 68 Bayswater Road, Hillary, Durban, South Africa. *(South African)*

RUDOLPH, ROY PETER, 34 Rossview Road, Seaview, Durban, South Africa. *(South African)*

SHAVE, ANDREW JOHN, 115 Vista Way, Kenton, Harrow, Middx. *(London)*

STEVENSON, ALAN MATTHEW LESLIE, 44 Ferguson Avenue, Renfrew, Scotland. *(Scottish)*

STIDARD, PETER JEFFERY, "Lyndhurst," 48 Rectory Road, Frampton Cotterell, Bristol, BS17 2BP. *(Bristol)*

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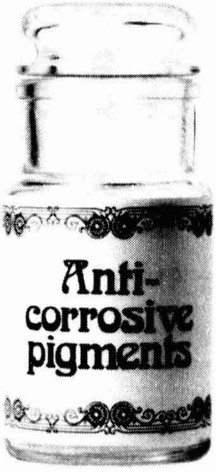

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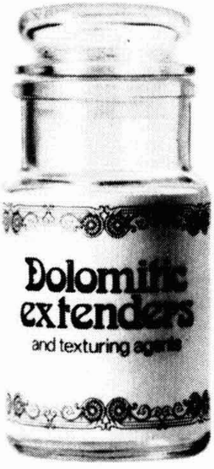

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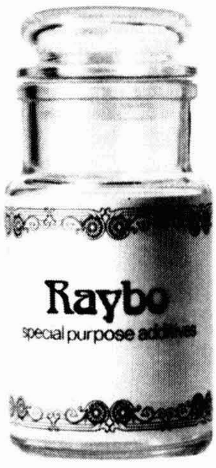

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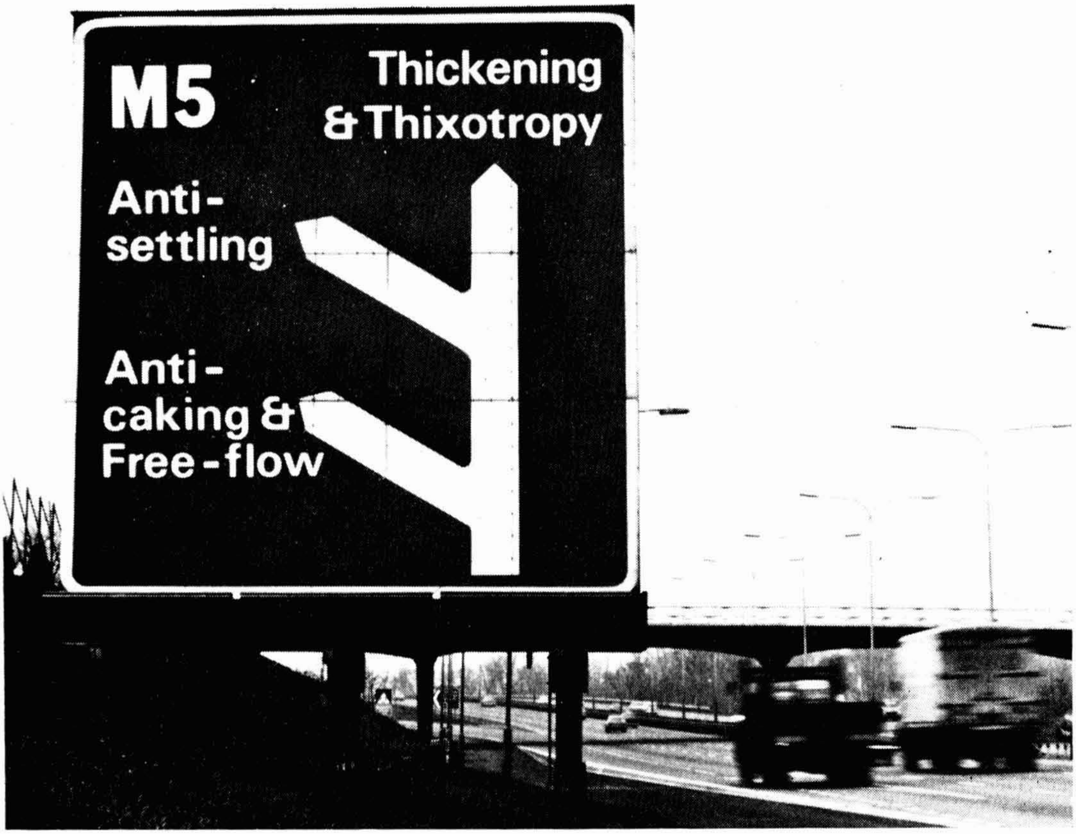
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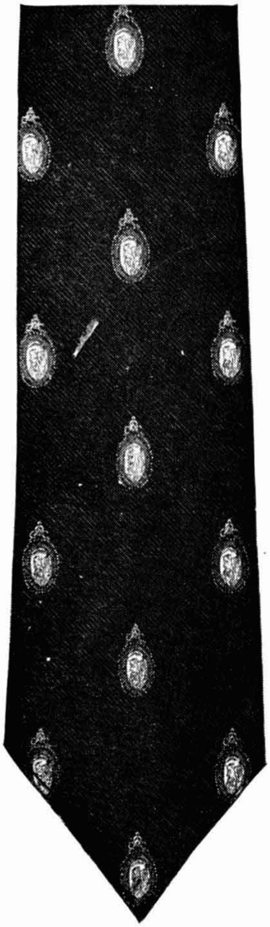

The tie is blue terylene, with the Association's insignia woven in red and gold silk.

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.

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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:—

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