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The dispersion of pigments and the rub-out properties of pigmented systems *U. Kaluza*

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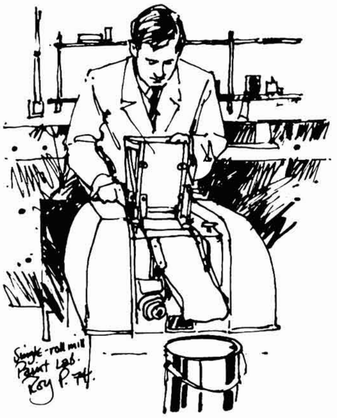
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Transactions and Communications

Owing to the illness of the translator, the papers published in this issue do not include translations of the summaries in Russian.

В виду болезни переводчика нет возможности публиковать выдержки статей на русском языке.

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J. Oil Col. Chem. Assoc. 1974, 57, 353-356

Transactions and Communications

Determination of the infinitesimal hardness behaviour (IHV) by interpolation and reduced extrapolation

By K. M. Oesterle

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Summary

It is known from previous papers by the author that in order to determine accurately the IHV value of a substance (Infinitesimales Harte-Verhaltens = Infinitesimal Hardness Behaviour) a number of indentation values y must be determined at each of a number of loadings on the indentor. On the other hand, a paper by Morris suggests that it would be possible to consider only one indentation value for each load.

In order to determine the IHV value, the author constructs a regression curve through a number of y values at each load. This curve is extended by *interpolation* to the point $F = 0$, $y = 0$. By this procedure y values may be obtained in the proximity of the zero point and consequently F/y values can be calculated in the region of $F = 0$. A curve can now be drawn through the determined points to cut the F/y ordinate at the IHV value.

The variation (standard deviation) of a series of experimental y values from the regression curve provides a quantitative assessment of the regularity of the film structure, for the quality of the grinding, and so forth.

Keywords

Equipment primarily associated with analysis, measurement or testing

indentation hardness tester

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

infinitesimal hardness behaviour

La détermination des caractéristiques du comportement infinitésimal de dureté par interpolation et par extrapolation reduite

Résumé

Par des publications prélables de l'auteur il fut démontré que pour la détermination de la valeur IHV il en faut une pluralité de valeurs d'impression, y pour chaque charge F pesant sur l'element pénetratrice (indentor)—ceci en contradiction d'une publication de Morris de laquelle on pourrait croire q'une seule valeur de pénétration y par chaque charge suffisait.

Pour arriver à la valeur IHV on doit dessiner une courbe de regression à travers les valeurs y qu'on prolonge par *interpolation* jusqu'à proximité de $F = 0$, $y = 0$, ce qui rend possible d'établir une courbe de regression $F/y = f(F)$ qui touche l'ordonné a la valeur IHV.

La variance des distances des valeurs y de leurs courbe de regression nous donne un chiffre pour évaluer la régularité du film, p.e. qualité de broyage etc.

Bestimmung des Infinitesimalen Härteverhaltens (IHV) durch Interpolation und reduzierte Extrapolation

Zusammenfassung

Bekanntlich muss bei der Bestimmung des IHV-Wertes (Wert des Infinitesimalen Härte-Verhaltens) eine Vielzahl von Eindringwerten y des mit einigen Belastungen F Indentor gemessen werden. Durch die Vielzahl dieser Eindringtiefen—nicht nur durch je eine Eindringtiefe, wie man aus einer Arbeit von Morris leicht schliessen könnte-, legt man eine Regressionskurve und verlängert sie durch *Interpolation* bis zum Wert $y = 0$, $F = 0$. Man erhält dadurch y-Werte bis nahe an den Nullpunkt und kann nun F/y-Werte bis zu kleinsten Belastungen F berechnen. Durch diese errechneten F/y-Werte lässt sich eindeutig eine Kurve zeichenen, die man mit hoher Genauigkeit verlängern kann zu ihrem Schnittpunkt mit der F/y-Ordinatenachse, dem IHV-Wert.

Aus der Abweichung der y-Werte von der Regressionskurve lasst sich die Varianz dieser Werte berechnen, welche ein Mass ist fur Regelmässigkeit des Filmes, d.h. z.B. auch für die Güte der Vermahlung.

In his paper on the characterisation of mechanical properties of paint films by microindentation, Morris[1] in his Fig. 4 (reproduced below as Fig. 1) shows "IHV" curves (which would be better described as F/y curves) which give the impression of a variety of F/y values for the film, due to irregularities in the measuring procedure and to variations in the structure of the films used in this work. In most cases these variations are due to irregularities in the material owing, probably, to insufficient grinding, irregular agglomeration or re-agglomeration effects, specific selective adsorption in pigment/vehicle interaction etc.

It has been pointed out previously[2, 3, 4] that it is not sufficient to consider only a single point at each value of the loading on the indentor for the determination of the Infinitesimal Hardness Behaviour (IHV) values. The reason for this is that by drawing curves through single values of the depth of penetration y at each value of the load F as was done in Morris's Fig. 4, gives equal importance to each point, including those which are discrepant.

According to earlier work[2, 3] it is necessary to draw or calculate a regression curve of all the values of y at each

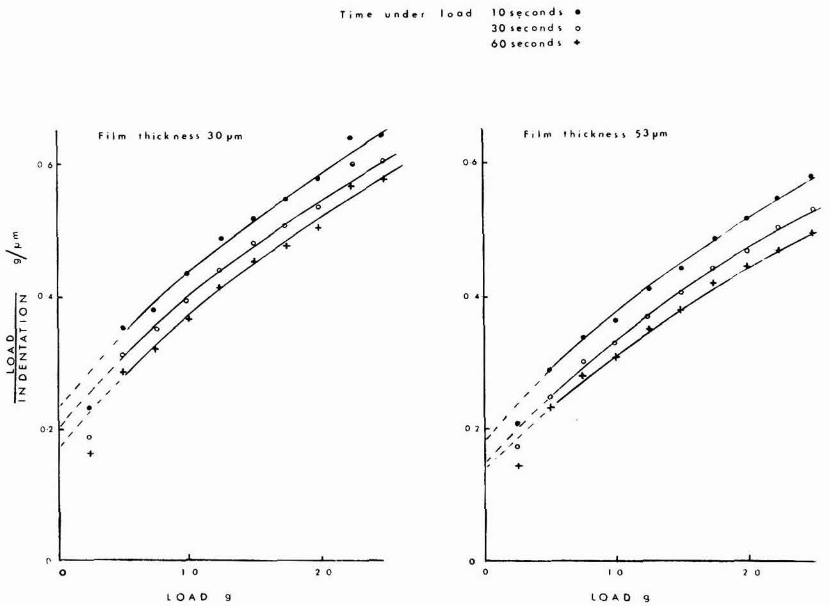


Fig. 1. Graphs for a pigmented solvent acrylic (23°C and 65 per cent relative humidity)

loading of the indentor used, in order to obtain a reliable value of the IHV. Morris[1] states that, "... in addition, the value of the intercept (the IHV value) was obtained by extrapolation, is highly dependent on the least accurate of the data points, which are derived using the conditions of lowest load" and again that, "... there is practical difficulty in extrapolating the IHV curves ..."

This difficulty can be overcome by a method involving *interpolation*. The existence of the IHV value implies that the regression curve of all indentation values when produced backwards must pass through the origin where $F = 0$, $y = 0$. Thus if the regression curve $y = f(F)$ is drawn from the origin, a reliable value of y can be obtained by interpolation at any chosen value of the load F in the proximity of $F = 0$. The value of IHV is simply the value of F/y when the load applied tends to zero.

This is illustrated in Figs. 2-7 and shows that the true IHV value can be determined very easily and precisely.

Figs. 2 and 3 show the same IHV value for films of different thickness.

Figs. 4 to 7 show good agreement of the IHV values for different times of load application.

It is purely accidental that in Fig. 2 the F/y curve appears to be a straight line, whilst the same paint in Fig. 3 gives a definite curve. Both these graphs yield the same IHV value, and it is only the effect of the spatial configuration of the coating which causes the difference in curvature of the two curves; the material is the same and the IHV values are in accordance. This peculiarity has been discussed previously at the FATIPEC Congress in 1968.[2] The same situation is illustrated in Figs. 6 and 7.

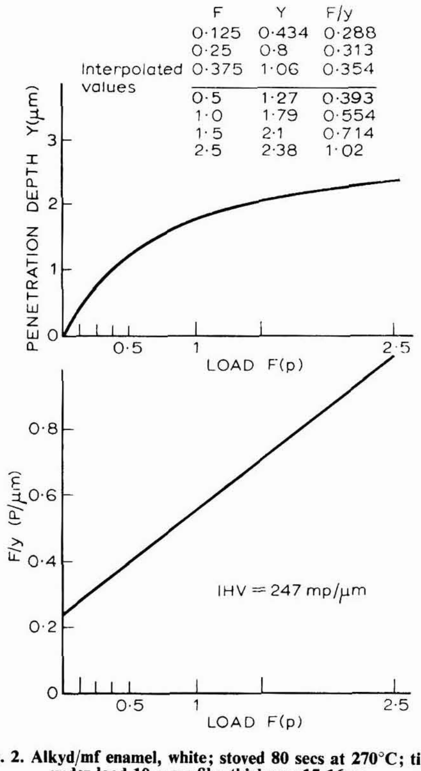
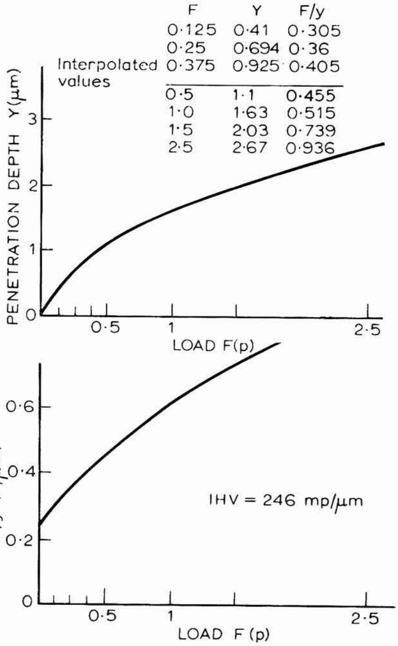
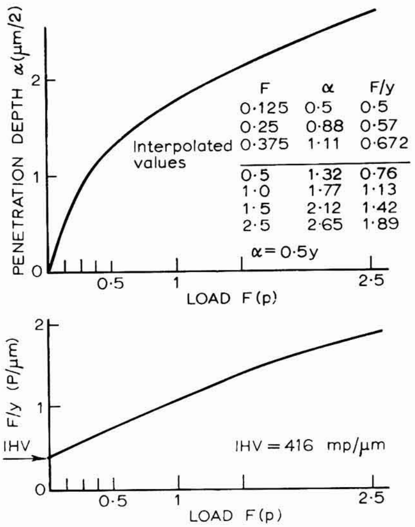

	F	Y	F/y
Interpolated values	0·125	0·434	0·288
	0·25	0·8	0·313
	0·375	1·06	0·354
	0·5	1·27	0·393
	1·0	1·79	0·554
	1·5	2·1	0·714
	2·5	2·38	1·02

Fig. 2. Alkyd/mf enamel, white; stoved 80 secs at 270°C; time under load 10 secs; film thickness 15-16µm



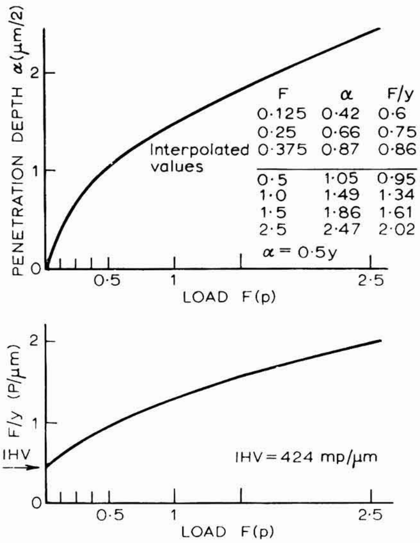
	F	Y	F/y
Interpolated values	0·125	0·41	0·305
	0·25	0·694	0·36
	0·375	0·925	0·405
	0·5	1·1	0·455
	1·0	1·63	0·515
	1·5	2·03	0·739
	2·5	2·67	0·936

Fig. 3. Alkyd/mf enamel, white; stoved 80 secs at 270°C; time under load 10 secs; film thickness 25-27μm



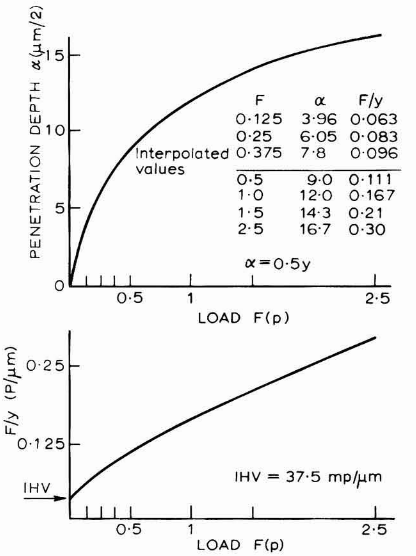
	F	α	F/y
Interpolated values	0·125	0·5	0·5
	0·25	0·88	0·57
	0·375	1·11	0·672
	0·5	1·32	0·76
	1·0	1·77	1·13
	1·5	2·12	1·42
	2·5	2·65	1·89

Fig. 5. Epoxy powder coating; time under load 20 secs; film thickness 80μm



	F	α	F/y
Interpolated values	0·125	0·42	0·6
	0·25	0·66	0·75
	0·375	0·87	0·86
	0·5	1·05	0·95
	1·0	1·49	1·34
	1·5	1·86	1·61
	2·5	2·47	2·02

Fig. 4. Epoxy powder coating; time under load 5 secs; film thickness 80μm



	F	α	F/y
Interpolated values	0·125	3·96	0·063
	0·25	6·05	0·083
	0·375	7·8	0·096
	0·5	9·0	0·111
	1·0	12·0	0·167
	1·5	14·3	0·21
	2·5	16·7	0·30

Fig. 6. Alkyd enamel, air drying; time under load 10 secs; film thickness 30μm

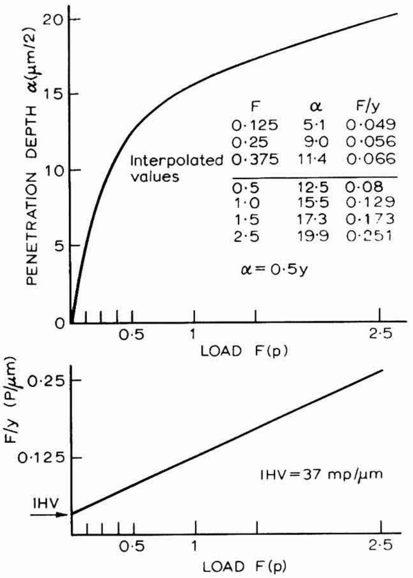


Fig. 7. Alkyd enamel, air drying; time under load 20 secs; film thickness 30μm

Although these straight lines may be due to some peculiarity, at least they provide further evidence against the theory[5] that the F/y curves without exception pass through the zero point $F/y = 0, F = 0$ and that as a consequence the IHV value does not exist.

At the beginning of this paper it was stated that the variation of the indentation values at a given load gives an insight into the regularity of the paint films or plastics. This can be demonstrated by the variance s of the distance of the y values from the regression curve and provides a scale for the evaluation of the quality of the dispersion and, in general, the regularity of the film. This can be calculated for the films shown in Figs. 2 and 5 which exhibit good and poor regularity, respectively.

If y = indentation depth

y_r = value of y on the regression curve at the same load

n = a value to be added to x, where $x = y - y_r$

$\delta = x + n$

N = number of indentation values

then

$$s = \sqrt{(\Sigma(\delta - \delta_2)^2) / (N - 1)}$$

For Fig. 2, $s = 6.3 \times 10^{-2}$, indicating good film regularity; and for Fig. 5, $s = 3.85$, indicating poor film regularity.

Conclusion

It has been shown that in contrast to more or less simplifying the computation of the indentation depth y against the load curve and the further calculation of the $F/y = f(F)$ values, it is possible to operate with far greater precision by the introduction of the "Interpolation" method.

This interpolation method consists of drawing the regression curve of the y values and extending it to the most certain point on the curve, namely the point where $F = 0$ and, consequently, $y = 0$. Between this point and the indentation produced by the smallest load used given by the regression curve, the value of y for any small load may be read by interpolation, so that from the extended regression curve the value of F/y can be calculated in the region where $f(F)$ tends towards zero and thus the IHV value determined very exactly.

The process has been illustrated by practical examples. Some of these give straight lines for F/y instead of the more usual curve, but this peculiarity affords further proof that the "theory" of the "non-existence of the IHV" cannot be valid.

The variance s of the distance of the indentation points y from the regression curve provides a numerical measure of the regularity of a paint film (for example, extent of grinding etc).

[*Received 16 February 1974*

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J. Oil Col. Chem. Assoc. 1974, 57, 357-367

Assessment of non-slip weatherdeck paints*

By J. Gagliardi, L. A. Hill and F. Marson

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Summary

A number of coatings have been assessed with regard to their suitability over various pretreatments for use as non-slip weatherdeck coatings on naval vessels. Practical trials as well as laboratory tests were carried out. Two-pack materials based on epoxy resins have been found to give the best performance.

Keywords

Types and classes of coatings and allied products
non-skid coating

Types and classes of structures or surfaces to be coated
steel

Properties, characteristics and conditions primarily associated with dried or cured films
abrasion resistance
film thickness
gasoline resistance
impact resistance
skid resistance
weather resistance

Une appréciation des peintures antidérapant pour les ponts principaux de navires

Résumé

On a apprecié une gamme de revêtements au point de vue de leur efficacité, où ils sont appliqués après de divers prétraitements du support, en tant que revêtements antidérapants sur les ponts principaux de navires de guerre. On a effectué des essais pratiques de même que des essais au laboratoire. On a trouvé que les matériaux à deux emballages basés sur les résines époxydes donnent le meilleur rendement.

Bewertung Nichtschlüpfriger Anstrichmittel für dem Wetter Ausgesetzte Decks

Zusammenfassung

Eine Anzahl von Anstrichmitteln wurden nach verschiedenen Vorbehandlungen auf ihre Eignung als nichtschlüpfrige Lacke für dem Wetter ausgesetzte Decks von Seeschiffen bewertet. Sowohl praktische, als auch Laboratoriumsversuche wurden durchgeführt. Zweikomponentenmaterialien auf Basis von Epoxyharz verhielten sich dabei am besten.

Introduction

Refs. 1, 2

Coatings on the weatherdecks of naval vessels are required to protect against corrosion and be reasonably wear resistant. The main walkways should be slip-resistant especially when wet. In one overseas navy, this requirement has been met by using abrasive-coated tread strips stuck to the cleaned steel deck in stepping-stone fashion and the rest of the deck painted with a standard type of paint.[1] Various difficulties, such as lifting of the strips, incorrect laying, corrosion beneath the strips and painting over them, were encountered when the system was tried in the Royal Australian Navy.[2] For these reasons and because the conventional alkyd-based deck-paints often have a life of only months under service conditions, the quality of some commercially available deck coatings was assessed.

Experimental

Ref. 3

Materials tested

Eleven paints, including the standard Navy deck paint, were obtained from local and overseas sources. These were chosen to give information on the durability of a number of binder systems and of the effect of variation in surface texture on wear properties. Details are given in Table 1. Paint No. 11 is a commercial paint based on the work of Berger and Cizek.[3]

Panel preparation and pretreatments

Refs. 4, 5

The panels for laboratory tests and panel exposure were made from black steel, 16 standard wire gauge (1.6mm in thickness).

Pretreatments

The paints were applied over the following pretreatments to check their suitability for use with the non-slip topcoats, and also to provide sufficient information to recommend surface pretreatments.

Wire brush and acid wash Where the panels were showing signs of rust, the loose rust was first removed with a wire brush. A phosphoric acid solution to RAN specification Misc. 131[4] was then brushed on, allowed to stand for 2 hours; the excess rinsed off in running tap water and the panels dried in an oven at 80°C for 30 minutes. The coating was applied as soon as the panels had cooled to room temperature.

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*This paper was issued as Report No. 566 of the Defence Standards Laboratories. It is published by kind permission of the Chief Superintendent.

Table 1

Products tested

Code no. of paint system	Type	Number of packs	Country of origin	Notes
1	Epoxy	2	USA	Two coats applied
2	Epoxy	2	Australia	Two coats applied
2a	Epoxy	2	Australia	Two coats of Paint No. 2 applied over one coat of special primer
3	Epoxy	2	USA	One coat applied
3a	Epoxy	2	USA	One coat of Paint No. 3 applied over one coat of special primer
4	Oil	1	Australia	*Navy system* Zinc chromate primer—one coat
—	Oil/alkyd	1	Australia	Undercoat—one coat
—	Alkyd	1	Australia	Deckpaint—one coat
5	Phenolic	1	USA	Two coats applied
6	Phenolic	1	USA	Two coats applied
7	Epoxy	2	USA	Two coats applied
8	Solventless epoxy	2	Australia	Two coats applied
9	Epoxy	2	Australia	Two coats applied
10	Acrylic latex	1	Australia	Two coats applied
11	Moisture-cured urethane	1	Australia	Two coats applied

Note. Paint No. 3 contained such coarse grit that only one coat could be applied to obtain a film thickness comparable with the remaining treatments.

Blast clean The panels were sand blasted to give a Class 3 finish[5] with a profile height of 0.001 to 0.0015in (25 to 37μm). They were coated as soon as possible after blasting.

Blast clean and metal spray Sand blasted panels prepared as above, were sprayed with zinc to give a minimum thickness of 0.002in (50μm) and then overcoated with 0.003in (75μm) aluminium.

Inorganic zinc dust alkali silicate primer Sand blasted panels, prepared as above, were given a brush application of an inorganic zinc-rich primer based on alkali silicate (zinc silicate primer), to give a dry film thickness of 0.001 to 0.0015in (25 to 38μm). Two days' drying was allowed before overcoating.

Zinc silicate primer overcoated with wash primer Panels coated with the above zinc silicate primer were given a light spray application of a one-pack wash primer and allowed to dry for 4 hours before overcoating.

Application of paint When the viscosity permitted, the paint was applied by a scraper blade. Where a scraper blade could not be used, the paint was applied by brush. Where possible two coats of paint were applied, with 24 hours allowed for drying of each coat. The total film thickness was that recommended by the suppliers and, generally, was in the range of 0.02 to 0.04in (0.5 to 1.0mm). It was measured at six or more points using an electronic film thickness gauge (Permascope type ES).

A three-day ageing period was allowed before laboratory testing was carried out unless stated otherwise. Details of the test methods employed and the results obtained are given below.

Laboratory tests

Application properties, finish (appearance) and re-coatability

Application properties were assessed by the operator according to the following scale:

(a) easily applied, no experience required;

(b) easily applied with experience;

(c) applied with some difficulty but good finish obtained;

(d) applied with some difficulty but moderate finish obtained;

(e) applied with some difficulty but poor finish obtained;

(f) almost impossible to apply; and

(g) impossible to apply using stated technique.

The appearance of the dried film was assessed visually on the following scale:

(a) good decorative finish;

(b) acceptable;

(c) poor;

(d) unacceptable.

Re-coatability after the stated drying time was assessed on the following scale:

(a) easily re-coated, no visible defects or drag marks;

(b) drag marks but no visible defects;

(c) defects visible, type of defect to be assessed and recorded.

The results of these three properties are shown in Table 2.

All of the paints tested showed satisfactory application properties, finish and ease of re-coating.

Resistance to impact

Refs. 6, 7, 11

An impact test was carried out using the apparatus described in Method 17 (a) DEF 1053[6], but no provision was made for plate deformability. A series of six impacts each 0.5in (12mm) off centre from the previous impact was made. A 0.375in × 3.5in × 6in (10 × 90 × 150mm) steel plate was placed on the bottom die block to prevent normal deformation of the test sample.

Table 2

Ease of application, finish, film thickness and recoatability assessments

Code No.	Application properties rating	Finish rating	Gloss	Thickness 0.001 in (mm)	Recoatability rating	Drying time (hours)	Comment
1	b	a	Low	35 ± 5 (0.9 ± 0.1)	a	24	Solvent evaporates fairly quickly making it difficult to apply finish.
2	b	a	High	35 ± 5 (0.9 ± 0.1)	a	24	If applied too thickly has a tendency to develop pinholes.
3	b	a	High	45 ± 5 (1.1 ± 0.1)	a	24	Pinholes with heavy coats. Coarse grit makes it difficult to apply thinnly. Only one coat applied.
4	a	a	Low	7 ± 0.5 (0.18 ± 0.05)	a	24	Soft after 2 days drying.
5	a	a	Low	40 ± 5 (1.0 ± 0.1)	a	4	May dry too quickly to be applied satisfactorily to a large area.
6	b	a	Low	35 ± 5 (0.9 ± 0.1)	a	4	Satisfactory
7	b	a	High	35 ± 5 (0.9 ± 0.1)	a	24	Satisfactory
8	c, becomes a when reduced	a	High	30 ± 5 (0.75 ± 1)	a	24	Too viscous as supplied: easily applied when solvent added.
9	a	a	Low	25 ± 5 (0.6 ± 0.1)	a	24	Viscosity could be slightly too low for commercial application.
10	c	a	Low	20 ± 3 (0.5 ± 0.1)	a	24	Difficult to apply by spreader. Applicable with some difficulty by brushing.
11	c	a	Low	45 ± 5 (1.15 ± 0.1)	a	24	Poor flow properties.

Three samples of each paint over the various pretreatments or primers were tested as follows:

1. With no further conditioning.
2. After 4 hours at 0°C.
3. After 200 hours' artificial weathering in Atlas weatherometer (Cycle conforming to ASTM G-23 Type D[11]).

The results were assessed on a scale from 10, for good, to 0 for complete failure, as described in Section 4.7.8 of MIL-D-23003 (ships),[7] and are reported in Tables 3 a-c.

Table 3

Impact test

Table 3a—Room temperature impact test

Code No.	Metal pretreatments					
	Recommended primer	Acid wash	Blasted metal	Metal spray	Zinc silicate primer	Zinc silicate primer with wash primer
1	—	4 to 5	4 to 5	4 to 5	4 to 5	4 to 5
2	4 to 5	4 to 5	4 to 5	4 to 5	4 to 5	4 to 5
3	4 to 5	4 to 5	4 to 5	4 to 5	4 to 5	4 to 5
4	—	7	7	7	7	5
5	—	8	8	8	8	8
6	—	1	1	1	1	1
7	—	5 to 6	5 to 6	5 to 6	5 to 6	5 to 6
8	—	7	7	7	7	7
9	—	7	7	7	7	7
10	—	4 to 5	4 to 5	8	4 to 5	4 to 5
11	—	7	7	7	7	7

Table 3b—Impact test after 4 hrs conditioning at 0C°

1	—	4 to 5	4 to 5	4 to 5	4 to 5	2 to 3
2	4 to 5	5	4 to 5	4 to 5	4 to 5	4 to 5
3	4 to 5	4 to 5	4 to 5	4 to 5	4 to 5	4 to 5
4	—	6	7	7	4 to 5	4 to 5
5	—	8	8	8	8	8
6	—	1	1	1	1	1
7	—	5 to 6	5 to 6	5 to 6	5 to 6	1
8	—	7	7	7	7	7
9	—	7	7	7	7	1
10	—	4 to 5	4 to 5	8	4 to 5	4 to 5
11	—	7	7	7	7	7

Table 3C—Impact test, after 200 hours' artificial weathering

1	—	4 to 5	4 to 5	4 to 5	4 to 5	3 to 4
2	4 to 5	4 to 5	4 to 5	4 to 5	4 to 5	3
3	All show cracking and lifting after 200 hr, not impacted					
4	—	7	7	7	4 to 5	4 to 5
5	—	7	7	7	7	2 to 3
6	—	4 to 5	4 to 5	4 to 5	4 to 5	4 to 5
7	—	5 to 6	5 to 6	5 to 6	5 to 6	1
8	—	7	7	7	7	7
9	—	6	6	6	4	Not impacted. Finish cracked and peeled off after 200hr.
10	—	4 to 5	4 to 5	8	4 to 5	4 to 5
11	—	7	7	7	7	7

Assuming a value of 6 as acceptable, only paints 8 and 11 were satisfactory under all conditions and on all substrates. Paint 5 was satisfactory over all surfaces other than the wash-primed zinc silicate primer, later shown to be a poor pretreatment. Paints 4 and 9 were satisfactory over phosphoric acid wash, blast-cleaned surface and metal spray but not over the zinc silicate primer, with or without wash primer.

Non-slip properties

Refs. 6, 8

Non-slip properties were determined by Method 30 of DEF 1053[6] but modified so that the test surfaces consisted of:

(a) tanned sole leather smoothed with grade O glass paper;

(b) vulcanised rubber with hardness 60-80BS degrees or durometer A.

Conditions of test were:

1. Dry.
2. Wet with sea water.
3. Oiled with SAE 10W oil.
4. Both oiled with SAE 10W oil and wet with sea water.

The load was 28lb applied uniformly over test materials for both the static coefficient of friction and the coefficient of sliding friction at a rate of traverse of 5ft/min (1.5m/min). The apparatus is illustrated in Fig. 1. The results were recorded as an average of four individual readings, and are given in Tables 5a and 5b.

The requirements of DEF 1117A "Paint, Non-slip"[8] state that the coefficient of friction under the various conditions shall be not less than the values given in Table 4.

Table 4

Specification requirements for coefficient of friction

Test material	Condition of surface		
	Dry	Wet	Oily
Static friction			
Leather	0.75	0.75	0.70
Rubber	0.85	0.75	0.70
Sliding friction			
Leather	0.60	0.60	0.40
Rubber	0.75	0.65	0.40

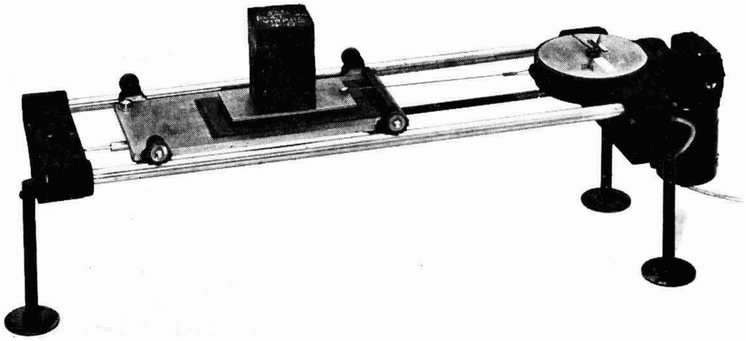

Fig. 1. Apparatus used for determining non-slip properties

Table 5

Coefficients of friction

Table 5a—Sliding coefficient of friction at 5 ft/min (1.5 m/min)

Code No.	Rubber				Leather			
	Dry	Seawater	Oil	Oil and seawater	Dry	Seawater	Oil	Oil and seawater
1	0.9	0.9	0.8	0.8	0.6	0.6	0.6	0.6
2	0.9	0.9	0.9	0.9	0.6	0.6	0.7	0.7
3	0.8	0.6	0.6	0.6	0.6	0.5	0.5	0.5
4	1.0	0.8	1.0	1.0	0.6	0.6	0.7	0.6
5	0.9	0.9	0.9	0.9	0.6	0.6	0.6	0.6
6	1.0	1.0	1.0	0.9	0.6	0.7	0.7	0.7
7	1.0	0.9	0.9	0.8	0.6	0.6	0.6	0.6
8	0.9	0.9	0.9	0.9	0.7	0.7	0.7	0.6
9	0.9	0.9	1.0	1.0	0.7	0.7	0.7	0.6
10	0.8	0.6	0.8	0.6	0.5	0.5	0.5	0.5
11	1.0	1.0	1.0	0.9	0.7	0.7	0.7	0.7

Table 5b—Static coefficient of friction

Code No.	Rubber Dry	Rubber Seawater	Rubber Oil	Rubber Oil and seawater	Leather Dry	Leather Seawater	Leather Oil	Leather Oil and seawater
1	1.3	1.3	1.4	1.4	0.9	1.1	1.1	1.2
2	1.2	1.3	1.2	1.3	0.8	1.1	1.1	1.2
3	1.0	0.9	0.9	0.9	0.9	0.8	0.8	0.9
4	1.4	1.4	1.6	1.4	1.2	1.4	1.4	1.0
5	1.5	1.4	1.4	1.4	1.0	1.1	1.1	1.3
6	1.6	1.6	1.7	1.6	1.0	1.4	1.4	1.5
7	1.3	1.3	1.4	1.3	0.9	1.1	1.1	1.2
8	1.3	1.4	1.4	1.4	1.2	1.1	1.3	1.3
9	1.3	1.3	1.4	1.4	1.1	1.1	1.3	1.4
10	1.3	1.2	1.5	1.5	1.0	1.2	1.2	1.3
11	1.6	1.5	1.7	1.6	1.1	1.2	1.3	1.3

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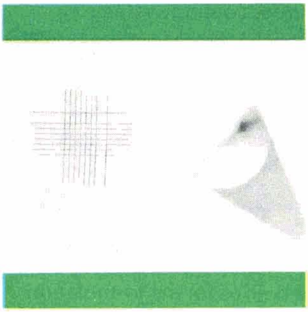

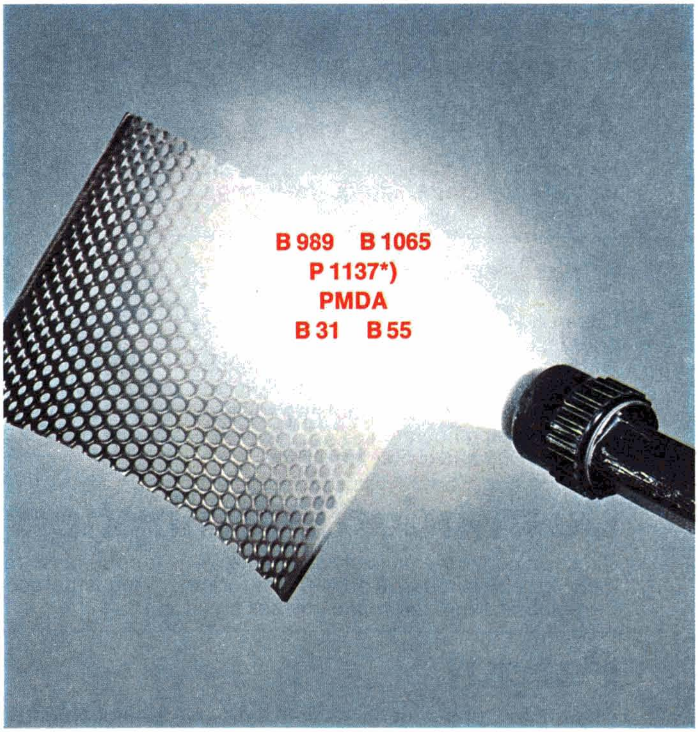

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Using these values as a guide, all the coatings had satisfactory non-slip characteristics except paints 3 and 10, which were marginally below these requirements.

Accelerated corrosion

Ref. 7

The apparatus used to carry out this test was similar to that described in the US Specification, MIL-D-23003 (Ships).[7] It consisted of a glass jar, 12in (300mm) in diameter and 12in (300mm) high, fitted with a number of Perspex shelves and a perforated bubbling tube. The shelves were drilled with numerous holes 0.5in (12mm) diameter. The test solution was 10 per cent w/v sodium chloride. Air which had bubbled through a depth of at least 6in (150mm) of water was then bubbled into the test solution at a rate of 0.3 ft^3/min (8.5 l/min). The duration of the test was 15 days at 20°C and the panels were allowed to age for 7 days before immersion. Immediately prior to immersion, a 1in (25mm) strip of paint was removed from one end of each test panel, leaving bare metal exposed.

The following aspects were considered in the assessment of corrosion:

1. Degree of corrosion of base metal.
2. Any film defect.
3. Lifting of coating or loss of adhesion.
4. Rust spread at bared edges of coating.

Paint 5 showed scattered spots of rust and slight corrosion of the base metal, over all pretreatments. Paint 10 blistered badly over metal spray pretreatment and corrosion of the metal spray occurred. It also showed small blisters and rust staining over zinc silicate primer. All other paints over all five pretreatments were satisfactory.

Accelerated weathering

Refs. 9, 11

Abrasive cleaned steel panels, 6in × 2½in (150 × 60mm) were coated with each paint; the edges and backs of the panels were protected with aluminium enamel. The panels were subjected to artificial weathering for 200 hours in an "Atlas" weatherometer using a cycle conforming to ASTM G-23 Type D.[11] Assessment was made in accordance with AS K41 Method 481.1[9] for discoloration, chalking, checking, cracking and loss of gloss, on a scale where 10 shows no defect and 0 complete failure. The results are reported in Table 6.

Table 6

Ratings after 200 hours' artificial weathering

Code No.	Defect rating				
	Discoloration	Chalking	Checking	Cracking	Loss of gloss
1	5	9	10	10	7
2	6	9	10	10	8
3	6	9	0	0	8
4	5	8	10	10	8
5	5	8	10	10	8
6	6	8	10	10	8
7	8	8	10	10	9
8	4	8	10	10	8
9	7	8	10	10	8
10	9	8	10	10	8
11	7	8	10	10	8

Only one paint, No. 3, performed badly in this test, by cracking. Apart from discoloration and loss of gloss, the remaining paints were unaffected.

Failure in respect of decorative properties, such as colour and gloss, is not considered as serious for a deck coating as for other coating purposes unless the failure is severe.

Resistance to abrasion

Two test panels of each paint applied over blast-cleaned steel were subjected to a modified Gardner abrasion test, as described in US Specification, MIL-E-11237 (ORD),[10] after 48 hours' drying, using 36 × aluminium oxide abrasive paper. The loss of weight after 500, 1,000 and 2,000 cycles was recorded.

The results shown in Table 7 indicate that paints 4, 8, 10 and 11 have less resistance to abrasion than the others.

Table 7

Resistance to abrasion

Code No.	Loss in g/number of cycles			Comments
	500	1,000	2,000	
1	—	0.80	0.95	—
2	—	0.15	0.20	—
3	—	0.85	1.05	—
4	6.3	—	—	After 2 days' drying, material was soft
4	1.00	1.7	2.7	Results after 14 days' drying
5	0.70	0.80	0.90	—
6	0.40	0.50	0.55	—
7	0.20	0.25	0.28	—
8	1.60	2.05	2.30	—
9	0.15	0.20	0.25	—
10	1.4	2.0	3.4	0.7 for 125 cycles
11	3.25	3.75	4.15	—

Resistance to fuels and lubricants

Test panels, 6in × 4in (150 × 100mm), of each paint over each pretreatment were immersed in:

1. SAE 10W oil for 24 hours at 20°C.
2. Avtur for 24 hours at 20°C.
3. Avgas 115/45 for 15 minutes at 20°C.

It is desirable, for deck paints, that there be no effect from these three other than a slight softening.

The results shown in Table 8 indicate that Paint 4 failed over all pretreatments and Paint 9 failed over the zinc silicate primer.

Storage properties

All the paints tested had satisfactory storage properties except Paint 11, which gelled. Fresh samples were obtained but they too solidified before testing could be completed.

Table 8
Resistance to fuels and lubricants

Code No.	SAE 10W oil	Avtur	Avgas 115/45
1	No effect	Very slight softening	Very slight softening
2	No effect	No effect	No effect
3	No effect	No effect	No effect
4	Primer softened and can be scraped off base metal (for all pretreatments)		
5	Film soft and can be removed from panel with knife edge, but the softness is no greater after immersion than before (for all pretreatments)		
6	No effect	No effect	No effect
7	No effect	No effect	No effect
8	No effect	No effect	No effect
9	Coating over zinc silicate primer and zinc silicate primer with wash primer has poor adhesion and can be pulled off in sheets. Other pretreatments are unaffected		
10	No effect	No effect	No effect
11	No effect	No effect	No effect

Exterior durability trials

Resistance to natural weathering

Conventional panel trials, using 16 gauge (1.6 mm) black steel panels, were conducted at the paint testing station, Williamstown Naval Dockyard. The panels were exposed on racks at 45° to the horizontal facing north. This trial was expected to yield information on the weathering and decorative properties of the systems. The five main pretreatments described in this report were used in these trials. The total film thickness of the various paints was as given in Table 2. Ratings after 24 months' exposure are given in Table 9. Where the ratings on all pretreatments are the same, only one set of ratings is shown.

Except for paints 9 and 10, all the paints tested showed an appreciable change in colour on exposure. Five paints, numbers 1, 4, 5, 6 and 10, were satisfactory on all substrates and only one, paint 3, failed on all substrates. Paint 2 was satisfactory over metal spray and zinc silicate primer. Paints 7, 8 and 11 were satisfactory over metal spray, zinc silicate primer, zinc silicate primer with wash primer, whilst paint 9 only failed on the zinc silicate primer with wash primer.

Resistance to vehicular traffic

Three steel plates 8ft × 5ft × 0.25in (2.5m × 1.5m × 6mm) were blast cleaned and pretreated in various parts in a similar manner to the resistance to natural weathering panels except that the phosphoric acid pretreatment was omitted. The paints under test were applied by brushing strips 6in (150mm) by 5ft (1.5m). Two coats were applied, allowing 24 hours between coats. The panels were exposed on the roadway at the entrance to a car park at Williamstown Naval Dockyard. A considerable amount of gravel was present in the test area and some of the failures noted were due to mechanical damage by this means.

As several samples of paint 11 gelled, no further testing was done on this paint. Paint 5 was tested only on blast cleaned and metal sprayed steel because of lack of material. Paint 2 was also tested over a special primer supplied by the manufacturer and this was designated paint 2A. Table 10 shows the total film thickness for the various paint systems.

The results of two years' exposure are shown in Table 11. These results indicate that the use of wash primer over the zinc silicate primer is not a satisfactory pretreatment. Taking this into account, paints 2, 3, 7, 8, 9 and 10 performed reasonably well, although fading and discoloration occurred with all systems tested.

Table 9
Resistance to natural weathering

Code No.	Pretreatment of surface	Results after two years' exposure						
		Discoloration	Chalking	Checking	Cracking	Flaking	Blistering	Rusting
1	All	2	7	10	10	10	10	10
2	Phosphoric wash	4	8	10	10	10	10	8
	Blast cleaned	4	8	10	10	10	10	8
	Zinc silicate with wash primer	4	8	10	10	10	10	9
	Remainder	4	8	10	10	10	10	10
3	Blast cleaned and phosphoric wash	—	—	—	—	0	—	0
	Metal spray	3	7	10	8	10	10	10
	Zinc silicate	3	7	10	8	10	10	9
	Zinc silicate with wash primer	3	7	10	6	10	10	9
	Recommended primer ..	3	7	10	6	10	10	7
4	All	2	8	10	10	10	10	10
5	All	2	8	10	10	10	10	10
6	All	4	8	10	10	10	10	10
7	Phosphoric wash	—	—	—	—	0	—	0
	Blast cleaned	2	8	10	10	10	10	4
	Remainder	6	8	10	10	10	10	10
8	Phosphoric wash and blast cleaned	1	8	10	10	10	10	2
	Remainder	2	8	10	10	10	10	10
9	Zinc silicate with wash primer	8	8	10	10	5	10	10
	Remainder	8	8	10	10	10	10	10
10	All	8	6	10	10	10	10	10
11	Phosphoric wash and blast cleaned	4	7	10	10	10	10	8
	Remainder	4	7	10	10	10	10	10

Table 10

Vehicular traffic—film thickness of system in thousandths of an inch (mm for figures in parentheses)

Code No.	Blast cleaned	Metal spray	Zinc silicate primer	Zinc silicate with wash primer
1	40-50 (1.0-1.2)	50 (1.2)	50 (1.2)	50 (1.2)
2	20-30 (0.5-0.75)	40 (1.0)	50 (1.2)	50 (1.2)
2A	20-30 (0.5-0.75)	30-40 (0.75-1.0)	60 (1.5)	60 (1.5)
3	40 (1.0)	50 (1.2)	50 (1.2)	50 (1.2)
4	10-14 (0.25-0.35)	20 (0.5)	13-15 (0.3-0.37)	13-15 (0.3-0.37
5	40-50 (1.0-1.2)	60 (1.5)	— —	— —
6	20-40 (0.5-1.0)	40-50 (1.0-1.2)	40 (1.0)	40 (1.0)
7	50 (1.2)	40 (1.0)	40 (1.0)	40 (1.0)
8	40 (1.0)	40-50 (1.0-1.2)	40-50 (1.0-1.2)	40-50 (1.0-1.2)
9	25-30 (0.6-0.75)	40 (1.0)	30-40 (0.75-1.0)	30-40 (0.75-1.0)
10	20-30 (0.5-0.75)	30 (0.75)	15 (0.37)	15 (0.37)
11		Not coated		

As was to be expected, coatings applied over bare metal showed rusting where the coatings were damaged.

Resistance to foot traffic

Ref. 5

An area measuring 20ft × 3ft (6m × 1m) of a dry dock caisson at Williamstown Naval Dockyard was sand blasted to a Class 3 finish[5] and given similar pretreatments to the plate used for the vehicular traffic trials.

Strips of paint 3ft × 6in (1m × 0.15m) were applied by brush, two coats of finish being applied with 24 hours' drying between coats. Film thickness of the paint systems are shown in Table 12.

Paints 3, 5 and 11 were not tested and paints 6, 7 and 10 were only tested on some of the pretreatments due to shortage of materials. Results after two years' exposure are shown in Table 13.

[*For Tables 11 and 13 see pages 364 and 365*]

Table 12

Caisson—film thickness of system in thousandths of an inch (mm for figures in parentheses)

Code No.	Blast cleaned	Metal spray	Zinc silicate primer	Zinc silicate with wash primer
1	25 (0.6)	25 (0.6)	20-25 (0.5-0.6)	20-25 (0.5-0.6)
2	25 (0.6)	20-25 (0.5-0.6)	15-20 (0.37-0.5)	20-25 (0.5-0.6)
2A	15 (0.37)	25 (0.6)	25 (0.6)	20-25 (0.5-0.6)
3		Not coated		
4	10-12 (0.25-0.3)	10-15 (0.25-0.37)	10-12 (0.25-0.3)	10-12 (0.25-0.3)
5		Not coated		
6	20 (0.5)	15-20 (0.37-0.5)	— —	— —
7	25 (0.6)	25-30 (0.6-0.75)	20 (0.5)	— —
8	25 (0.6)	30 (0.75)	25 (0.6)	25-30 (0.6-0.75)
9	15 (0.37)	25 (0.6)	12-15 (0.3-0.37)	15 (0.37)
10	15 (0.37)	20-25 (0.5-0.6)	20 (0.5)	— —
11		Not coated		

Table 11

Results of two-year exposure to vehicular traffic

Code No.	Pretreatment	Discoloration	Chalking	Checking	Cracking	Flaking	Blistering	Rusting	Percentage coating remaining	Comments
1	1. Blast cleaned	NA[1]	NA	NA	NA	NA	NA	NA	10	Loss of coating noted after one year's exposure continued. This loss was partly caused by gravel from the surrounding area. Where base plate is exposed rusting has occurred. Surface retains some non-slip properties.
	2. Zinc silicate primer 3. Zinc silicate with wash primer	5	5	10	10	10	10	10	70	Retains some non-slip properties. Loss partly caused by gravel cuts.
	4. Metal spray	5	5	10	10	10	10	10	100	Retains some non-slip properties.
2	All pretreatments	5[2]	6	10	10	10	10	10	100	The coating remains intact but loss of adhesion to the zinc silicate primer overcoated with was primer is occurring. Considerable loss of non-slip properties.
4	All pretreatments	NA	NA	NA	NA	NA	NA	NA	Nil	Loss of coating noted after one year's exposure continued to such an extent that little remained after two year's exposure. Where base plate is exposed rusting has occurred.
5	Blast cleaned (rest of pretreatments not tested)	NA	NA	NA	NA	NA	NA	NA	Nil	Coating completely removed from panel.
6	1. Metal spray	NA	NA	NA	NA	NA	NA	NA	10	Most paint lost.
	2. Blast cleaned	4	6	10	10	10	10	7	85-90	10-15% lost by gravel cuts. Retains some non-slip properties.
	3. Zinc silicate primer 4. Zinc silicate with wash primer	4	6	10	10	10	10	10	90	10% lost by gravel cuts. Retains some non-slip properties.
7	1. Zinc silicate with wash primer	NA	NA	NA	NA	NA	NA	NA	Nil	Coating completely lost after one year's exposure.
	2. Rest of pretreatments	5	7	10	10	10	10	10	100	Retains some non-slip properties.
8	All pretreatments	4	7	10	10	10	10	10	100	
9	1. Metal spray 2. Zinc silicate with wash primer	NA	NA	NA	NA	NA	NA	NA	Nil	Complete loss of coating after one year's exposure.
	3. Rest of pretreatments	4	7	10	10	10	10	10	100	Retains some non-slip properties.
10	1. Blast cleaned	5	7	10	10	10	10	7	90	About 10% of film cut out by gravel etc.
	2. Rest of pretreatments	5	7	10	10	10	10	10	90	
11	Not tested	—	—	—	—	—	—	—	—	

Note: 1. NA—Not able to assess because of loss of coating.

2. Where results for all pretreatments are the same, only the one result is shown.

Table 13

Results of two years' exposure on caisson

Code No.	Pretreatment	Discoloration	Chalking	Checking	Cracking	Flaking	Blistering	Rusting	Percentagd coating remaining	Comments
1	All pretreatments[2]	NA[1]	NA	NA	NA	NA	NA	NA	5 to 20	Loss of coating which was evident after one years' exposure continued, so that little remains after two years. Similar results on all pretreatments.
2 2a	All pretreatments Blast cleaned	3	7	10	10	10	10	10	100	Surface wear noted after one year's exposure, did not progress any further after two years' exposure. Considerable loss on non-slip properties.
3	Not tested	—	—	—	—	—	—	—	—	
4	All pretreatments	3	7	10	10	10	10	10	50	Loss of coating independent of pretreatment. Rusting on bare metal.
5	Not tested	—	—	—	—	—	—	—	—	
6	1. Blast cleaned only	3	7	10	10	10	10	8	50	The gradual loss of coating evident after one year's exposure continued.
	2. Metal spray, remainder of pretreatments not tested.	NA	NA	NA	NA	NA	NA	NA	20	Metal spray pretreatment gave poorer results than blast cleaning only.
7	All pretreatments except zinc silicate with wash primer	4	7	10	10	10	10	10	80	Coating began to show signs of removal after two years. Non-slip properties retained.
8	All pretreatments	3	8	10	10	10	10	8	100	Some loss of non-slip properties.
9	All pretreatments	3	8	10	10	10	10	10	100	Slight loss of non-slip properties.
10	1. Blast cleaned only	2	8	10	10	10	10	8	90	The wear noted after one year's exposure did not progress much further at 2 years' exposure.
	2. Remainder of pretreatments except zinc silicate with wash primer	2	8	10	10	10	10	10	90	Some loss of non-slip properties.
11	Not tested		—	—	—	—	—	—	—	

Note: 1. NA—Not able to assess because of loss of coating.

2. Where the results for all pretreatments are the same, only the one result is shown.

This test was more severe than the one for resistance to vehicular traffic. Fading, discoloration and rusting over bare metal at damaged areas occurred for all coatings tested. Paints 2, 7, 8, 9 and 10 performed reasonably well.

Discussion

Effect of pretreatments

The resistance to the vehicular traffic test indicated that zinc silicate primer followed by wash primer was not a satisfactory pretreatment. Materials which performed reasonably well on other pretreatments failed badly when applied over zinc silicate primer overcoated with wash primer. Impact resistance tests also indicated that this pretreatment gave the poorest adhesion. Bare metal was also unsatisfactory because rusting always occurred at breaks in the coatings. Metal (zinc-aluminium) spray or inorganic based zinc silicate primer (without wash primer) are both suitable pretreatments.

Suitability of coatings

Considering only, therefore, the results relating to metal spray and zinc silicate primer pretreatments, a summary of test results is shown in Table 14. This shows that, of the materials tested, paints 2, 7, 8, 9 and 10 were acceptable in the practical trials. Paint 10, however, had poor non-slip properties, poor resistance to impact, wear and accelerated corrosion. This paint was based on acrylic latex, whilst paints 2, 7, 8 and 9 were all two-pack epoxy resin based materials. Therefore, it was considered that of the types of coatings tested two-pack epoxy based coatings are likely to be superior in performance as non-slip weatherdeck coatings. However, it is clear that not all two-pack epoxy materials are suitable because paints 1 and 3, also two-pack epoxy materials of American origin, were unacceptable.

Relevance of laboratory tests

The need to treat laboratory test results with caution is obvious from a study of Table 14. The resistance to abrasion results and the resistance to impact results do not correlate well with the results of the practical trials. However, the resistance to accelerated weathering results correlate well with the resistance to natural weathering results. The results tend to confirm the view that practical trials should be included, wherever possible, in programmes for the assessment of paint quality.

It is apparent from these trials that failures are largely connected with damage due to wear and abrasion. Natural weathering exposures, although accelerating the ageing of the paint film by ensuring that the incident ultra-violet energy level is higher than for horizontal exposure, do not provide a substitute for trials involving damage by wear and abrasion.

Conclusions

Pretreatments

Metal (zinc-aluminium) spray and inorganic zinc silicate primers are suitable pretreatments for use beneath weatherdeck paints. Bare steel is unsatisfactory as a substrate because corrosion occurs at breaks in the film and spreads beneath the film. The use of a wash primer over zinc silicate primer weakened rather than improved the adhesion of subsequently applied weatherdeck paints.

Suitable coatings

Of the materials tested, two-pack materials based on epoxy resin appear to be the most suitable for use on steel weatherdecks when applied over suitable pretreatments.

Laboratory tests

The results of laboratory tests, particularly resistance to impact and wear, do not always correlate well with the results of practical trials.

Table 14

Summary of test results

Tests	Acceptable materials										
1. *Laboratory tests*											
Application properties	1	2	3	4	5	6	7	8	9	10	11
Finish	1	2	3	4	5	6	7	8	9	10	11
Recoatability	1	2	3	4	5	6	7	8	9	10	11
Impact	—	—	—	—	5	—	—	8	—	—	11
Non-slip properties	1	2	—	4	5	6	7	8	9	—	11
Accelerated corrosion	1	2	3	4	5	6	7	8	9	—	11
Accelerated weathering	1	2	—	4	5	6	7	8	9	10	11
Resistance to abrasion	1	2	3	—	5	6	7	—	9	—	—
Resistance to fuels and lubricants	1	2	3	—	5	6	7	8	9	10	11
Storage properties	1	2	3	4	5	6	7	8	9	10	—
2. *Practical trials*											
Resistance to natural weathering	1	2	—	4	5	6	7	8	9	10	11
Resistance to vehicular traffic	—	2	3	—	—	—	7	8	9	10	*
Resistance to foot traffic	—	2	—	—	*	—	7	8	9	10	*
3. *Overall performance*	—	2	—	—	—	—	7	8	9	—	—

Note: A blank space indicates that the material failed the test.

* Indicates that the test was not performed.

Acknowledgements

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The dispersion of pigments and the rub-out properties of pigmented systems*

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Summary

Dispersion is a time/energy consuming process. A mathematical description of this process yields values for the speed constants of dispersion and the final shade strength. It is shown how these factors depend upon the quantitative composition of the ground material in both solvent-containing and solvent-free systems, and how they vary with different dispersing equipment. From the resultant relationships, a simple method for determining the optimum composition of the ground material is derived, and a wider interpretation of events occurring in dispersion given.

Before the dispersing properties of pigments are evaluated, it is important to see whether the depth of shade of a paint film corresponds to the actual degree of dispersion of the pigment, or whether secondary influences increase or decrease the tint. These secondary influences, particularly in solvent-containing systems, are due to the "rub-out" effect, which depends upon the atmosphere over the system, the flash-off time and temperature, the viscosity of the system, the specific surface of the pigments, their degree of dispersion, and the mix ratio of white/coloured pigments. The rub-out effect is due to the phenomenon of "demixing" which is caused by differences in particle size or mobility between coloured and white pigments, and by differences in the degree of distribution between the various pigment components. Possible methods for preventing or treating the effects of rub-out are quoted and interpreted.

Keywords

Processes and methods primarily associated with:
analysis, measurement or testing
rub out test
manufacturing or synthesis
flocculation
grinding
pigment dispersion

Properties, characteristics and conditions primarily associated with raw materials for coatings and allied products
tinting strength

A propos de la dispersion des pigments et du comportement au rub-out des systemès pigmentés

Résumé

La dispersion des pigments est une opération qui coûte du temps et de l'énergie. Au moyen d'une description mathématique de ce processus, on obtient des données sur la constante de la vitesse de dispersion et sur le pouvoir colorant final. On fait ressortir ici à quel point ces paramètres dépendent de la composition quantitative des matières à broyer, d'une part pour les systèmes à teneur de solvants et d'autre part pour ceux qui ne contiennent pas de solvants, et l'on montre également l'influence des différents appareils de dispersion. A partir des relations ainsi obtenues, on a mis au point un procédé très simple pour la détermination de la composition optimale du mélange à broyer et l'on donne une interprétation plus approfondie des phénomènes qui se produisent au cours de la dispersion des pigments. Avant d'évaluer le comportement des pigments à la dispersion, il importe de vérifier si l'intensité de la teinte d'un film de peinture correspond au degré de dispersion effectif du pigment utilisé, ou bien si elle a été augmentée ou diminuée par des influences secondaires. La cause de ces modifications réside, notamment lorsqu'il s'agit de systèmes à teneur de solvants, dans l'effet de rub-out. On montre ici que celui-ci dépend de l'ambiance au moment de l'évaporation des solvants ainsi que du temps et de la température d'évaporation, de même que de la viscosité du système, de la surface spécifique des pigments, du degré de dispersion de ceux-ci et du rapport entre le pigment blance et le pigment de couleur. On souligne que l'effet de rub-out repose sur des phénomènes de démixtion qui sont dus aux différences dans la granulométrie et la mobilité des pigments blancs et pigments de couleur, ainsi qu'aux différences dans le degré de distribution de chacun des pigments. On indique et interprète les possibilités d'empêcher ou d'atténuer l'effet de rub-out.

Über die Dispergierung von Pigmenten und das Rub-out-Verhalten Pigmentierter Systeme

Zusammenfassung

Die Dispergierung ist ein zeit- bzw. energieverbrauchender Prozess. Über eine mathematische Beschreibung dieses Prozesses erhält man Werte für die Geschwindigkeitskonstante der Dispergierung und die Endfarbstärke. Die Abhängigkeit dieser Grössen von der quantitativen Zusammensetzung des Mahlgutes bei lösungsmittelhaltigen und lösungsmittelfreien Systemen sowie bei verschiedenen Dispergiergeräten wird dargestellt. Aus den resultierenden Beziehungen wird ein einfaches Verfahren zur Bestimmung der optimalen Mahlgutzusammensetzung abgeleitet und eine erweiterte Interpretation der bei der Dispergierung ablaufenden Vorgänge gegeben.

Vor der Beurteilung des Dispergierverhaltens von Pigmenten ist es aber wichtig zu prüfen, ob die Farbtiefe eines Anstrichfilmes dem tatsächlichen Dispergiergrad des Pigmentes entspricht, oder ob sie durch sekundäre Einflüsse nach höheren oder niedrigeren Werten him verschoben ist. Die Ursache hierfür istbesonders in lösungsmittelhaltigen Systemen—der Rub-out-Effekt. Dessen Abhängigkeit von der Ablüftatmosphäre, -zeit und -temperatur der Viskosität, der spezifischen Oberfläche der Pigmente, deren Dispergiergrad und dem Mischungsverhältnis von Weiss- und Buntpigment wird dargestellt. Der Rub-out-Effekt beruht auf Entmischungserscheinungen, die verursacht werden durch Teilchengrössen- bzw. Beweglichkeitsunterschiede zwischen Bunt- und Weisspigment, sowie durch Unterschiede im Verteilungsgrad der einzelnen Pigmentkomponenten untereinander. Möglichkeiten zur Verhinderung bzw. Behandlung der Rub-out-Effekte werden aufgezeigt und interpretiert.

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*Presented to a meeting of the Irish Section on 15 February 1974.

О диспергировании пигментов и Rub-out-поведении пигментированных систем

Обобщение – *Резюме*

Диспергирование является трубующим времени и энергии процессом. Математическим описанием этого процесса получают данные для скоростной постоянной диспергирования и для конечной интенсивности цвета. Дается изображение зависимости этих величин от количественного состава измельчаемого материала в содержащих растворитель и свободных от растворителя системах, а также в различном оборудовании для диспергировании. Из результирующих соотношений выводится простой метод для определения состава измельчаемого материала и дается расширенная интерпретация протекающих во время диспергирования процессов.

Перед оценкой поведения пигментов при диспергировании важно провести проверку, соответствует ли глубина окраски пленки покрытия действительной степени диспергирования пигмента или она сместилась вследствие вторичных влияний в сторону более высоких или более низких значений. Причиной этого является – особенно в содержащих растворитель системах – Rub-out-эффект. Изображается его зависимость от атмосферы отходящего воздуха, его температуры и времени для удаления, от вязкости, от удельной поверхности пигментов, их степени диспергирования и от соотношения смеси белого и цветного пигмента. Rub-out-фэфект основывается на явлениях расслоения, которые вызываются различиями в величние частиц или подвижности между цветным и белым пигментом, а также различиями в степени распределения отдельных компонентов пигмента между собой. Показываются и интерпретируются возможности для избежания и устранения Rub-out-эффектов.

Introduction

Historically, the development of the paint industry is based on a highly skilled craft, which formerly had to cope with a large variety of natural raw materials of fluctuating quality. This led to the accumulation of a great deal of empirical knowledge and to the development of a "flair" for the formulation, processing and application conditions. A large proportion of this has been retained over the years, and is still the secret of success for a large number of paint manufacturers. Resin and pigment suppliers must bear this in mind when considering the vast range of binders and pigments available.

A few remarks will be made about this somewhat complex field, together with some findings on the dispersion of pigments and the rub-out properties of pigmented systems; that is, their colour stability under various application and drying conditions.

A knowledge of the relationship between the dispersion and rub-out properties and the various parameters is not only interesting from the point of view of processing methods and costing but also, for example, for colour formulation calculations, because the accuracy of the matchings also depends on the dispersion conditions and the colour stability of the pigmented system.

First of all, some of the conditions governing pigment dispersion will be discussed, and then the phenomenon of the "rub-out effect" will be considered more closely.

Pigment dispersion is a very time- and energy-consuming process and, therefore, costs money. This is because the colour strength of a pigment is developed only during the dispersion process.

Experimental

Refs. 1-3

In all the author's investigations, the colour strength was determined as K/S according to Kubelka and Munk[1] and, usually, at a reduction of 1 : 24. The paints were poured on to panels to give a coating with uniform hiding power. All were allowed the same flash-off time. A part of the coating was rubbed with a finger. All colour strength values given below refer to the rubbed surface. The reason for this will be given later.

The binder used was an acrylic-melamine system with xylene, butanol (1 : 1) as solvent. Dispersion was carried out in an attritor at a constant temperature of 25° ± 0.5°C.

Fig. 1 shows the development of colour strength with increasing dispersion time.

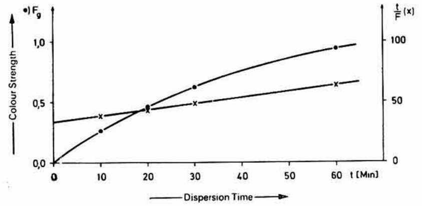


Fig. 1. Colour strength as a function of dispersion time

It will be seen that the colour strength tends towards a final value. However, by a transformation of co-ordinates, a procedure first used to solve this problem by von Pigenot,[2] the curve can be reduced to a straight line by plotting the reciprocal of the colour strength ($1/F$) against the reciprocal of the dispersion time ($1/t$), or to give a better correlation coefficient, by plotting the term t/F against t.

In this case the reciprocal of the intercept with the ordinate of the straight line has the dimension of rate and represents the dispersion rate constant of the system which will be called G.

The reciprocal of the gradient of the straight line gives the final colour strength E of the system. The equation for the straight line, therefore, is:

$$\frac{t}{F}=\frac{t}{E}+\frac{1}{G} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Both the dispersion rate G and the final colour strength E are, unfortunately, not constant values for any given pigment, but depend also on the dispersion conditions, the binder system and the mill base composition.[3]

The dispersion process

Solvent-containing systems

Refs. 4-6

In a solvent-containing system at constant pigmentation P, the dispersion rate decreases exponentially with increasing binder concentration B (Fig. 2).

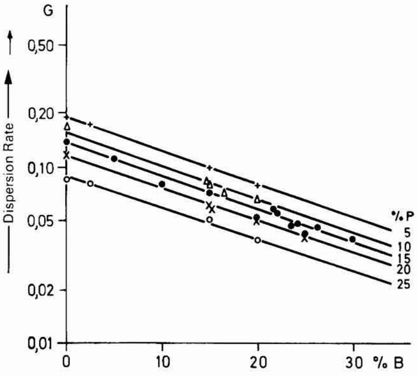


Fig. 2. Dispersion rate as a function of the binder concentration at different pigment concentrations

At a constant binder concentration, however, there is a linear decrease in dispersion rate with increasing pigment concentration (Fig. 3).

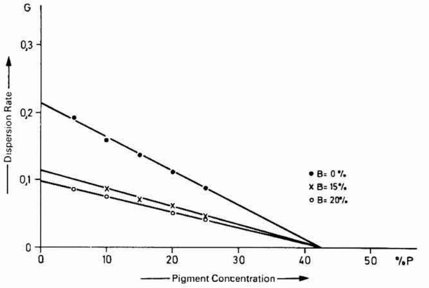


Fig. 3. Dispersion rate as a function of the pigment concentration at different binder concentrations

This leads to the following relationship between G, P and B:

$$G = (a - bP) \times 10^{-cB} \dots\dots\dots\dots (2)$$

where a, b and c are constants obtained from the gradients and intercepts of the straight lines in Figs. 2 and 3.

The final colour strength E is also dependent on the composition of the mill base. As is shown in Fig. 4, it increases with increasing binder concentration and decreases with increasing pigment concentration (Fig. 5).

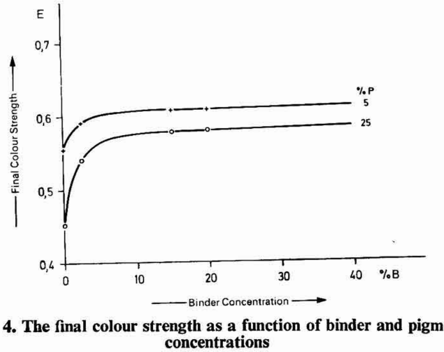


Fig. 4. The final colour strength as a function of binder and pigment concentrations

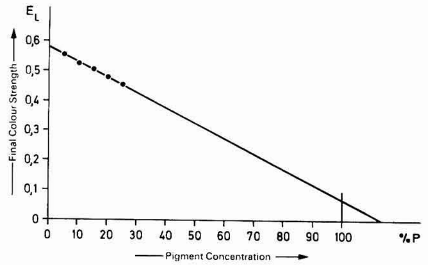


Fig. 5. The final colour strength in a pure solvent as a function of pigment concentration

It can be seen from Fig. 5 that at a pigmentation of 100 per cent the extrapolated final colour strength is not zero but has a finite value. This value corresponds to the initial colour strength before dispersion, if the pigment were to be carefully stirred into the binder and then mixed with white paint.

The equation for the dependence of the final colour strength on the pigment and binder concentrations can be calculated, and is as follows:

$$E = \frac{BP\,(a_1 + a_2P)}{BP + (a_3P + a_4)\,(a_1 + a_2P)} + (a_5 - a_6P) \,.. (3)$$

where a_1 to a_6 are constants.

The throughput and the optimum pigment concentration at the maximum throughput can be calculated from equations (2) and (3).

The throughput is defined as the amount of pigment which, in unit time and volume in the particular binder system, corresponds to some defined quality standard and can be defined for a required colour strength F by:

$$D = (P/t)\,F,\ V,\ B \dots\dots\dots\dots\dots (4)$$

If the time t in equation (4) is substituted by the value obtained from equation (1), the throughput can be represented by:

$$D = PG\,((1/F) - (1/E)) \dots\dots\dots\dots (5)$$

It is easy to see, therefore, that the throughput tends towards zero as the desired colour strength F approaches the final colour strength E.

Substituting equation (2) gives:

$$D = (aP - bP^2)\,10^{-cB}\,((1/F) - (1/E)) \dots\dots (6)$$

and from this relationship it can be seen immediately that there must be a throughput maximum related to P owing to the term $(aP - bP^2)$.

The dependence of the final colour strength on the pigment and binder concentrations need no longer be taken into account with pigments concentrations less than, or equal to, 10 per cent and binder concentrations less than, or equal to, 30 per cent. The errors are thus in the region of 5 per cent. The optimum concentration, P_{max}, at the throughput maximum is obtained by differentiation of equation (6) with respect to P. This gives:

$$P_{max}\ \text{(per cent)} = a/2b \dots\dots\dots\dots\dots (7)$$

The optimum pigment concentration, P_{max} can be determined by finding the dispersion rates, G_1 and G_2, in a given binder solution at two pigment concentrations, P_1 and P_2, and using the equation:

$$P_{max}\text{ (per cent)} = \frac{G_1P_2 - G_2P_1}{2(G_1 - G_2)} \quad \text{........(8a)}$$

Or, if the intercepts A_1 and A_2 of the straight-line graphs for the colour strength development (equation (1)) are used, which are equivalent to $1/G_1$ and $1/G_2$ then:

$$P_{max}\text{ (per cent)} = \frac{A_2P_2 - A_1P_1}{2(A_2 - A_1)} \quad \text{........(8b)}$$

Special attention should be paid to the choice of binder concentrations as, at too high a concentration, the dispersion rate is too low and, at too low a concentration, the final colour strength is also too low and there might be difficulties in letting down (shock phenomenon, etc.). In the author's experience, the best binder concentration for organic pigments is about 20 per cent.

Fig. 6 gives an idea of the conformity of throughputs calculated theoretically according to equation (6) and those determined experimentally.

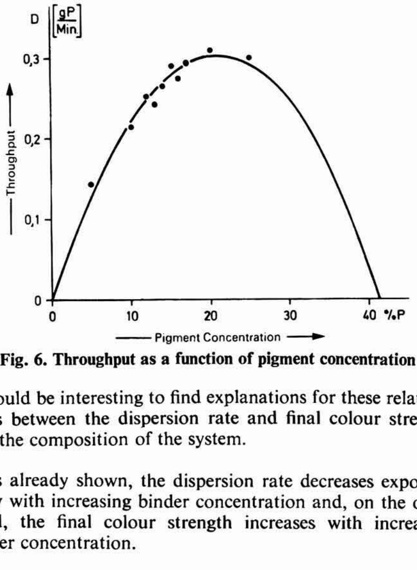


Fig. 6. Throughput as a function of pigment concentration

It would be interesting to find explanations for these relationships between the dispersion rate and final colour strength and the composition of the system.

As already shown, the dispersion rate decreases exponentially with increasing binder concentration and, on the other hand, the final colour strength increases with increasing binder concentration.

What are the reasons for this behaviour?

It is generally assumed that the application of shear to the pigment agglomerates is the decisive factor in pigment dispersion. It is also known that this shearing is improved by increasing viscosity of the binder system. Furthermore, it is also known that the viscosity of a binder solution increases exponentially with increasing binder concentration. Consequently, the dispersion rate should increase with increasing binder concentration. The exact opposite is, however, the case.

The reason for this is obviously because in systems with relatively low viscosities, it is not the shear force that is the decisive factor governing the dispersion rate but the diffusion rates of the binder and solvent molecules.

The diffusion rate, dn/dt, is proportional to the concentration gradient $\delta c/\delta x$ and inversely proportional to the size of the diffusing molecules r and the viscosity η. Therefore:

$$dn/dt = (KT/6\pi r\eta)(\delta c/\delta x) \quad \text{..................(9)}$$

where K = Boltzmann constant

T = Absolute temperature

A similar result is obtained if the penetration or wetting rate of a liquid medium into the pores of a pigment agglomerate is considered.

According to Washburn,[4] the penetration time t is given by:

$$t = \frac{k^2l^2}{R} \cdot \frac{2\eta}{\gamma_2 \cos \nu} \quad \text{...............(10)}$$

where k = constant for the pore geometry

l = length of pores

R = radius of pores

η = viscosity

$\gamma_2 \cos \nu$ = wetting tension of the binder solution

For a given pigment, the pore geometry can be considered as constant and the wetting tension will vary by only a few per cent for the range of binder concentrations. Therefore, the viscosity is the decisive factor in determining the penetration time. Since the viscosity increases approximately exponentially with the binder concentration, the penetration or wetting rate and the diffusion rate will decrease. If these factors are decisive in governing the dispersion rate, then the dispersion rate must decrease exponentially with the binder concentration and be inversely proportional to the viscosity; and this is what, in fact, is observed (Fig. 7).

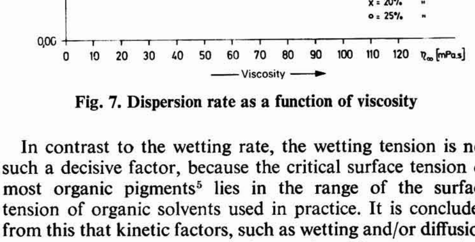


Fig. 7. Dispersion rate as a function of viscosity

In contrast to the wetting rate, the wetting tension is not such a decisive factor, because the critical surface tension of most organic pigments[5] lies in the range of the surface tension of organic solvents used in practice. It is concluded from this that kinetic factors, such as wetting and/or diffusion rates, are of more importance for the dispersion process than the energetic factors, such as wetting tension or wetting power.

What causes the change in final colour strength E with change in binder concentration and the decrease in dispersion rate with increasing pigment concentration?

It is known that the energy supplied during dispersion is used to overcome the adhesion between the individual pigment particles in the agglomerates. However, the dispersed particles tend to re-agglomerate, a process that opposes the separation during dispersion. The extent of re-agglomeration and the stability of the newly formed agglomerates and aggregates depends on both the nature and amount of the energy imparted throughout the milling and on the degree of stabilisation of the particles.

It is known that fragments formed during the breaking up of particles can re-agglomerate immediately after their formation, if the forces of attraction are high enough.[6] Conversely, the dispersion process can be carried further if the particles, isolated from the existing agglomerates, can be stabilised against re-agglomeration by the adsorption of binder components. Although dispersion proceeds more slowly at higher binder concentrations, more and finer dispersed particles can exist in the isolated state. Consequently, the level of the final colour strength is higher. This means that the stabilisation of a given state of dispersion depends on the availability of stabilising molecules and on the mean distance between pigment particles. This, therefore, is the reason for the decrease in final colour strength and dispersion rate with increasing pigment concentration.

Solvent-free systems

The above conditions apply, in particular, to systems containing solvents. In solvent-free systems, where the binder concentration is constant (100 per cent) these relationships are only partly true.

As with the systems of relatively low viscosity containing solvents, the dispersion rate also decreases with increasing binder viscosity in highly viscous, solvent-free systems, if a triple roll mill is used (Fig. 8).

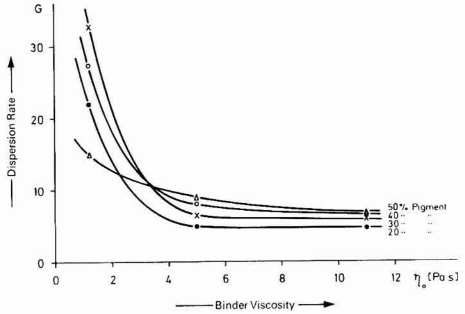


Fig. 8. Dispersion rate as a function of binder viscosity at various pigment concentrations (solvent-free system, triple roll mill)

With increasing pigment concentration, the dispersion rate passes through a maximum, the height and position of which depend on the binder viscosity (Fig. 9).

The height of the maximum decreases with increasing binder viscosity, and its position shifts simultaneously towards higher pigment concentrations.

Obviously, there is a slightly different dispersion mechanism in solvent-free systems from that operating in solvent-containing systems. This can be seen from the fact that for a mineral oil varnish (containing a solvent), the dispersion rate decreases linearly with increasing pigment concentration in spite of the system's relatively high viscosity of 3.3 Pa.sec (33 poise).

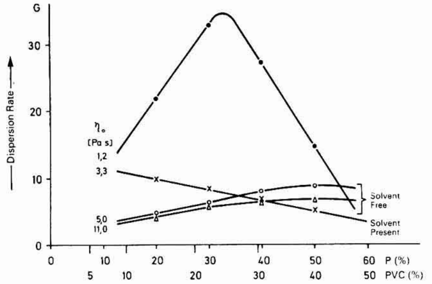


Fig. 9. Dispersion rate as a function of pigment concentration in three solvent-free and one solvent-containing systems (triple roll mill)

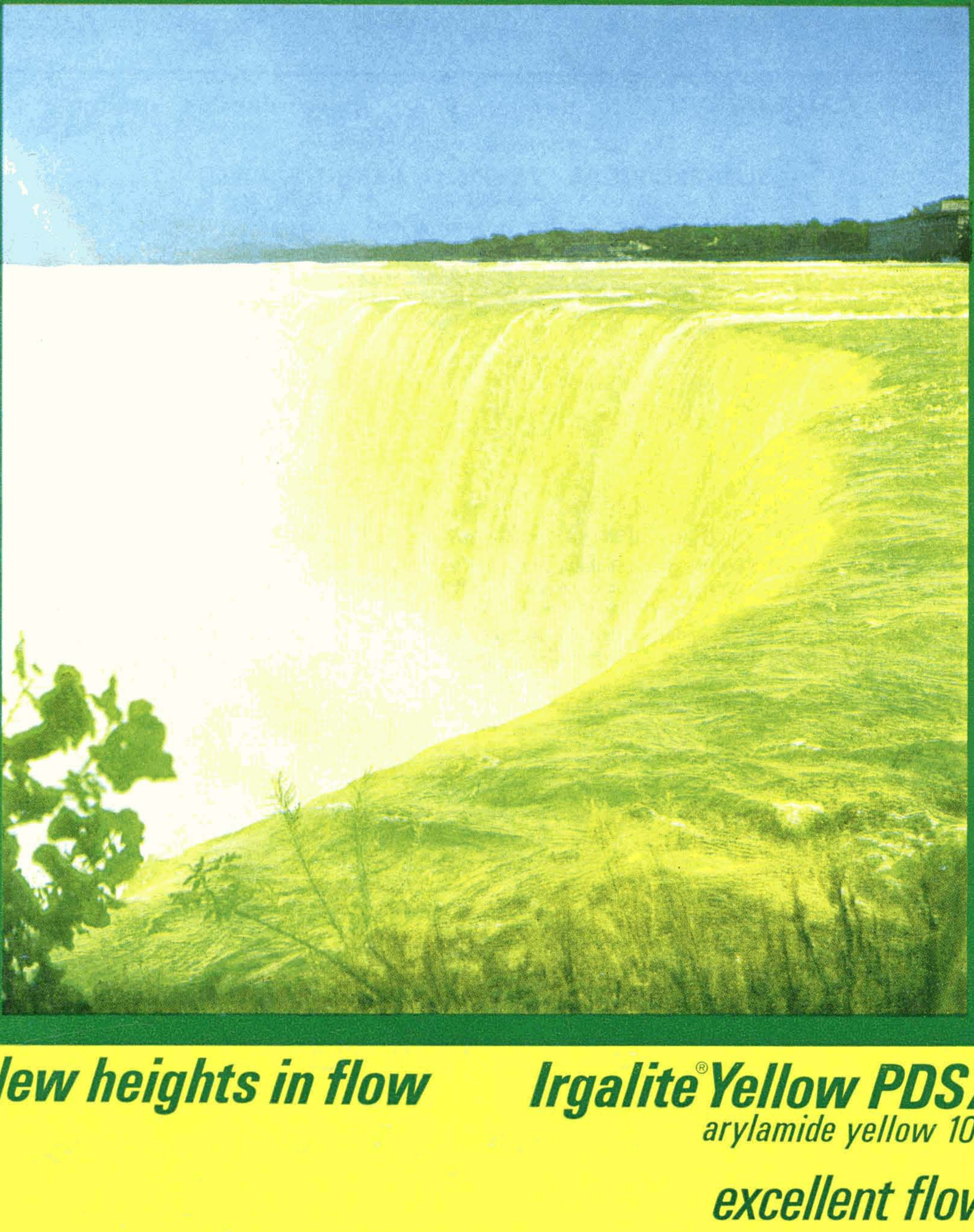
How is this explained? It has already been shown that the diffusion processes determine the rate of dispersion. In comparison with binder molecules, solvent molecules are considerably smaller and diffuse relatively quickly on to the particle surfaces and into the agglomerate pores. In doing so, they weaken the forces of attraction between the primary particles and the aggregates. On account of their small size, solvent molecules exert only a weak stabilising effect against re-agglomeration. The probability of re-agglomeration increases with increasing pigment concentration; therefore, the dispersion rate is reduced.

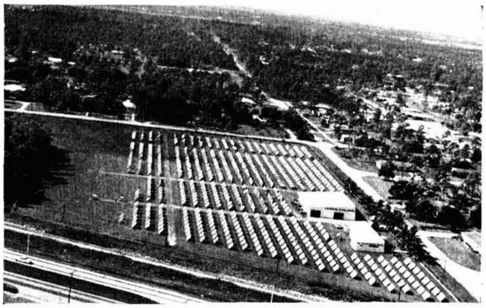
On the other hand, in solvent-free systems the relatively large molecules diffuse much more slowly, but can give better stabilisation against re-agglomeration.

This means that in solvent-free systems, the pigment particles can be stabilised at much higher pigment concentrations than can be obtained with systems containing a solvent. Now, large polymer molecules stabilise more efficiently than small ones, and if it is assumed that the binder components have similar molecular compositions, the viscosity of the binder (solvent-free) can be taken as a measure of the mean molecular weight. Hence it can be explained why the maximum value of dispersion rate will be higher at the lower binder viscosities and will lie at correspondingly lower pigment concentrations. The molecules of a binder with a low molecular weight diffuse more quickly and lead to a higher dispersion rate; but they do not have such a good stabilising effect, so that the maximum value of dispersion rate lies at a lower pigment concentration than that of systems with higher viscosity.

If the available binder is not sufficient for complete stabilisation of all particles, the dispersion rate will decrease with increasing pigment concentration and will become zero at a certain value. The pigment concentration at which the dispersion rate becomes zero is displaced towards higher values with increasing molecular weight or viscosity due to the greater stabilising effect.

The increase in dispersion rate at lower pigment concentrations can be explained by the fact that the fully stabilised pigment particles act as mutual grinding agents. This means that particles which are surrounded by an absorption layer of binder molecules that stabilise effectively, become so close together at increasing concentrations that the particles in the outer region of an agglomerate become detached and dispersed as a result of the shear applied by two particles





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moving against each other. Likewise, this procedure occurs in the next layer of agglomerate and so on until it is fully dispersed.

The final colour strength is practically constant at higher pigment concentrations and is independent of the binder. Only after the pigment concentration has exceeded a certain critical value does it decrease owing to poor stabilisation.

Rub-out effect

Refs. 7, 8, 8, 9, 10, 7, 8, 8, 11, 12, 7, 8, 8, 13-15

Some precautions must be observed when determining the dispersion behaviour of pigments by colour strength measurements on systems reduced with white, since defects such as flocculation and flooding can take place. This is especially true for relatively low-viscosity, solvent-containing systems in which the so-called "rub-out" effect can show up.[7, 8]

The effect in question shows up colour strength differences in paint films which have been subjected to varying mechanical forces during application and drying, for example, through dipping, spraying, pouring, brushing and roller coating. In the laboratory, the rub-out test is usually carried out by pouring the paint to be tested on to a suitable substrate (for example, card or a metal panel) to give a uniform opaque covering. After a defined flash-off time, a portion of the surface is rubbed with the finger until the colour difference between the poured-on and the rubbed surface has reached a maximum and remains constant. Hence, the name "rub-out effect". It should also be noted here that the rubbed-out area of the paint film should remain completely opaque.

Unless otherwise stated, the investigations were carried out using a conventional acrylic/melamine stoving system containing butanol and xylene in a ratio of 1 : 1.

Fig. 10 shows three metal panels on which the lower part of the paint surface has been rubbed.

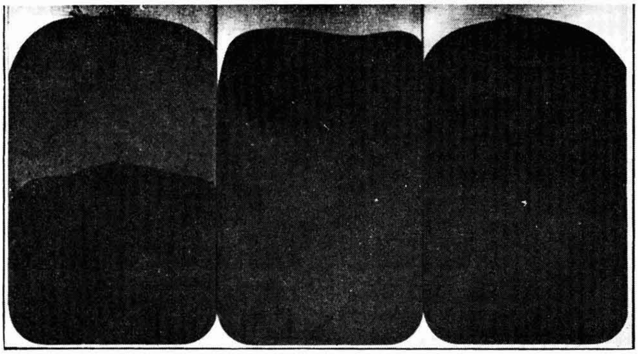

Fig. 10. Rub-out effects

On the left-hand panel, the rubbed surface is stronger in colour than the poured surface, and this is referred to as a "positive rub-out effect". On the central panel, no colour strength difference can be seen; on the right-hand panel, the rubbed area is weaker than the unrubbed area, and this corresponds to a negative rub-out effect. The distinction between flocculation on the left-hand panel and flooding on the right-hand panel is not very significant as, on one hand, an interpretation is implied which is not necessarily correct, and on the other hand the effects are based, in principle, on the same mechanism, as will be seen.

For a quantitative determination of the rub-out effect, the reflectance values for the rubbed and unrubbed surfaces are measured and, according to Kubelka-Munk, converted to K/S values, which are proportional to the colour strength F.

From the K/S values of the rubbed surface (F_g) and the unrubbed surface (F_{ng}), a "rub-out number" RZ is calculated according to the following equation:

$$RZ = (F_g/F_{ng}) - 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

This means that a positive rub-out effect is characterised by a positive numerical value, and a negative effect by a negative value. If there is no rub-out effect, $RZ = 0$.

Rub-out effects, as characterised by the rub-out numbers, depend on a great number of parameters[8] of which the most important may be mentioned.

The first are the ambient conditions for the tests.

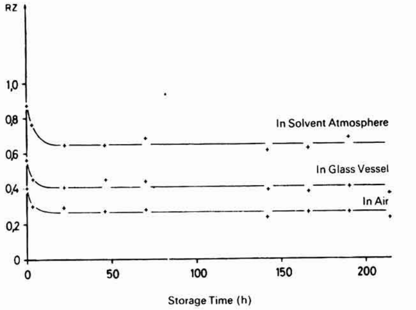

Fig. 11. RZ as a function of the ambient conditions and of the storage time of the unmixed paints

As can be seen from the graph, the rub-out number in an atmosphere practically saturated with solvent vapour is roughly twice that obtained under normal conditions in air.

Macroscopic observation shows that for the samples tested in a solvent atmosphere (that is, with a low flash-off rate), flooding of the titanium dioxide occurs, whilst with increasing flash-off rates, an increase in cell formation is observed (Fig. 12). Microscopic investigations show an

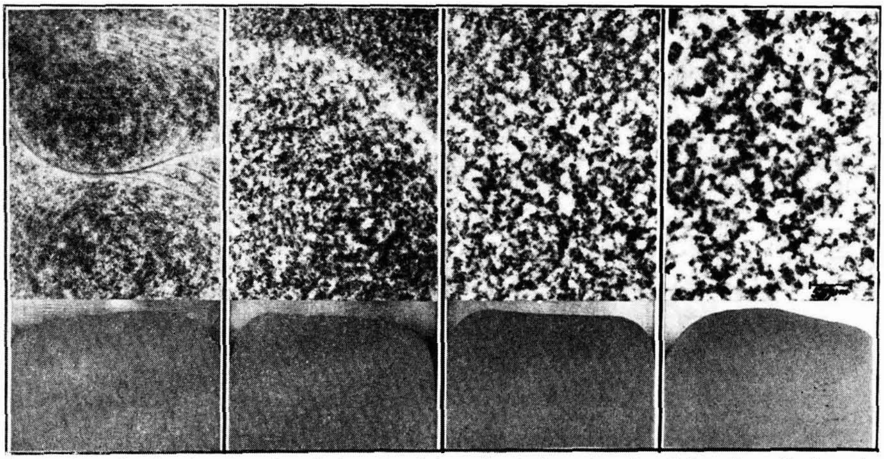

Fig. 12. Increasing floc size of a coloured pigment and decreasing tendency towards cell formation with decreasing evaporation rate (left to right)

increase in the floc size of coloured pigments with decreasing evaporation rate (Fig. 12).

An increase in the temperature gives rise to an increase in the rub-out effect (Fig. 13). It is interesting to note that at a temperature of —60°C, which corresponds to the freezing point of the solvent, the rub-out effect becomes zero.

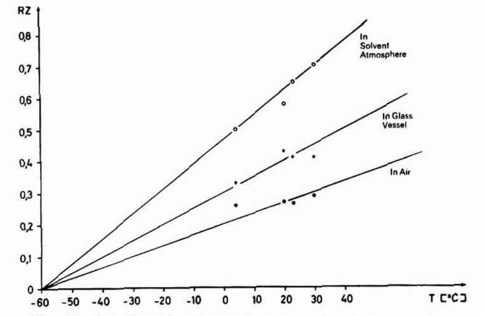

Fig. 13. Relationship of the rub-out number to temperature

The flash-off time also has an effect, as is shown in Fig. 14 The rub-out effect for given ambient conditions increases with the flash-off time and attains a final value.

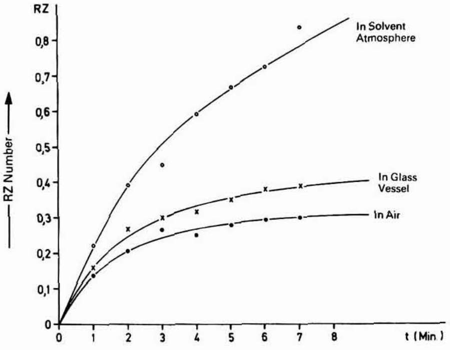

Fig. 14. Rub-out number as a function of flash-off time

The above parameters can be considered as procedure parameters. The following more functional parameters, however, are of more importance since they allow a further insight into the mechanism which leads to the rub-out effects.

Viscosity influences the rub-out effect in such a way that initially positive rub-out effects decrease with increasing viscosity, whereas initially negative rub-out effects become more negative (Fig. 15).

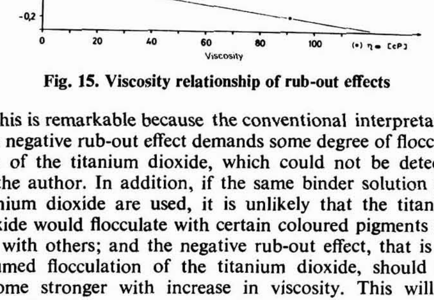

Fig. 15. Viscosity relationship of rub-out effects

This is remarkable because the conventional interpretation of a negative rub-out effect demands some degree of flocculation of the titanium dioxide, which could not be detected by the author. In addition, if the same binder solution and titanium dioxide are used, it is unlikely that the titanium dioxide would flocculate with certain coloured pigments and not with others; and the negative rub-out effect, that is the assumed flocculation of the titanium dioxide, should not become stronger with increase in viscosity. This will be demonstrated later.

If a range of phthalocyanine pigments is compared, an increase in the rub-out effect with an increase in the specific surface (Fig. 16) can be observed.

The scattering of the measured values is due to the fact that fine organic pigments are finer than TiO_2 and the surface determined by nitrogen adsorption represents only approximately the actual particle sizes in paints.

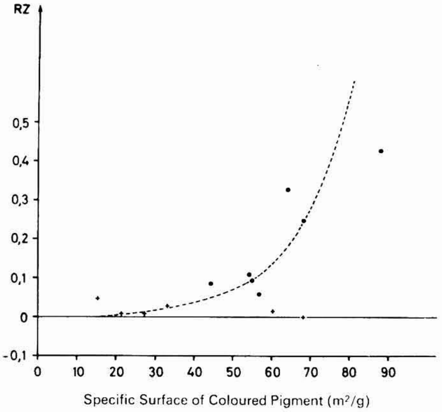

Fig. 16. Rub-out number as a function of the specific surface of the colour pigment

If various grades of titanium dioxide in an acrylic system are compared, it is found that an initial steep increase occurs in the rub-out number with increasing specific surface area, followed by a gradual decrease (Fig. 17).

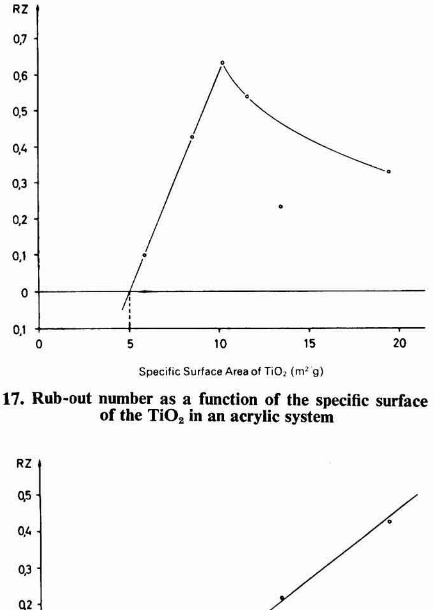

Fig. 17. Rub-out number as a function of the specific surface area of the TiO_2 in an acrylic system

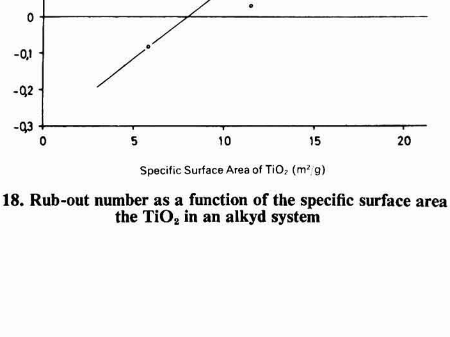

Fig. 18. Rub-out number as a function of the specific surface area of the TiO_2 in an alkyd system

In an alkyd medium, however, there is a linear increase in the rub-out number (Fig. 18).

These three examples show that:

1. The particle sizes of the individual pigments and the actual types of pigment exert a large influence on the rub-out effect.

2. At a certain particle size, the rub-out number becomes zero.

3. When a particle size is above or below a certain value, the rub-out numbers change their sign.

This influence becomes even clearer from the dependency of the rub-out effects on the degree of dispersion. It is known that the colour strength of a coloured pigment increases with decreasing particle size[9, 10] or increasing degree of dispersion.

Thus, the colour strength of the rubbed surface is an expression of the particle size, which is relatively easy to determine. The colour strength of the rubbed surface has been chosen because separation and flocculation have been cancelled by rubbing and the colour strength corresponds, by and large, to the actual degree of dispersion.

The following figs. show the dependence of the rub-out effect on the degree of dispersion, expressed as the colour strength of the rubbed surface F_g:

Fig. 19 shows this relationship for a range of copper phthalocyanine pigments; and Fig. 20, for a derivative of perylene tetracarboxylic acid di-imide in three different binders. The degree of dispersion of the titanium dioxide was the same in all cases. Fig. 21 shows the rub-out number as a function of the degree of dispersion of the TiO_2 at a constant degree of dispersion of the coloured pigment.

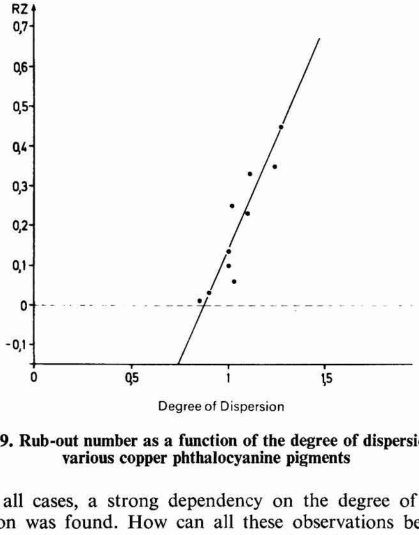

Fig. 19. Rub-out number as a function of the degree of dispersion of various copper phthalocyanine pigments

In all cases, a strong dependency on the degree of dispersion was found. How can all these observations be explained and brought to a common denominator?

Rub-out effects are separation phenomena which, generally, are based on the different particle sizes of the various pig-

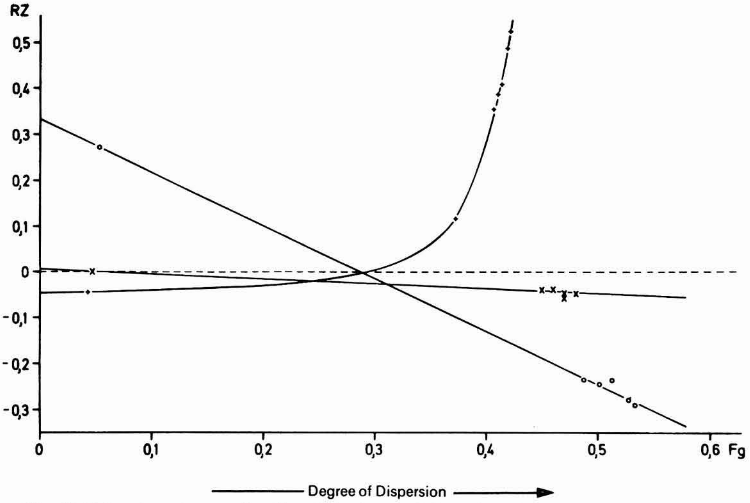

Fig. 20. Rub-out number as a function of the degree of dispersion of a perylene pigment in three different binders

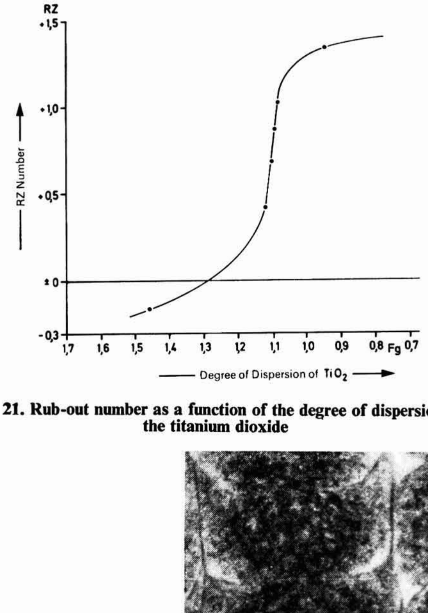

Fig. 21. Rub-out number as a function of the degree of dispersion of the titanium dioxide

ments in a single system.[7, 8] This is substantiated by the relationships discovered, as well as by the following findings and considerations.

In a drying paint film, flow and convection phenomena take place within the film, due to the evaporation of solvent. Pigment particles are carried along in the currents. The larger particles, for example pigment flocs, accumulate in the regions of low flow, and the relatively small particles, for example the unflocculated TiO_2 particles, accumulate in the fast-flowing regions, such as on the paint surface. These small particles become fixed in these regions when the flow ceases owing to the increasing viscosity of the paint film through solvent evaporation during the flash-off period.[8]

If the current is very strong, for example when drying in an air current, there may also be cell formation (Fig. 12), and the smaller particles would be found in the fast-flowing cell peripheries and the larger particles in the slow-flowing central cell areas (Fig. 22).

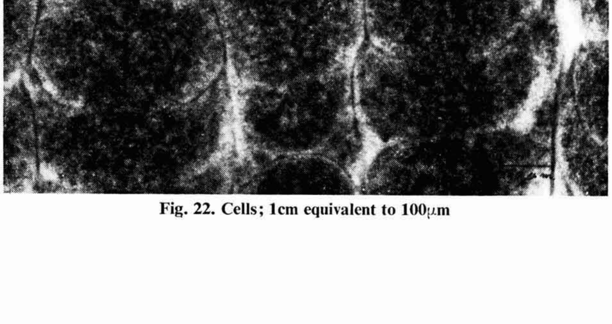

Fig. 22. Cells; 1cm equivalent to 100μm

Cell formation and flotation and their causes will not be considered in detail here, as these phenomena are not the direct cause of the rub-out effect.[11]

When particles of varying sizes are contained in a single system, therefore, a classification takes place, under the particular conditions described, and pigment particles separate into their various sizes.

A small supply of energy during application and drying, for example from pouring, favours this separation, whilst a high energy supply, for example spraying or hard brushing, reduces its effect. Consequently, the colour strength of the rubbed-out surface corresponds largely to the degree of dispersion of the pigment and reflects the conditions before separation.

Generally, if the coloured pigment particles are more mobile (smaller) than the white particles, they will float and a negative rub-out effect will be observed. If the coloured particles are larger than the white particles (ie, the coloured pigment is strongly flocculated), a positive rub-out effect results.

A condition for no rub-out effect, therefore, is that the particle sizes and particle size distributions of the coloured and white pigments be similar.

This also means that phthalocyanine and other organic pigments must always be flocculated to some extent, as their primary particles must, generally, be considerably smaller than those of titanium dioxide pigments in order to ensure optimum optical properties. Consequently, if the rub-out effect changes with an increasing degree of dispersion from positive to negative, it means that the coloured pigment flocculates only very slowly or not at all. On the other hand, change of rub-out effect from negative to positive is due to an increase in the flocculation of the coloured pigment.

This is understandable as, according to Smoluchowski[12] the flocculation rate, or decrease in the number of primary particles N, is given by:

$$-(dN/dt) = 8\pi DRN^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

where R is the collision radius and D the diffusion coefficient of the particles. The diffusion coefficient according to Einstein is given by:

$$D = KT/(6\pi rp\eta) \quad \ldots\ldots\ldots\ldots\ldots\ldots (13)$$

where K = Boltzmann constant
T = Absolute temperature
rp = Radius of primary particles
η = Viscosity

Therefore, if only the coloured pigment flocculates, the flocculation rate, and thus the actual particle size and the positive rub-out effect, will:

1. Increase with increasing temperature (Fig. 13).
2. Increase with decreasing particle size, that is increasing degree of dispersion (Figs. 16-21).
3. Decrease with increasing viscosity (Fig. 15).
4. Increase with increasing ratios of coloured to white PVC.

It is, therefore, possible to control the rub-out effect to a certain extent by these four parameters.

Sedimentation is of no practical importance in producing a rub-out effect. Owing to the small particle sizes and the rapidly increasing viscosity of the film during flash-off, there is not enough sedimentation time available for a layering effect to become visible, except in the rare cases. Moreover, the sedimentation movements are masked and disrupted by convection currents and transportation phenomena.[7, 8]

The cylinder test can give little information about rub-out behaviour, because the dynamic phenomena occurring during drying of the film are largely depressed or eliminated.

The interpretation of the rub-out effect in terms of separation phenomena is confirmed by the relationship between the rub-out number and the white/coloured pigment ratio at a constant PVC.[8]

Fig. 23 shows that the rub-out number rises proportionally with the white/coloured pigment ratio in the region of relatively high coloured pigment concentration. After a maximum value is reached, it decreases with increasing TiO_2 content.

Systems with negative rub-out effects show exactly the opposite behaviour (Fig. 24).

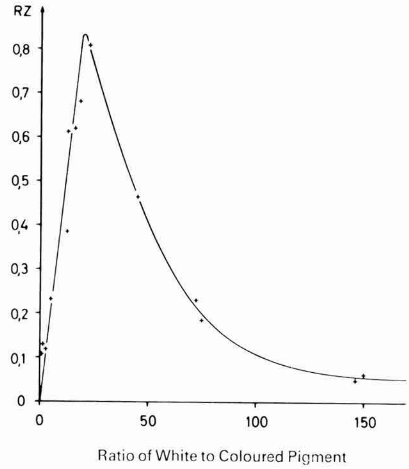

Fig. 23. Rub-out number as a function of the white/coloured pigment ratio at constant PVC (system with a positive rub-out effect)

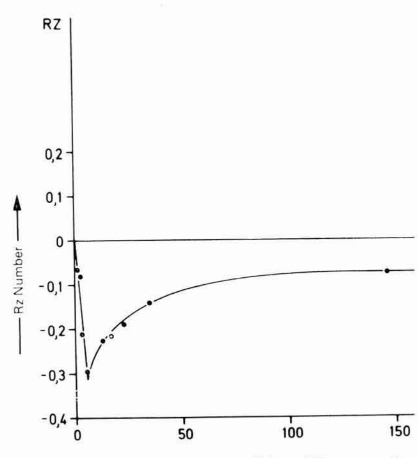

Fig. 24. Rub-out number as a function of the white/coloured pigment ratio at constant PVC (systems with negative rub-out effects)

This state of affairs arises because a rub-out effect cannot, by definition, be observed with systems containing only a coloured pigment or only TiO_2. The reason for this is because no separation can occur in a system containing only one component and with increasing dilution of this one component by a second, the degree of separation must increase to a maximum at a certain ratio of the two components.

In the past, increases in the positive rub-out effect have been explained by increased flocculation of the coloured pigment. This is rather unlikely, because increasing the proportion of white pigment dilutes the coloured pigment so that the probability of flocculation should be decreased. The same principle applies, conversely, to the negative rub-out effect, the explanation for which has been given hitherto as flocculation of the white pigment.

In addition to the increases in the actual particle size, two additional effects are caused by flocculation of the coloured pigment. The first is a decrease in the specific colour strength according to the Mie theory. This is based on the "coming together" of the coloured particles, and it also occurs when the coloured pigment concentration is increased.[13, 14]

The packing density of the particles in the flocs is comparatively low, and the white particles act as diluents. Consequently, the coloured particles absorb light better than agglomerates or aggregates, so that the loss in specific colour strength through flocculation in systems pigmented with both white and coloured pigments can be considered to be only relatively small.

A much greater influence on the apparent colour strength of a reduced system is exerted by the distribution of the coloured pigment particles, which are predominantly light-absorbing, in the particles of white pigment, which mainly reflect and scatter light. Before flocculation of the coloured pigment, all particles were evenly distributed throughout the available volume. However, on flocculation, this component is no longer so finely distributed, because the particles in the flocculates are concentrated within a relatively small space. Thus the intervening spaces are correspondingly large and contain no coloured particles. By this means, a second type of separation is superimposed on that caused by differences in mobility.

Some of the factors influencing the rub-out effect have been described and their mode of action suggested. The means of minimising the particularly obvious and troublesome positive rub-out effect will now be discussed briefly.

The working hypothesis is: if the rub-out effect is due to differences in particle size of the coloured and white pigments, then it can be minimised by closing the size gap.

As deflocculation of the coloured pigment by various additives did not succeed and as an increase in primary particle size of the coloured pigment did not seem applicable for optical reasons nor a reduction in the degree of dispersion for economic reasons, an attempt was made to flocculate the TiO_2. This method succeeded with various organic acids as Fig. 25 shows.

It is important to note that the additives were most effective when they were added to the titanium dioxide before it came into contact with the binder.

Furthermore, the efficiency of the additives increases with increasing molecular area. This can be seen in the following graph (Fig. 26), where the optimum quantities of additives have been plotted against the reciprocals of the molecular areas, which were obtained from level projections of Catalin models.

It is interesting to find that the optimum quantity of the additives decreases with increasing equivalent diameter of the TiO_2 particles and becomes zero at a value of approximately 290nm (Fig. 27). This value of the equivalent diameter corresponds to the specific surface of the TiO_2 (5 m^2/g) where, with the same binder, the rub-out effect would also be zero (Fig. 17).

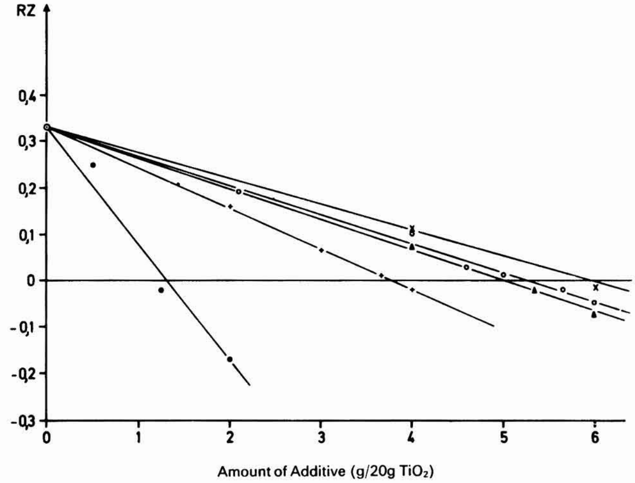

Fig. 25. Minimisation of the rub-out effect: the rub-out number as a function of the quantity of additives × Lauric acid; O phenylacetic acid; ▲ palmitic acid; + cinnamic acid; ● iso dodecyl benzene sulfonic acid

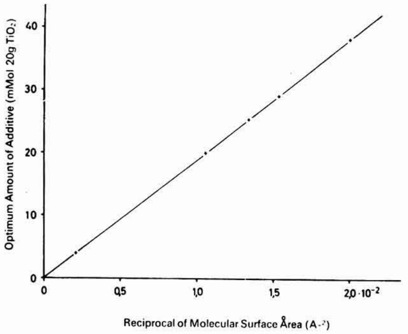

Fig. 26. Optimum quantity of additives as a function of the reciprocal molecular area

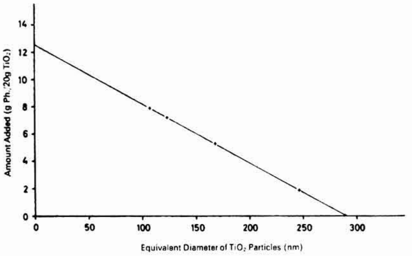

Fig. 27. Optimum quantities of phenylacetic acid as a function of the equivalent diameter of the TiO_2 particles

The results once again underline the great influence exerted by particle size on the rub-out effect.

In conclusion, the results of the experiments will be considered by microscopic examination.

Fig. 28 shows the liquid paint film under low magnification, on the left in the stabilised state and on the right in the unstabilised state. The improvement in the distribution of the coloured pigment after treatment in comparison to the initial state can clearly be seen.

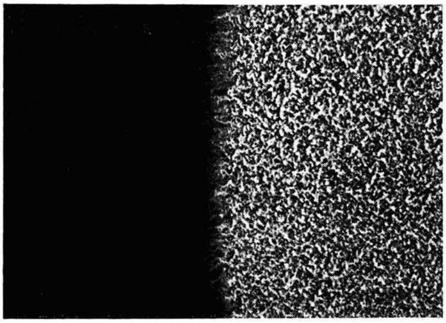

Fig. 28. Liquid paint film; left stabilised, right unstabilised. Magnification ×100

A photograph of the same system (Fig. 29) at a higher magnification shows in the unstabilised system on the left many small single particles of the unflocculated TiO_2 next to the large coloured flocculates, whereas there has obviously been some co-flocculation in the stabilised system on the right.

However, this coflocculation need not necessarily be due to an attraction between the white and the coloured pigment particles. It is much more likely to be caused by flocculation of the coloured and white particles occurring at the same time and at the same speed. Thus, the flocculates penetrate each other, and consequently coflocculation is observed.

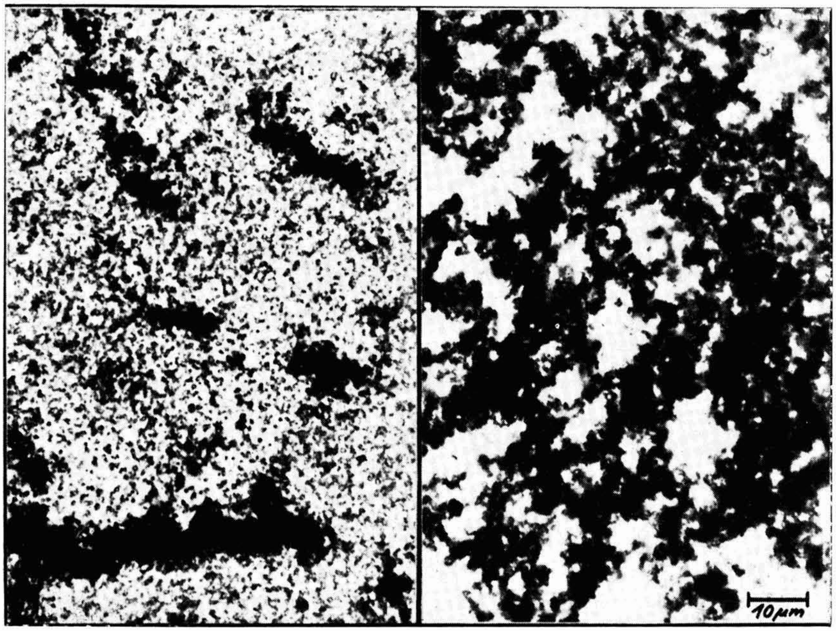

Fig. 29. Liquid paint film; left unstabilised, right stabilised

Under these conditions, separation (that is, the rub-out effect caused by the differing particle sizes and the variable distribution of one pigment component in the other) is no longer possible. At the same time, the packing density of the coloured particles remains much lower in the coflocculates than in pure pigment flocculates, as they are kept apart by the white particles. Thus, the chances are reduced of any possible slight reductions in the specific colour strength.

Fig. 30 shows a stoved finish. In the unstabilised system on the left, the fairly immobile coloured flocculates accumulate in the relatively low-flow areas of the cell centres, whilst the comparatively mobile TiO_2 particles are fixed in the strongly flowing cell peripheries. In the stabilised system on the right, no pigment separation can be observed despite the formation of cells.

This fig. shows that the tendency towards cell formation has not been influenced by the additives which flocculate the white pigment.

These results also confirm Daniels findings that coflocculation represents an optimum compromise.[15]

Conclusions

1. Rub-out effects always occur when:

   (a) Different pigment types with different particle sizes are contained in a single system.

   (b) The viscosity of the system is relatively low.

   (c) Convection currents are set up during the solvent flash-off.

   (d) The degrees to which the pigments are distributed in one another may change.

   (e) The system is exposed to various mechanical forces during application and drying, for example during spraying, brushing, roller coating, dipping or pouring.

These conditions are met in practically all finishes containing a solvent and more than one pigment, and by aqueous decorative paints; in such systems, in principle, rub-out effects would be expected.

2. From the above, it follows that:

   (a) It cannot be expected that colour formulations which apply to one particular binder system and to a given method of dispersing and application can be simply transferred to another system and to other working methods.

   (b) Allowance must be made when estimating colour properties, such as shade, strength and purity.

   (c) Allowance must be made when estimating and measuring the dispersion behaviour of pigments.

It is advisable to carry out rub-out tests in all cases before making any statements on the above points. In the investigations into dispersion described, only the colour strength of the rubbed surface has been used as a criterion.

   (d) Pigments are only stable on rub out under certain conditions. The search for a pigment which is universally stable to rub-out is, therefore, not a very promising proposition.

   (e) The rub-out effect can be minimised by the use of certain additives.

   (f) When no rub-out effect occurs in a multi-pigment system, it does not necessarily mean that one or other of the pigments is flocculation stable, but only that the system is rub-out stable. Finely divided organic

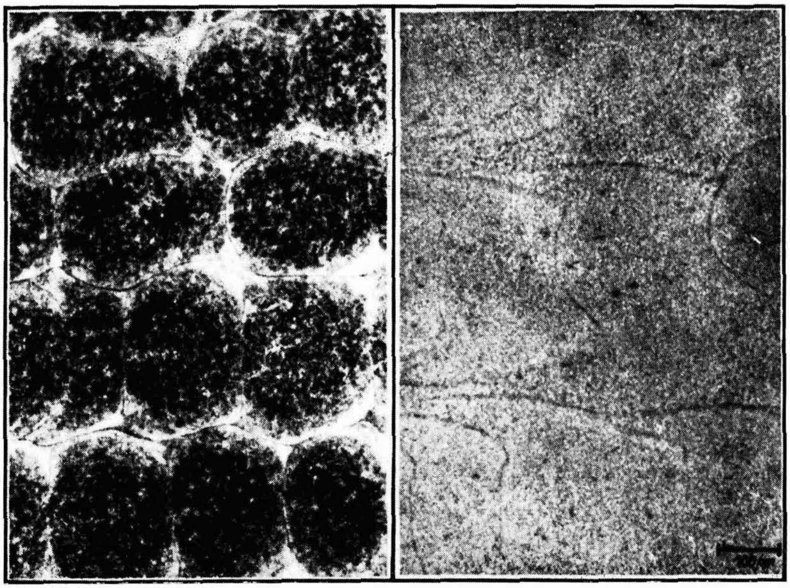

Fig. 30. Stoved finish; left unstabilised; right stabilised

pigments used in combination with TiO_2 must be flocculated to a certain extent.

(g) Because the rub-out effect does not solely depend on the flocculation of the pigments, it is rather meaningless to distinguish between rub-out effect, flocculation, flooding or floating. Instead, the terms "positive" and "negative" rub-out effects should be used.

(h) The dispersion properties of pigments depend to a large extent on the quantitative composition of the mill base, that is on the pigment/binder ratio. The pigment concentration at the throughput maximum is relatively easy to determine.

(i) The viscosity of the binder has a decisive influence on the dispersion process, because it governs the important kinetic factors, diffusion and wetting rate.

(k) The influence of energetic factors such as wetting power or wetting tension (that is, the affinity between the components of the medium and the surface of the pigment particles) is of less importance to the dispersion process in organic media, if one species of solvent and binder is used.[16]

[*Received 29 May 1974*

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Next month's issue

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

The effects of carbon black pigment blends on the performance and quality of printing inks *by M. D. Garrett*

An automated goniophotometer *by W. Carr*

The influence of the use of calcium carbonate (whiting) as extender in soluble antifouling paints based on cuprous oxide *by V. J. D. Rascio and J. J. Caprari*

Reviews

Emulsions and emulsion technology. Part 1

By K. J. Lissant (Editor)

Marcel Dekker Incorporated, New York; 1974. Pp. xii + 440. Price $39.50

This is the first part of a two-volume treatise on emulsions and emulsion technology which, in turn, comprises Volume 6 of the publishers' Surfactant Science Series.

There are eight chapters to the book and the first three of these, concerned with Basic Theory, Making and Breaking Emulsions and Microemulsions, constitute the theoretical treatment of the subject. The remaining five chapters on Agricultural Emulsions, Food Emulsions, Medicinal Emulsions, Emulsion Paints and Asphalt Emulsions, deal with the more practical aspects and applications.

It does seem a little strange that, at the very outset, it should be deemed necessary to justify the treatise by establishing some relationship between emulsions and ecology; but perhaps that is the way of things these days. It is the avowed intention of the editor to eschew much of the classical mathematics of emulsion technology and to concentrate, rather, on a geometrical approach to the subject. The point is made, indeed, that many emulsion systems behave as if their performance were more dependent upon their physical and topographical configuration than on the chemical composition of their constituents. The resulting treatment is valuable and does give a clearer picture of some aspects of the subject as well as throwing illumination on some of the apparent anomalies of emulsions. The general theoretical treatment in Chapter 1 is in terms of low, medium and high internal phase systems and this does lead to simplification. The tendency to use the expressions "water-internal" and "oil-internal" in place of the more traditional "water-in-oil" (w/o) and "oil-in-water" (o/w) can be a little disconcerting; but, on the other hand, there is the occasional use of refreshingly direct language, as when it is admitted that many emulsions are made by "brute force."

Dealing with making and breaking of emulsions, in Chapter 2 the "HLB" method of selecting emulsifiers tends to be passed over relatively briefly, a good deal more attention being devoted to the author's own more detailed method of classifying and testing non-ionic emulsifiers. The balance is redressed in Chapter 3, however, where the HLB method is discussed in some detail. This chapter contains much useful information on emulsion manufacture, in terms both of emulsion components and the equipment used. There may even be some passing interest in learning how to break emulsions.

The chapter on microemulsions (defined as dispersions of one liquid in another in which the particle diameter is less than a quarter of the wavelength of light, ie 0.14µm) is a most useful one and the subject is thoroughly covered. The importance of the "interphase" in microemulsions is stressed and a good deal of attention is paid to the concept of "alcohol partitioning" between the oil phase and the interphase, the point being made that emulsification depends upon partitioning rather than on solubility.

Apart from the chapter on emulsion paints—disappointingly, almost the shortest in the book—and some aspects of the one on asphalt emulsions, the more practical section of the book, as already indicated, is of somewhat restricted interest to the surface coatings industry. Suffice it to say that Gerould Allyn deals with emulsion paints with the competence one would expect. The detectable slant towards American technology is, perhaps, understandable. In the space available, the treatment can be no more than basic.

The book is clearly printed, well bound and contains the minimum of typographical errors. Each chapter is followed by a list of references, each of which is fully adequate and some quite exhaustive. There is no index to the present volume and, although it is the intention to have a comprehensive one in Volume 2, the omission is certainly a temporary disadvantage. As a complement to existing works on the technology of emulsions, this volume will make a valuable addition to the library. One would, perhaps, be rather less certain of recommending it as one on which the embryonic technologist should cut his teeth.

A. McLEAN

Introduction to Organic Electrochemistry

By M. R. Rifi and F. H. Covitz

Marcel Dekker Inc., New York, 1974. Pp. viii + 417. Price $26.50

This volume is one of a series published by Dekker under the title "Techniques and applications in organic synthesis". It is a basic book, in the sense that process as are outlined only, with accompanying references to the relevant published work. There are six major chapters and three appendices, together with an author and a subject index.

Chapters 1-3 deal in turn with an introduction to the subject, basic principles of electrochemistry, and apparatus and techniques. Chapter 4 deals with the reduction of functional groups (i.e., carbonyl compounds, nitro groups, C-H bonds, etc.), whilst Chapter 5 treats the subject of oxidation by electrochemical methods.

Chapter 6, which may well be the one of most interest to polymer chemists, discusses electro-initiated polymerisation, and surveys the advantages and disadvantages of this method, it includes sub-chapters on both anodic and cathodic polymerisation, as well as on the techniques employed.

Chapter 7 deals with electrocoating and covers the anodic and cathodic deposition of polymers, the formulation of electrocoating solutions and dispersions, and the factors affecting deposition. The evaluation of electrodeposited polymer films is dealt with in two or three paragraphs. This chapter concludes with a short statement on the advantages and disadvantages of this method of application.

The reviewer is aware that this review reads like a list of contents. This is just what this book is about: short comments on the varying aspects of the subject, together with extensive references to the subject under discussion. All in all, a useful reference book on electrochemistry.

D. S. NEWTON

Printing and dyeing of fabrics and plastics

By R. W. James

Noyes Data Corporation, Parkridge, New Jersey, and London, England; 1974. Pp. x + 275. Price $36.00 (cloth cover edition)

The information in this book is based on US patent literature published in the period November 1962 to November 1973. The significant information only has been compiled so as to give a review of technical developments in the printing and dyeing of fabrics and plastics as illustrated by over 150 patented processes.

In the introduction, it is pointed out that the rapid growth in synthetic textile fabrics and general widespread use of plastics has brought about the need for new types of dyeing formulations and printing inks to meet the demands of a style- and colour-conscious society.

The first three chapters deal mainly with processes relating to textile fibres—cellulosics, polyesters and cellulose triacetates and polyamides. Then follow three chapters on acrylics and polypropylenes, polyolefine plastics and other plastic substrates with the emphasis on printing techniques; for example, printing inks for polyethylene, polypropylene, polyvinyl chloride and polystyrene and the materials used in the binders.

Concerning the dyeing processes for cellulosics, these include new dyestuffs, fixation and reducing agents, pre-treatments and resists, surfactants and polymeric pigment binders. For the synthetic fibres, polyesters, polyamides, acrylics and polypropylenes, the developments cover fibre pre-treatments, new dyeing formulations, fixation agents and processing technology.

For inks to print on the difficult substrates, such as polyethylene and polypropylene, there is detailed information on the polymeric binders and here synthesis of different types of polyamide resins is stressed.

In addition to the information on printing of plastics, the ink manufacturer will find much that is useful from a study of the processes relating to dyeing and printing of textile fabrics. This information will be helpful in providing background knowledge on textile dyeing and printing technology, which field is becoming of increasing interest to the ink manufacturer who may be concerned, for example, with transfer inks and their applications.

The book has a combined contents and subject index which makes for easy reference and there is a patent number index and lists of inventors and company names. Many of the components of formulations are described by trade names, and for a few of these materials more precise details on chemical constitution and source would have been welcomed. In general, however, these aspects have been adequately covered.

G. H. HUTCHINSON

Section Proceedings

Wellington

Durability of polymer dispersions

At a meeting earlier this year attended by twenty-three members, Mr J. W. Hirst of Revertex Limited, presented a paper entitled "Durability of polymer dispersions in paint systems."

Mr Hirst divided the polymers into two categories, vinyl acetate copolymers and acrylic copolymers. The vinyl acetate copolymers were in combination with acrylics, styrene etc., whilst the acrylic copolymers were of the form acrylic-to-acrylic, such as methyl methacrylate/butyl methacrylate, methyl methacrylate/ethyl acrylate and so forth. The results were discussed of recently completed exposure trials of five years duration at 45° facing south at Penrose, Auckland. Pigment volume concentrations of 25, 30, 35, 40, 50 and 60 per cent were considered, and slides and graphs were shown to demonstrate colour, dirt retention, chalking, cracking and gloss.

Paints based on vinyl acetate terpolymers showed a high resistance to fungal growth at the end of the five-year period. Vinyl acetate versatate paints showed very good durability, whereas vinyl acetate/styrene paints broke down completely on timber but were quite suitable on cement and asbestos. Methyl methacrylate/ethyl acrylate paints gave excellent overall durability, and methyl methacrylate/2-ethyl hexyl acrylate performed well at all levels of PVC. Over the complete range of PVCs considered, the methyl methacrylate/butyl acrylate systems were best. Similar exposures in Malaysia, South Africa and the UK had given results comparable to those summarised above. Mr Hirst pointed out that cost/performance was the most important factor when deciding upon any one system.

A vote of thanks was proposed by Mr G. Willis for a most interesting and informative talk.

L.H.O.

Minerals in New Zealand

Twenty members were present at a meeting on 27 June 1974 at Industry House, Wellington, when Mr D. R. Martin, Technical Sales Manager for Lime & Marble Limited, spoke about New Zealand's economic minerals.

The lecture was, of course, mainly concerned with his company's present and potential range of minerals. The main local deposits of such minerals as asbestos, bentonite, kaolin in its various forms and the calcium carbonates were revealed and discussed in terms of quality, quantity and general economics.

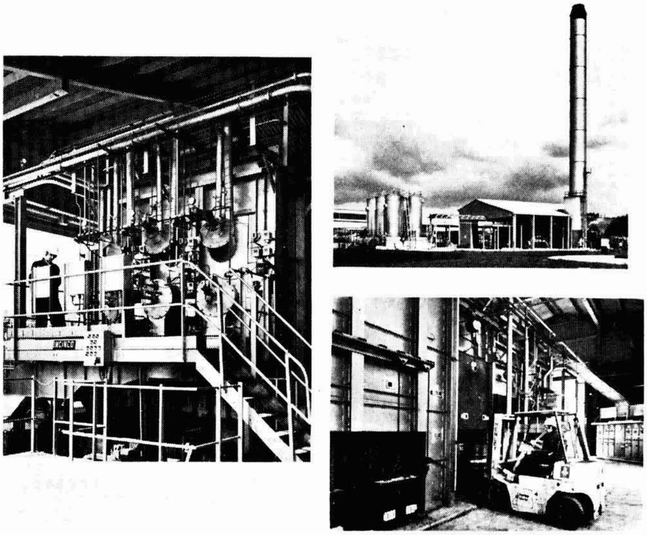
Another material vital to the surface coating industry—organically modified bentonite—was being investigated, but from recent development work on local deposits it had been shown that these were not suitable for conversion at this time. Mineral deposits of barytes and talc were known in New Zealand, but these would continue to be imported as the economics of mining them locally were not favourable.

Mr Martin told the group that compared with the area involved and population, New Zealand was richly endowed with many high quality minerals, but unfortunately until the internal transport systems could be geared to handle these minerals efficiently, full and profitable exploitation of them could not occur.

The lecture was followed by a vigorous question and answer session which revealed the interest that had been generated. A vote of thanks was given by Mr T. Slinn and the meeting was closed by the Chairman, Mr M. D. Taylor.

L.H.O.

Information Received



Three views of the new incinerator at Re-Chem International's centralised waste disposal complex near Pontypool, South Wales, which burns contaminated general factory waste, non-reusable oils, paint residues, contaminated solvents, as well as petrochemical, pharmaceutical and plastic waste. The incinerator was built for Re-Chem by the Incinerator Company Limited, Huntingdon, Cambridgeshire.

Energy use down in 1974

Energy consumed in the UK during June was 3.5 per cent less than in June 1973, and this is the seventh successive month in which energy use has fallen below that in the corresponding period of the previous year, according to reports from the Department of Energy.

Whilst consumption of coal was consistently lower in the first half of 1974 than in the same period during 1973, the use of natural gas increased by 22.5 per cent.

The Department of Energy's new monthly statistical bulletin "Energy Trends" suggests that the drop in consumption might have been due to a number of factors, which includes the high level of oil prices, continuing difficulties with coal supply during recovery following the miners' strike, and the continuation of energy saving practices introduced during the three-day working week.

E. & F. Richardson Limited

The Beaver Group Limited has announced that although contracts have been exchanged for the sale of its subsidiary company E. & F. Richardson Limited to Sigma Coatings Limited, the central purchasing department of the Beaver Group will continue to act as purchasing agents for raw materials and other supplies for E. & F. Richardson Limited.

Goodlass Wall sales

Goodlass Wall & Co Limited has announced that it will be concentrating its selling activities through two new groupings from 1 January 1975. A new Indirect User Group will be formed under the personal direction of the managing director, Mr J. L. Bickers. There will also be a Direct User Group, which will come under the direction of Mr W. G. Wainwright who was recently appointed deputy managing director.

Rohm & Haas expansion on Teesside

The Philadelphia-based chemical manufacturer Rohm & Haas has announced plans for a major expansion of its methyl methacrylate monomer plant on Teesside to increase annual capacity to 150 million lb. The plant came on-stream in 1972 with an annual capacity of 60 million lb of monomer per year. Construction of the new facilities is planned to begin in the second quarter of 1975 with completion scheduled for March 1977.

Design and engineering for the expanded Teesside facilities are being handled by the company's Engineering Division, which is located at Bristol, Pa.

APG turnover and profits up

A 9.75 per cent increase in operating profits compared with the same period in 1973 is reported in Allied Polymer Group's interim announcement issued recently. Pre-tax profits for the first six months of 1974 were £1 553 000—an increase of £138 000 over the 1973 figure.

New products

Ludopal LH22

An ultra-violet curing, unsaturated polyester resin designated "Ludopal LH22" has been introduced by BASF for use in the formulation of photo-curing primers and air-inhibited lacquers. In comparison with Ludopal LH21, Ludopal LH22 has a longer shelf-life although its reactivity is not substantially lower.

New Degussa diffusion colours

The Ceramic Colours Division of Degussa, Frankfurt am Main, has developed a new process for the production of diffusion colours, which are mainly used for staining glasses with low heat expansion coefficients. The diffusion colours manufactured by this process are better and cheaper than the previous grades. For industrial glass, Degussa offers the types 170 30026 (light yellow) and 170 60014 (yellowish-brown); for borosilicate glass the type 170 30031 (brownish-yellow) and 170 60046 (brown). The new diffusion colours are supplied in the form of very fine powders. The two types can be mixed to obtain different shades. The colours are applied by the brush, spray gun or screen printing methods.

New resin modifier from Monsanto

A new paint additive for non-aqueous industrial coatings is being introduced by Monsanto to the European market. The product is a resin modifier for high quality industrial finishes and the company claims significant cost/performance advantages when compared with silicone finishes. The silicone-free additive, named "Multiflow", does not impair initial or re-coat adhesion, nor will it contaminate production equipment. Its low viscosity offers ease of handling and dispersion into resin formulations and it is compatible at the concentrations used with most types of synthetic resins.

Temperature recorders

New portable self-contained "Dickson" temperature recorders are now available from Linton Instrumentation. Standard ranges are available for both high and sub-zero temperatures, and chart rotation is normally over 24 hours or 7 days.

Linton Instrumentation can also supply the new GIV series 6215 micro dosing pump, which extends the range to extremely low flow rates.

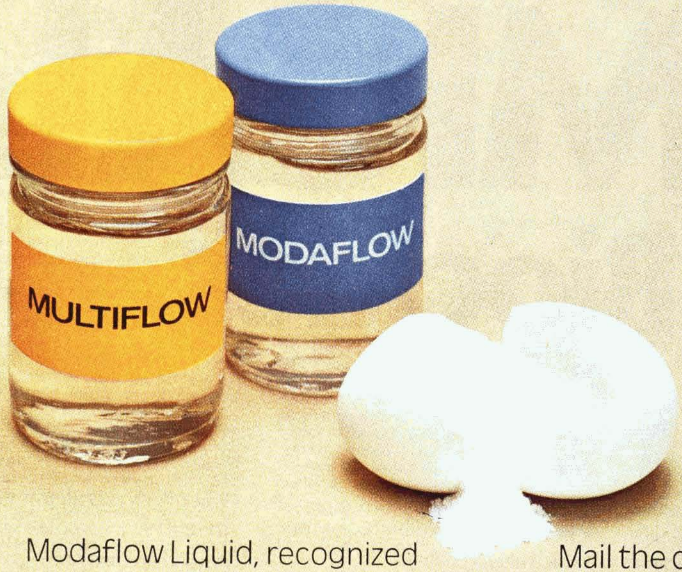
Literature

Fulmer materials optimizer

The Fulmer Research Institute has announced the publication of "The Fulmer Materials Optimizer", a new materials information system for the selection and specification of engineering materials. The system consists of four volumes of readily assimilated information on the performance and current costs of commercially available metals, plastics, ceramics and related component manufacturing processes and a method of selecting the optimum material for a given application.

Lead in the environment

A 47-page booklet entitled "Lead in the environment and its significance to man" has been published by the Department of the Environment Central Unit on Environmental Pollution; it costs 45p from HM Stationery Office.



Announcing AMICAL™ Biocides

Abbott Laboratories has perfected two new biocides for effective preservation of latex paints—Amical 48 (EPA Reg. No. 275-21) and Amical 77 (EPA Reg. No. 275-22).

Amical requires no special handling precautions.
Amical biocides are new organic chemicals which do not contain heavy metals or phenolic groups. Amical is not irritating to the skin nor is it considered toxic when inhaled. And normal precautions used in handling other bulk chemical ingredients are adequate for handling Amical.

Amical is highly effective against fungi in latex systems.
Amical provides a broad spectrum of antifungal activity, and is especially effective against common fungi which attack coatings.

Amical controls the growth of terrestrial algae.
Most currently available fungicides are ineffective against algae. However, in an independent laboratory test, only a trace of algal growth was evident on paints containing as little as 0.2% of Amical 48.

Amical also acts as a package preservative.
Both Amical 48 and Amical 77 provide in-can preservation at recommended fungicide levels for exterior latex paints. Tests indicate that a separate preservative is not necessary when Amical is used as the fungicide or algicide.

Amical is effective with or without zinc oxide.
Amical does not require zinc oxide to be effective. If you use ZnO, lower levels of Amical are needed.

Amical is stable at all paint pH ranges.
No instability or change in composition can be noted through a pH range of 4.0 to 10.5.

For additional data, samples or the name of our agent in your area, write to Amical, Abbott Laboratories S.A., Chemical Division, 2 rue Thalberg, 1201 Geneva, Switzerland. Telex 845 27276—Telephone 31-95-38.

ABBOTT

ABBOTT LABORATORIES S.A.
Chemical Division
Geneva, Switzerland
Abbott Laboratories
North Chicago, Illinois 60064

OCCA—XXVII Exhibition

Olympia, London. 22-25 April 1975

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Many applications to exhibit received from overseas

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General information

At the closing date (1 October) it was clear that the stand area requested would mean the Association staging one of its largest Exhibitions. Many applications to exhibit are from overseas and among countries represented are Belgium, Finland, France, Germany, Holland, Hungary, Italy, Norway, Poland, Switzerland and the United States of America. At the time of going to press, the Committee had not yet met to allocate the stands, but it was planning to do so in order to inform exhibitors early in November. The situation regarding the availability of extra space for late applicants when this issue of the *Journal* is published cannot, therefore, be known, but any organisation which has not yet sent in an application but now wishes to do so, should contact the Director and Secretary immediately by *Telex (922670 OCCA Wembley)* or telegram (Code OCCA Wembley) notifying the number of units required based on the unit size of 4.32m^2.

The OCCA Exhibition and the raw material shortages

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

The "Official Guide" and season admission tickets

The "Official Guide" to the Exhibition is now being prepared for publication; advertisements can be accepted from non-exhibitors and those wishing to do so should contact the Assistant Editor to the Association at its headquarters in Priory House, Wembley.

Members of the Association will automatically be sent an individual copy of the Official Guide, together with a season admission ticket, when the booklet is published (normally several weeks before the opening day). It has been decided on this occasion, however, to make a small charge to non-members of £1.00 to cover both the Official Guide and the season admission ticket. Forms of application for copies of the Official Guide will be circulated widely, both at home and abroad, with an information leaflet in six languages at the beginning of 1975.

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

Venue

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

Motif of Exhibition 1975

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

Special visits by overseas trade delegations

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

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

Admissions to the Profession Grade

At the meeting of the Professional Grade Committee held on 24 September, approval was given for the names of the following Ordinary Members to be entered on the Professional Grade Register for the categories shown. The Section to which each Member is attached is shown in italics.

Fellows

Lawrence Percy Bester (*South African*)
Walter Richard Lunt (*West Riding*)
Thomas Graham (*Manchester*)

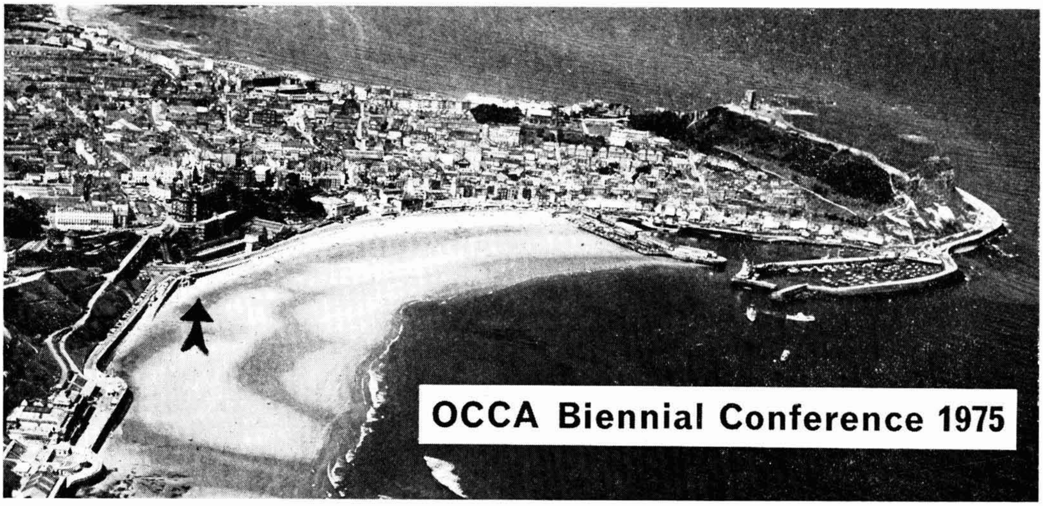
Associates

Stanley Oswitch (*General Overseas—USA*)
Kenneth Laurence Bargrove (*London*)
Geoffrey Peter Jones (*Wellington*)
Leslie John Randall Campey (*General Overseas—Canada*)

Thames Valley Section

Preliminary notice of one-day symposium: Gloss and its assessment

The Section is to hold a one-day symposium at Brunel University on Tuesday 25 March 1975 with the theme "Gloss and its assessment". The subjects covered will include gloss emulsion paints, printing inks, pigments and recent physical methods for gloss assessment. Further details will be announced in future issues of the *Journal*.



OCCA Biennial Conference 1975

Performance of surface coatings—does reality match the theory?

As already announced in the *Journal*, the next biennial Conference of the Association will take place at Scarborough from 17 to 21 June 1975. The headquarters will be the Grand Hotel, with overflow accommodated at the St. Nicholas Hotel. These two hotels are situated opposite each other on St. Nicholas Cliff.

The title of the Conference will be "The performance of surface coatings—does the reality match the theory?" and it is intended that as on previous occasions, full preprints will be published for despatch to delegates in advance of the Conference.

Forms for registration will be despatched to all members of the Association attached to the Sections in the United Kingdom, Ireland and the General Overseas Section early in 1975.

Non-members wishing to attend this important function should write immediately to the Director & Secretary so that forms can be sent to them upon publication. **Those wishing to avail themselves of the preferential conference fee for members should ask for membership application forms at the same time.** Details of the papers to be presented will be appearing in forthcoming issues of this *Journal*.

The photograph above shows an aerial view of the coast at Scarborough, with the harbour and castle ruins (right) and the town stretching inland from miles of sandy beaches. The arrow points to the Grand Hotel, headquarters for the Conference next year. A drawing of the keep of the castle has been adapted as the symbol for the conference. Arrangements are being made for coach tours for the ladies attending the conference to many of the places of historical interest in the vicinity as well as to places of great scenic beauty.

Lecturers and others wishing to offer papers for this important bienniel Conference should write immediately to the Director & Secretary of the Association (or *Telex* 922670).

News of Members

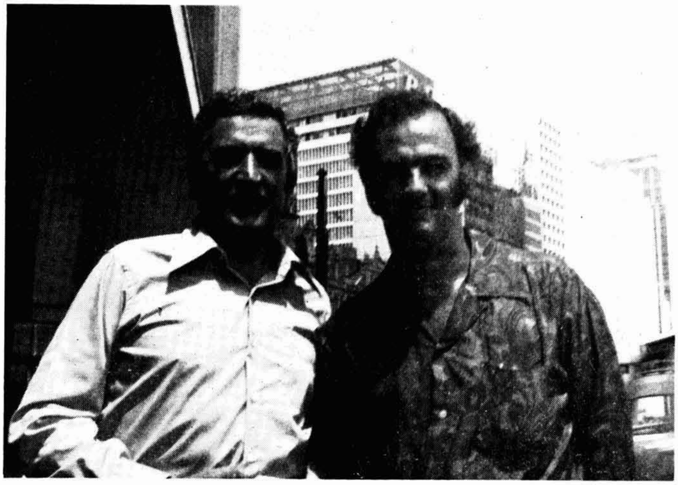
Dr S. R. W. Martin, an Ordinary Member attached to the London Section, retired in May and resigned his directorship of Ault & Wiborg Group Limited and also his post as Managing Director of W. A. Mitchell & Smith Limited.

Dr Martin was a graduate of the Imperial College of Science and Technology and his first appointment in the resin industry was with Dr Kurt Albert GmbH (now part of Hoechst) of Wiesbaden, where he worked in 1934/35; afterwards he worked in the company's British factory until it was bombed in 1941. After appointments with ICI Plastics Division and Arthur Holden & Sons Limited, he joined W. A. Mitchell & Smith in 1952.

Dr Martin has written many articles for the industry and is the author of a textbook "Synthetic Resin Chemistry for Students," as well as being a contributor to volumes 2 and 3 of the Association's Paint Technology Manuals. He was Hon. Treasurer of the London Section from 1955 to 1960 and a Member of Council from 1955 to 1957.

Dr K. A. J. Sugars, an Ordinary Member attached to the London Section, has been appointed Managing Director/General Manager of Tioxide Australia Pty Limited with effect from 1 April 1975. Dr Sugars is at present Group Sales Controller for Tioxide International in London.

Reunion in Hong Kong



On his journey to the New Zealand Convention in August, the President visited Hong Kong and was delighted to meet Jim McKean, a former member of the West Riding Section Committee who is now based in Hong Kong.

Joint Symposium

Optimum use of resources in the surface coatings industries

The first joint symposium between OCCA and the Paintmakers Association was held at University College, London, on 17 September 1974. There were seventy delegates present, and these were drawn not only from the UK, but also from Belgium, Ireland, Sweden and West Germany.

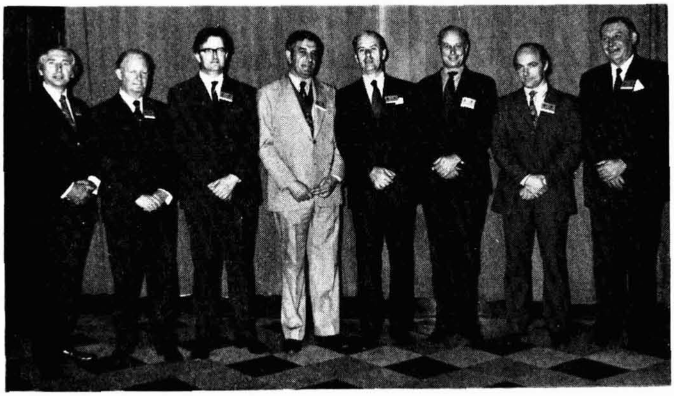
The morning session was chaired by the Association's President, Mr L. H. Silver. Readers will know that the Symposium was originally planned for the day of this year's OCCA Annual General Meeting, but due to unforeseen circumstances had to be postponed. Mr Silver pointed out, however, that although the situation with regard to raw materials appeared to have eased since the Symposium was originally conceived, there was still a great need to conserve material, fuel and other resources, and to utilise financial and labour resources to maximum efficiency. All these topics would be dealt with during the course of the day.

Mr Silver then introduced the first speaker, Mr A. L. Waddams, who directs chemical marketing research and allied information services for BP Chemicals. Mr Waddams spoke on petrochemicals, considering the short, medium and long term supply situation in view of the recent explosive changes in the petroleum industry, and assessing briefly the prospects of alternative raw materials.

Mr J. M. Cruden, Production Manager at the Harlow Chemical Company, presented the second paper, "The role of waterborne polymers," and Dr F. M. Smith, Technical Director for Ciba-Geigy UK Limited, the third entitled "Optimum use of organic pigments." After suitable periods for discussion, the morning session was terminated at 12.30 and delegates adjourned for a reception and luncheon.

The afternoon session began at 2.00 p.m., and was chaired by Mr R. L. White, Vice-President of the Paintmakers Association. The three papers presented were: "Utilisation of financial resources" by Mr A. J. Marsh, Finance and Planning Director for Revertex Holdings; "The role of the consultant" by Mr H. R. Touchin, of Touchin Technical Laboratories; and "Utilisation of management resources" by Mr I. Mottershaw, from the Management Advisory Unit of the Chemical and Allied Products Industry Training Board. The discussion period following these papers aroused such interest that the Chairman eventually had to terminate the proceedings before all the questions and comments from the floor could be taken.

Mr White thanked the lecturers and also the delegates for their enthusiastic approach, and officially terminated the day's proceedings shortly after 5.00 p.m. It is hoped that the papers will be published in full in one of the 1975 issues of this *Journal*.



The lecturers and chairmen. From left to right: Dr F. M. Smith, Mr A. L. Waddams, Mr J. M. Cruden, Mr L. H. Silver (OCCA President, chairman of the morning session), Mr R. L. White (Paintmakers' Association Vice-President, chairman of the afternoon session), Mr A. J. Marsh, Mr I. Mottershaw and Mr H. R. Touchin

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

BARR, WILLIAM, BSc, PhD, 21 Keats Way, Rushden, Northants NN10 0NP. *(Midlands)*

CAPALDI, RICHARDO UMBERTO, BSc, 16 Sidmouth Road, Welling, Kent DA16 1DS. *(London)*

CLARKE, RAYMOND JOHN, 6 Canterbury Court, Wallis Road, Ashford, Kent TN24 8BY. *(London)*

REID, HUNTLY ROBERT, 4 Gooiland, Carinus Street, Labiance, Bellville CP, South Africa. *(South African)*

VORSTER, OLOF CARUSO, PO Box 395, Pretoria, South Africa. *(South African)*

WOOLF, LESLIE, ARIC, Metrotect Ltd., PO Box 1, Whitechapel Road, Cleckheaton, Yorkshire. *(Manchester)*

YARWOOD, MERVYN DRUMMOND, GradRIC, 84 Mornington Road, Bolton, Lancashire. *(Manchester)*

Newcastle Section Symposium

Ultraviolet polymerisation and the surface coatings industry

The Section is organising a one-and-a-half-day symposium to be held on 10 and 11 April 1975 with the title "Ultraviolet polymerisation and the surface coatings industry—theoretical and practical considerations." Papers will be presented by speakers from the industry and universities, covering practical and theoretical aspects of the rapidly developing technology of ultraviolet curing. Topics will include photo-initiated polymerisation, photo-condensation polymerisation, photo-degradation and photo-stabilisation, ultraviolet curing sources, photo-sensitive oligomers and polymers, and photo-initiators.

All enquiries should be directed to the Section Hon. Social Secretary, Mr H. Fuller, Tioxide International Limited, Carlton Weathering Station, Yarm Back Lane, Stockton-on-Tees, Cleveland TS21 1AX. Further details will appear from time to time in this *Journal*.

Auckland and Wellington Sections

Wairakei Convention 1974

The 1974 Annual Convention of the New Zealand Sections was held from 2 to 4 August at the Wairakei Hotel, which lies inland on North Island. There were two hundred members, non-members and wives present from all over New Zealand.

Mr M. D. Taylor, Chairman of the Wellington Section, opened the Conference on the Saturday morning with a brief introduction on the broad topic of the papers to be presented, the theme being "Environment and the surface coatings industry". He then introduced the President of the Association, Mr L. H. Silver, who had made a special visit to New Zealand to be present at the Convention. Mr Silver was the opening speaker, and his paper was entitled "The paint industry in the UK today".

The British paint industry today

by L. H. Silver

Mr Silver began by pointing out that the UK paint industry had had on average a very poor production efficiency ratio when compared with the equivalent industry in Europe, but increasingly, and particularly in the smaller countries, efficiency had improved drastically with the introduction of larger batch sizes and better equipment. Technical and general management was improving slowly and this was reflected in the large increased profits shown by the major companies over the past few years. Money spent on advertising was also increasing sharply and had almost doubled since 1968. Some of this increase had been absorbed by inflation and higher charges but there was a concerted effort by companies to create more demand for new types of finishes, since demand had not increased as much as had been hoped for.

There existed today much environmental protection in the form of the "clean air" acts, which had done a lot in conjunction with various responsible companies to reduce air pollution, and today the air was cleaner than at any time since 1918. Mr Silver felt that whilst not being particularly spectacular, the UK paint industry was moving slowly forward, as shown by improved profits and performance figures, and that it would continue to do so, especially now that better all-round men and managers were being attracted to the industry.

Pollution—how much is too much?

by J. K. Heyes

The question of the extent to which the environment could stand discharge into it as a consequence of those human activities which had harmful or offensive consequences concerned everyone. The ability of any ecosystem, local or global, to remain balanced when the rate of any biological component was modified was extremely limited and any dependence upon, or interaction with, economic processes meant that any attempt at unrestrained increases in productivity must result in a collapse of the ecosystem. Biological systems were remarkably interdependent and man must beware of considering harmful only those pollutants which affected him directly. An effect upon any component of the biosphere might indicate a future unpredictable effect upon man or upon one of man's activities. Addition of pollutants into the atmosphere involved many processes, ranging from the combustion of the fossil fuels and the dereliction of land, which might both play a part in increasing the carbon dioxide concentration, to the production of oxides of sulfur and nitrogen from combustion and industrial processes. The emission of lead into the atmosphere came predominantly from the use of tetraethyl lead in the internal combustion engine and this could pass rapidly into the bloodstream or contaminate soil and enter food materials.

Mr J. K. Heyes

Other substances which finished up in foodstuffs and hence endangered the animals ingesting them included organomercurials, pesticides, herbicides and drugs which (as was shown with thalidomide) all involved the calculated risk that the benefits outweighed the possible hazard through long-term use. The normal test programme for such substances, though extensive, might miss long-term or cumulative effects, as was found with DDT in fish.

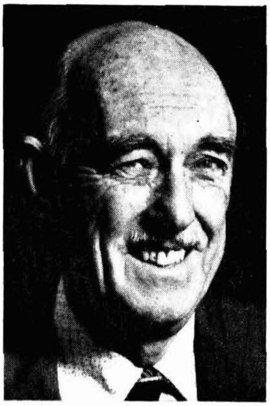
Both air-borne and soil-derived pollutants often finished up in the water system; the purity of this system and its ability to sustain the life of all living organisms was often seriously affected. Thermal pollution of natural waters obviously affected natural processes often in an unpredictable way, and the ability of living systems to concentrate radio-active wastes could not be ignored in any decision regarding the desirability and the design of future nuclear power plants.

The "in-equilibrium" society might be an impossibility, but since it appeared to be the only biologically viable alternative to a collapse of the ecosystem from any one of a number of causes, this had to be man's aim. Any pollutant, chemical or social, produced by man had clearly to be limited.

Raw materials and environment—effect on the resin industry

by A. H. McEwan

As with other industries, the resin manufacturer had had to re-examine raw materials and methods of manufacture. The reasons were basically twofold: the "oil crisis", and the need to clean-up the atmosphere or environment. In addition, demand had and was still exceeding supply. This excessive pressure on existing plant had meant breakdowns, fires and explosions which had further aggravated the supply position. As a consequence of the "energy crisis", chemists in the resins industry had been forced to forego research just to keep plants running, but this in itself could be frustrating as a raw material available today might not necessarily be so tomorrow. Up to 70 per cent of the chemist's time had been needed to evaluate replacement raw materials. However, some good generally had come from the work carried out during times of shortages, resulting in cheaper and better ways of manufacture.



Mr. A. H. McEwan

With regard to pollution, a swing towards water-based and high solids systems which used no or little solvent, and more use of powder coatings, were no longer things of the future and a great amount of development was now under way. The supply crisis was resolving itself slowly.

But whilst these two major crises were in the past, another one of grave proportions was currently affecting the industry: shipping and clearing from the wharves was resulting in problems of liquidity.

The morning session consisted of the above three lectures and after lunch those fit enough—having fully recuperated after the social gathering on the evening before—took off to the golf courses, the lake for trout fishing or the hills on horseback, whilst the less active members soaked in the thermal pools.

Saturday night was no less featureless. After the Official Dinner, the various sports prizes were distributed by Mrs Silver and Mr Taylor. Worthy of mention was the Golf Trophy won by the capital city, Wellington, and the prize for the best and biggest trout (5lb) going to one of the lady members. The festivities, generally, abated in the small hours of Sunday morning, most guests dropping by at the Spa for a medicinal plunge.

It was good to see so many bright and cheery faces at breakfast on Sunday—a true reflection on both the stimulation already created and the balmy atmosphere. Professor K. Hayes hosted the ladies' morning tea with a talk entitled "People and food—what is the future?" The second morning technical session was under way at 9.15 a.m., the title of the first paper being "Effect of recent environmental and other changes on the paint industry", which highlighted the Convention theme. After this, the final paper was given by Mr Jones of the Department of Health, and a Forum of all five speakers was conducted before an audience of some 150 delegates and wives.

The effect of environmental and other changes on the paint industry

by J. M. Robertson

Mr J. M. Robertson

An interesting and logical series of facts were presented by Mr Robertson. He discussed the implications of local and overseas antipollution regulations. Mr Robertson thought that, in fact, the overseas regulations would have a larger effect on their industry than the New Zealand regulations. The problems at Montedison's Scarlino titanium dioxide plant was given as one example. Rule 66 of the Los Angeles Council was having an effect on this company, but unfortunately, at that stage at least, the New Zealand regulations were not as restrictive as Rule 66 and seemed to be practical and workable as it related to their industry.

The approximate costs and requirements to cut down air pollution were discussed with particular reference to trade waste disposal, varnish and resin manufacture and dust or vapour collection. These were seen as distinct and definite beginnings to producing cleaner methods for making and applying paint. The New Zealand costs, of course, were negligible when compared to the enormous estimate of costs expected to be met in the US between 1972 and 1981; a total of $274 million. This, of course, had and would be reflected in increased imported raw material costs and presented the New Zealand paint industry with a serious liquidity problem. Mr Robertson said that for members of the Association, the future offered no problems but considerable challenges. In all things, he stressed, there was a need to "keep it simple".

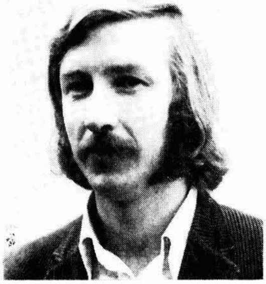
The President of the Association, Mr L. H. Silver, with Mr P. Sharp (left), Chairman of the Auckland Section, and Mr M. D. Taylor (right), Chairman of the Wellington Section

The President, Mr Silver, with Mr A. McEwan and Mr T. Whitfield (left), and Mr P. Hunt and Mr T. Slinn (right).

Mr Silver with Mr A. P. O'Neill (centre), Auckland Section Hon. Secretary, and Mr T. O'Flynn (left), Wellington Section Hon. Secretary

The Clean Air Act 1972 and its application to the paint industry

by M. T. Jones



Mr M. T. Jones

The Clean Air Act was passed by Parliament in October 1972 and came into force on 1 April 1973. Generally, the Act obliged the occupiers of all premises in that country to adopt the "best practicable means" to:

(a) collect and contain any air pollutant and to minimise by the selection of the most appropriate process and control equipment or otherwise, the emission of air pollutants from those premises;

(b) render any air pollutant emitted from those premises harmless and inoffensive.

Mr Jones went on to explain steps that could be taken to minimise pollution from the various processes carried out by the paint and allied industries. At the present time, the main pollutants causing concern were those which were producing offensive odours, for example the low molecular weight organic decomposition products from the manufacture of the various resins used by the industry. In most cases the use of some kind of afterburner would become compulsory to eliminate those materials. No controls were being requested for odourless hydrocarbon emissions until more work had been completed to establish whether a serious problem existed. Mr Jones mentioned too the necessity for special decanting rooms which had to be used to minimise the escape of malodorous chemicals, such as acrylate monomers and mercaptans.

The need for operators to be fully conversant with all the chemicals being handled was stressed. Co-operation was seen to be by far the most important aspect of the entire operation and Mr Jones expressed his department's willingness in this direction.

Closing forum

The discussion was chaired by Mr T. Bates, executive officer of the New Zealand Manufacturers' Federation.

Mr Peters opened the discussion. He commented that combustion engines contributed to 60 per cent of all pollution, whilst industry accounted for only 10 per cent.

Mr and Mrs Silver at the entrance to the Convention headquarters

Mrs Taylor, Mr T. Slinn, Mrs Sharp, Mr P. Sharp, Mrs Slinn, Mrs McEwan, Mr A. McEwan, Mrs Silver and Mr M. D. Taylor

Mrs Silver with Mrs Taylor (right) and Mrs Sharp (left) with a replica of a Maori canoe

Mr L. H. Silver said there was an over-reaction to Rule 66: controls in the USA were "all-out" ones, whereas New Zealand and UK were still in the process of complete Clean Air Act enforcement (in the paint industry).

Mr M. Dent commented that it was indeed possible to clean-up the environment, but in a lot of cases that would mean educating the customer to a completely new end product.

Mr Silver added that controls were working at factory level in the UK, with good liaison between industry and Government.

Mr A. Dalton suggested to the panel the need for discussion with the Government, and suggested that the Association as a representative body should make the approaches.

Mr J. Gilbert asked Mr McEwen to comment regarding the shipping/clearing problems and suggested that it should be streamlined by the Manufacturers' Federation.

Mr T. Slinn asked Mr Jones to comment regarding problems of interpretation of the Clean Air Act, and pointed out the need for technical assistance with individual problems and "universal" understanding of what was laid down, rather than the possibility of several interpretations.

Mr T. Whitfield said it was essential for all members of the Technical Committee of the Paint Manufacturers' Federation to be members of OCCA. He added that the legislation against "pollution" would cost money, but it was essential to "spend large".

The forum was indeed very stimulating, and could have developed further but unfortunately time was the enemy. Mr Taylor summed up by reiterating the need for more emphasis from the Association to the Government bodies concerned with pollution control. He thanked all speakers and the large attendance of about 150 delegates and wives to the final session; he was followed by Mr A. McEwen who thanked the delegates on behalf of the speakers. Mr P. Sharp, Chairman of the Auckland Section, thanked all who were concerned with organising the Convention and made an invitation to next year's Convention to be held from 1 to 3 August 1975.

Mr Taylor and Mr Sharp officially presented Mr Silver with a replica of a Maori canoe as a parting gift, and the Convention was officially closed at 12.20 p.m

Forthcoming Events

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

November

Monday 4 November

Hull Section: "The industrial application of organic titanates—with particular emphasis on surface coating applications" by Dr D. W. Brook, Titanium Intermediates Ltd., to be held at 6.30 p.m. at the George Hotel, Land of Green Ginger, Hull.

Wednesday 6 November

Scottish Section—Eastern Branch: Joint lecture with the BPBI, "The laser zee meter" by Mr J. G. Penniman Jnr. of the Pen Kem Company, Croton on Hudson, New York, USA, to be held at 7.15 p.m. at the Carlton Hotel, North Bridge, Edinburgh.

Thursday 7 November

Midlands Section—Trent Valley Branch: Social event.

Newcastle Section: "Patent law, with particular reference to the EEC" by Dr Wild, Berger Jenson & Nicholson Ltd., to be held at 6.30 p.m. at the Royal Turks Head Hotel, Grey Street, Newcastle upon Tyne.

Thames Valley—Student Group: "Dispersion of titanium dioxide in modern paint-making machinery" by Mr D. Craig, Tioxide International Ltd., to be held at 4.00 p.m. at Slough College in the main Lecture Theatre.

Friday 8 November

Manchester Section: "Water thinable coatings" by Mr R. H. E. Munn, Cray Valley Products Ltd., to be held at 6.30 p.m. at the Manchester Literary and Philosophical Society, 36 George Street, Manchester.

Saturday 9 November

Scottish Section—Student Group: Mr L. H. Silver (President), "Twenty-five years in the paint industry," to be held at 10.15 a.m. at the Three Pigeons, 573 Sauchiehall Street, Glasgow.

Tuesday 12 November

West Riding Section: "Automation in the paint laboratory" by W. A. Straw and D. S. Briggate, to be held at 7.30 p.m. at the Griffin Hotel, Leeds.

Thursday 14 November

Irish Section: Annual Dinner Dance.

Midlands Section—Trent Valley Branch: "Salary or job satisfaction" by Mr I. S. Moll (consultant), to be held at 7.00 p.m. at the British Rail School of Transport, London Road, Derby.

Scottish Section: "Printing inks—developments to meet modern requirements" by Mr G. H. Hutchinson of Croda Inks Ltd., to be held at 6.00 p.m. at the Beacons Hotel, 7 Park Terrace, Glasgow G3.

Midlands Section: "An individual's thoughts on paint—past, present and future" by Mr H. J. Clarke, Postans Paints Ltd., to be held at the Apollo Motel, Hagley Road, Birmingham.

Wednesday 20 November

London Section: "Coatings for immersed conditions." One-day joint Colloquium with the Institute of Corrosion Technology at Thames Polytechnic, Woolwich, commencing at 9.30 a.m.

Manchester Section—Student Group: "Metal pretreatment" by Mr C. Pearson of Pyrene Chemical Services, to be held at 4.30 p.m. at the Manchester Literary and Philosophical Society, Manchester.

Thursday 28 November

Thames Valley Section: "Forensic examination of inks and paints" by Mr R. M. Kevern, to be held at 7.00 p.m. at the Beech Tree Hotel, Maxwell Road, Beaconsfield, Bucks.

Friday 29 November

Bristol Section: "Precious metals for surface coatings" by Mr D. Blower of Engelhard Industries Ltd., to be held at 7.15 p.m. at the Royal Hotel, Bristol.

London Section: Ladies' Night at the Cafe Royal.

West Riding Section: Dinner Dance to be held at the Crown Hotel, Harrogate. Tickets at £5.00 each, inclusive of VAT, and application forms obtainable from the Hon. Secretary, N. Cochrane, 19 Rutland Road, Harrogate, Yorkshire HG1 1PY.

December

Monday 2 December

Hull Section: "Bulk storage of highly flammable low-flash solvents" by Mr J. B. Joliffe, Technical Bulk Service to be held at 6.30 p.m. at the George Hotel, Land of Green Ginger, Hull.

Thursday 5 December

Newcastle Section: "Paint hazards in the marine industry" by Mr C. P. Douglas, Swan Hunter Group, to be held at 6.30 p.m. at the Royal Turks Head Hotel, Grey Street, Newcastle upon Tyne.

Thames Valley—Student Group: "Developments in water-thinned paints" by Mr J. C. Bax, Scott Bader Ltd., to be held at 4.00 p.m. at Slough College in the main Lecture Theatre.

Friday 6 December

Irish Section: "Some aspects of modern printing and technology" by Mr K. Ponds, Ault & Wiborg Ltd., to be held at 7.45 p.m. at the Clarence Hotel, Dublin.

Manchester Section: "Let her paint an inch thick—to this favour must she come" by Mr A. C. Bushnell, County Hall, County Analysts' Department, Preston, Lancashire, to be held at 6.30 p.m. at the Manchester Literary and Philosophical Society, 36 George Street, Manchester.

Tuesday 10 December

London Section: "Schlieren optics: a convenient new method for characterising paint and other surfaces" by Mr D. M. Howell, Paint Research Association, to be held at 7.00 p.m. at the Polytechnic of the South Bank, Borough Road, London SE1.

Thursday 12 December

Scottish Section: "National Engineering Laboratory—function and activities" by Mr J. McCallan (NEL), to be held at 6.00 p.m. at the Beacons Hotel, 7 Park Terrace, Glasgow.

Wednesday 18 December

Scottish Section—Eastern Branch: "Problems of a packaging chemist" by Mr R. Logan, Van Leer (UK) Ltd., to be held at 7.30 p.m. at the Carlton Hotel, North Bridge, Edinburgh.

Oil and Colour Chemists' Association

President: L. H. SILVER

General

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

Sections

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

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

Membership

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

Professional Grade

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

Exhibitions

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

Conferences and Symposia

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

Publications

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

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

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

Part 1 "Non-convertible Coatings"
Part 2 "Solvents, Oils, Resins and Driers"
Part 3 "Convertible Coatings," Second Edition, pp. 350, £2.80
Part 4 "The Application of Surface Coatings"
Part 5 "The Testing of Paints"
Part 6 "Pigments, Dyestuffs and Lakes"
Part 7 "Works Practice," pp. 218, £3.00

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

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

ASSOCIATION TIES

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

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

. . . in a different way, of course, so do the advertisers in this Journal,* for they know that it has an unrivalled A.B.C. circulation (see graph on page xx) among the technical personnel in the paint, printing ink, and allied industries.

In such a work of reference, which is constantly consulted, the advertisements are naturally widely read by the very persons to whom companies wish to appeal.

Full information on advertising in this important medium, sample copies, rates cards, media data forms etc. can be obtained from:

***JOCCA**

Journal of the Oil & Colour Chemists' Association

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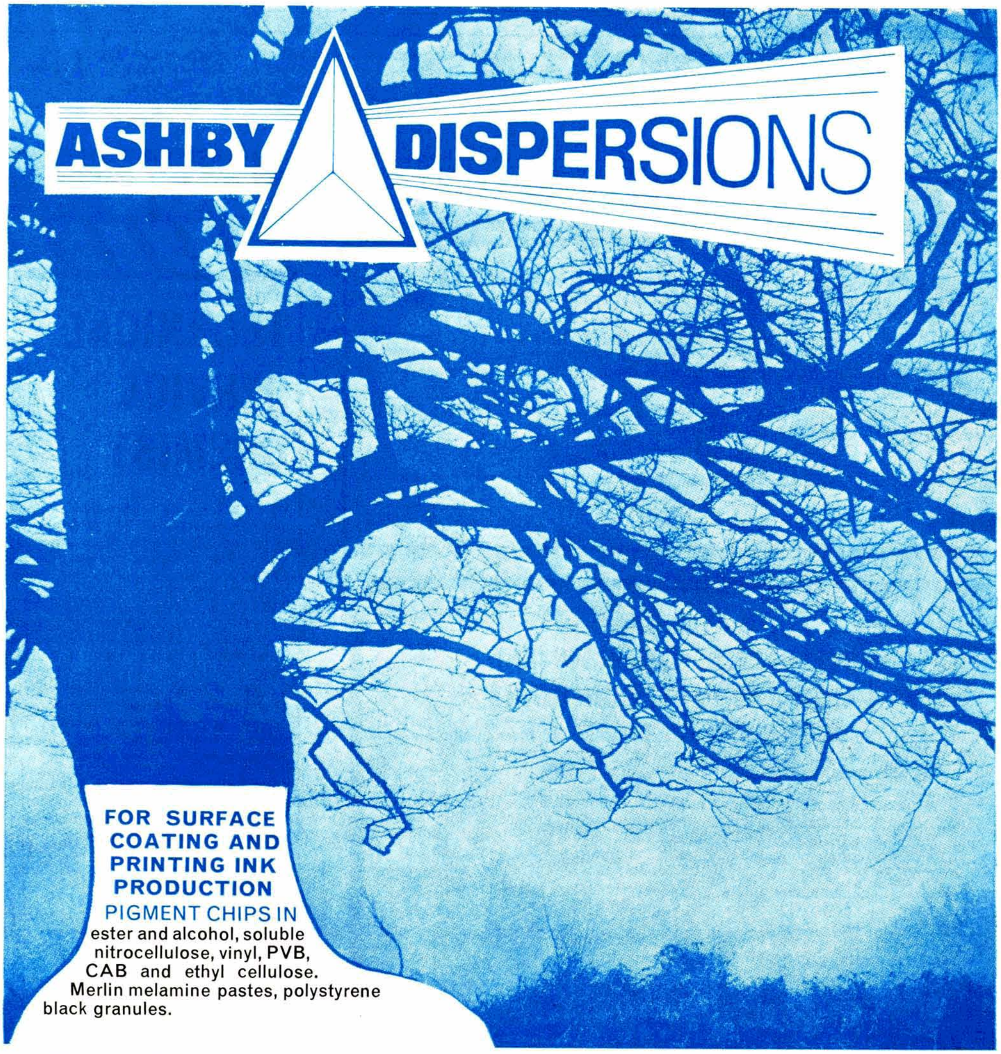

CLASSIFIED ADVERTISEMENTS

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

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This is a Senior appointment offering an attractive salary and it is envisaged that the suitable applicant would be at least 28 years old, having had at least 10 years' experience in the Printing Ink Industry.

We are a member of the Unilever Group and as such provide secure and progressive employment together with a comprehensive range of benefits one associates with major companies, including a first class contributory pension scheme and four weeks holiday after 12 months' service.

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The Company Personnel Manager,
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We are a major supplier to the Automotive Industry and a number of vacancies exist in our Automotive Development Laboratory for Development Chemists and Laboratory Technicians.

Experience of Automotive or Industrial Paints would be desirable but not essential. We are prepared to consider applicants with no industrial experience provided they have the potential to effectively contribute to the success of the department.

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An opportunity has arisen for a graduate or equivalent chemist with some years' experience in the formulation of condensation polymers for use in surface coatings, adhesives, etc., to join our Development Department. This post would be particularly suitable for a commercially oriented chemist currently working in the resins industry.

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The usual large company conditions of employment apply, including re-location expenses.

Please write, or telephone, for an application form to

Arthur Lodge, Personnel Manager, British Oxygen Chemicals Limited, Vigo Lane, Chester-le-Street, Co. Durham. Tel: Birtley 2631.

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Allied to dynamic drive and ability, is complete self motivation, which will be recognised in a position at Director or Senior Managerial level, or alternatively in consultancy, either in the UK or overseas.

Wide experience in all aspects of sales, technical service, development, manufacturing, quality control and laboratory procedures in above fields of operation. Familiar with budgetary control, technical press, advertising, lecturing and technical exhibitions. Box No. 400.

PUBLICATIONS

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Volumes 1-7

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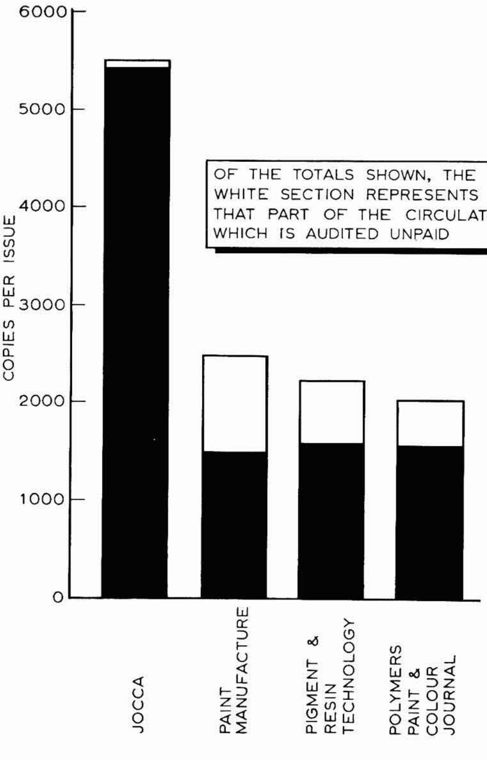

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