JOURNAL
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Vol. 51 No. 10

October 1968

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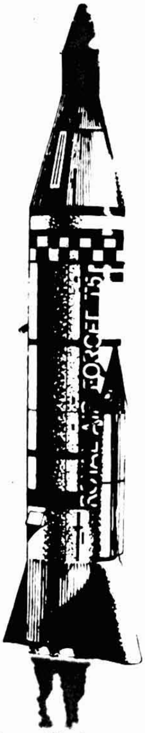
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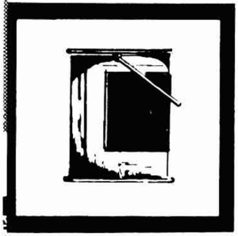


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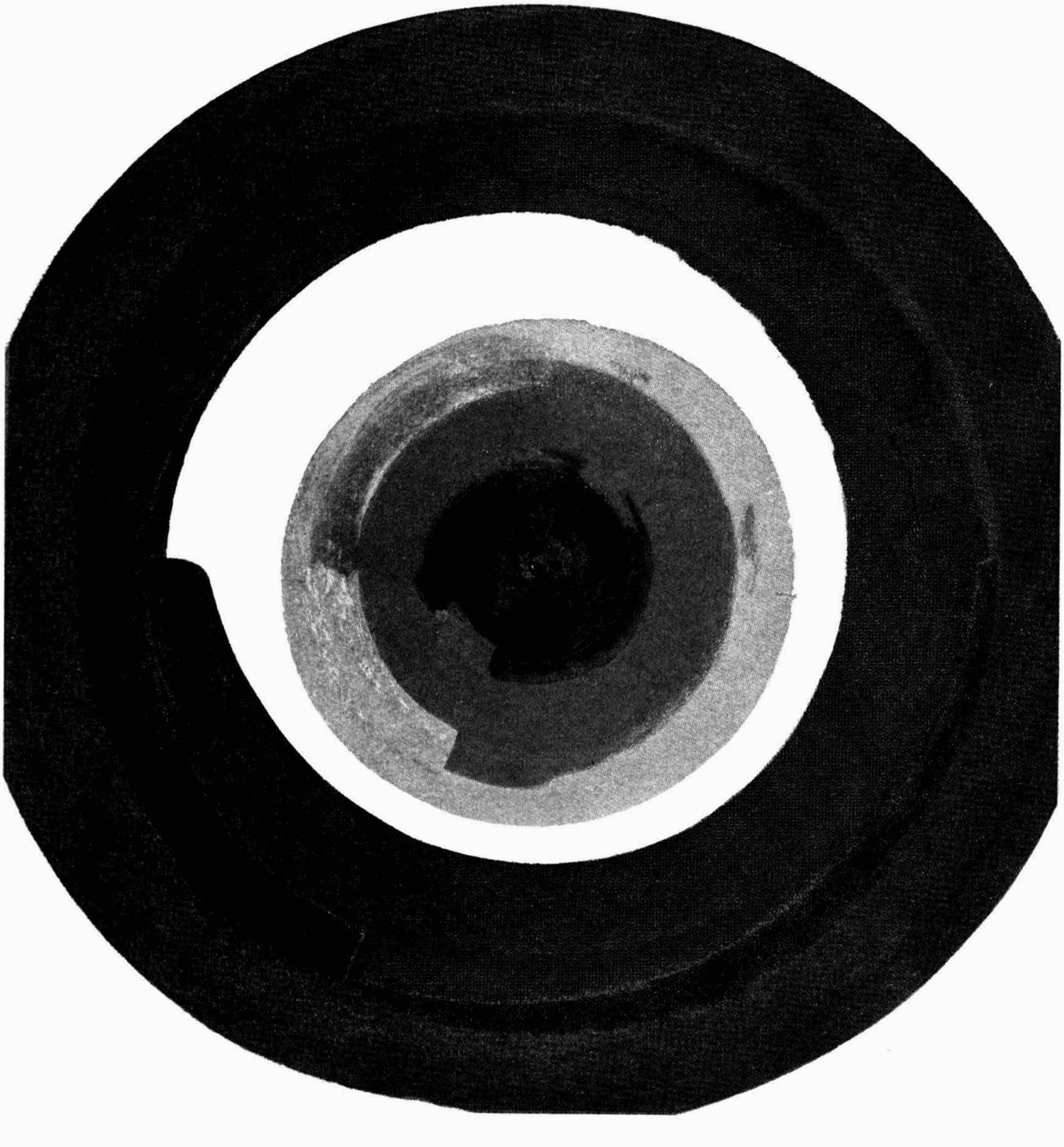


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EVERYTHING IN THE GARDEN'S LOVELY and NON YELLOWING AT BK

Frankfurter

ZEITUNG FÜR

S-Ausgabe / Freitag, 21. Juli 1967

Herausgegeben von Nikolas Benckiser, Bruno Decham

Wirtschaft und Gewerkschaften wünschen rasche

Aussprache mit Schiller über das Fünf-Milliarden-Programm / Erster Investitionshaushalt unzureichend / Sozialpart

Fk. BONN, 20. Juli. Die Vertreter der Wirtschaft und der Gewerkschaften haben beim jüngsten Gespräch der „konzertierten Aktion“ sowohl dem zweiten Investitionsprogramm der Bundesregierung als auch der Zielprojektion für die mittelfristige Wirtschaftsentwicklung (bis 1971) zugestimmt. Die Teilnehmer des Gesprächs mit Bundeswirtschaftsminister Schiller waren sich, wie das Kommuniqué mitteilt, darin einig, daß der erste Investitionshaushalt des Bundes die konjunkturelle Abschwungsbewegung gebremst hat; er habe jedoch für einen neuen Aufschwung nicht ausgereicht. Man war sich auch einig, daß dieses zweite, mit Krediten finanzierte Investitionsprogramm mit seinem Gesamtvolumen von fünf Milliarden Mark „für alle weitaus billiger als ein Anhalten der konjunkturellen Schwäche“ sei.

Diese Ansicht des Bundeswirtschaftsministers haben vor allem die Vertreter des Bundesverbandes der Deutschen Industrie unterstützt. Alle Anwesenden haben sich deshalb für eine zügige Beratung des Programms im Parlament und für eine rasche Verwirklichung ausgesprochen. Die Zustimmung kam auch von jenen Verbänden, die — wie beispielsweise der Deutsche Industrie- und Handelstag — bei den ersten Erörterungen über den zweiten Konjunkturhaushalt Zurückhaltung geübt hatten.

Der Bundeswirtschaftsminister hat mit seinen Gesprächspartnern außerdem seine Zielvorstellungen für die mittelfristige Wirtschaftsentwicklung bis 1971 erörtert. Sie stellen nach seinen Worten ein politisches Programm der Bundesregierung und nicht nur eine Vorausschätzung dar.

Zu einer ausgedehnten Diskussion kam es über die Zahlenangaben der verschiedenen wirtschaftlichen Zielvorstellungen. Die Vertreter der Wirtschaft kritisierten beispielsweise, daß eine Arbeitslosenquote von 0,8 Prozent anvisiert werde; derart exakt ließen sich solche Ziele nie verwirklichen, hieß es; außerdem stelle sich die Frage, ob bei einer Arbeitslosenquote von 0,8 Prozent noch von einem Gleichgewicht am Arbeitsmarkt gesprochen werden könne.

Die Gesprächsteilnehmer kamen überein, die Konsequenzen aus dem mittelfristigen Wirtschaftsprogramm auf der nächsten Gesprächsrunde im Herbst zu erörtern. Dabei geht es beispielsweise um die Frage, wie die Lohnpolitik, die Einkommensverteilung, die Wettbewerbs- oder Energiepolitik gestaltet werden müssen, um die anvisierten Ziele zu erreichen. Der Wirtschaftsminister geht davon aus, daß bis 1971 das Sozialprodukt jährlich real um durchschnittlich vier Prozent pro Jahr wachsen soll. Zugleich soll der Preisauftrieb auf eine Zuwachsrate von einem Prozent im Jahr 1971 zurückgeführt werden.

Die Sozialpartner wollen außerdem außerhalb der „konzertierten Aktion“ versuchen, über die Frage der Einkommens- und Vermögensverteilung eine Verständigung zu erreichen. Ihre Ergeb-

Hochschulen brauchen bis 1970 noch über fünf Milliarden

Der Wissenschaftsrat drängt zu Reformen / Neue Empfehlungen dem Bundespräsidenten übergeben

B. B. KÖLN, 20. Juli. Abschied von liebgewordenen Traditionen hält der Wissenschaftsrat für unerläßlich, wenn die Hochschulen zu handlungs- und koordinationsfähigen Organisationsformen kommen sollen. In seinen am Donnerstag dem Bundespräsidenten
nen neuen Empfehlungen für
bau der wissenschaftlichen Hc
bis 1970 erklärt der Wissen:
daß zwar Anregungen der
schen Rektorenkonferenz in di
tung schon verwirklicht wor
daß die bisherigen Reformen
Gewicht der alten Institutione
punktuelle Ansätze beschränl
ben seien und sich der herkö
Struktur oft nur widersprücl
fügten. Der Wissenschaftsrat
bis 1970 für den Ausbau der
den Hochschulen 5,6 Milliar
zu investieren und 1793 neue
den Lehrkörpern zu schaffen.

Bei der Übergabe der Emp
sprach sich Bundespräsident
Bonn für eine Überprüfung d
ten Bildungswesens aus. „W
vor tiefgreifenden Reformer
Bildungswesens nicht zurück
auch wenn wir Neuland betr
zu gehöre, im Hinblick auf

Der Wissenschaftsrat empfiehlt, den kleinen Senat als das zentrale Entscheidungsgremium der Hochschule zu stärken. In den leitenden Ämtern der Selbstverwaltung sei eine größere Konlen für Bauvorhaben, Stellenpläne, Studentenzahlen und Ausgabenvoranschläge. Der Wissenschaftsrat stellt fest, daß die Lage an den Hochschulen sich dank der Leistungen ihrer Träger in

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You have never seen one? You wouldn‘t. What makes the print visible is the carbon black in the ink. The ‘blackness‘ of the pigment is due to its light absorption which, according to quality, varies between 90 and 99,8%.
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Allgemeine

DEUTSCHLAND

Jürgen Eick, Karl Korn, Jürgen Tern, Erich Welter

40 Pfennig / Nr. 153 D 2955 A

rgesehen

:rteidigungs- und am Agrarhaushalt?

dürften die Beiträge vom 1. Januar 1968 an von 14 auf 15 Prozent des Arbeitsentgelts erhöht werden. Weitere Beitragserhöhungen um jeweils ein Beitragsprozent sind für 1969 und für 1970
vorgesehen, so daß am Ende
trag von 17 Prozent erreicht w
Beitragserhöhung würde der
versicherung vom 1. Januar a
cinnahmen von etwa zwei M
Mark verschaffen, die allerdin
die dann vorgesehene Renten
in vollem Umfang wieder a
würden. Die Rentenversicheru
damit auch im kommenden J
derum mit einem Milliarden-D
schließen müssen, das nur aus d
lage gedeckt werden kann.

Zur Verbesserung der Einnal
das Bundeskabinett allerdings
schlossen, daß künftig alle Ang
ohne Rücksicht auf ihr Einkom
:icherungspflichtig in der Re
sicherung werden. Die Pflichtgr
derzeit 1800 Mark Monatsein
soll also aufgehoben werden. V
Maßnahme werden etwa 300 0
stellte betroffen. Es wird a
wohl davon auszugehen sein,
diese Angestellten, wenn ein
zureichende Alterssicherung
von der Versicherungspflicht
lassen können. Das Arbeitsmir
schätzt die Mehreinnahmen der
versicherung auf rund 600 Milli
dere Fachleute gehen von Meh
men von etwa 300 Millionen M
Um weitere 400 Millionen Marl
Rentenversicherung dadurch
werden, daß es künftig bei de
keine Erstattung der bisher
Versicherungsbeiträge mehr ge
(Fortsetzung Seite 4, Spalte 6.)

Weniger Arbeitslo

F.A.Z. NÜRNBERG, 5. Juli.
der Arbeitslosen in der Bunde
hat sich im Juni weiter saiso
um rund 57 700 auf 400 800 v
Das entspricht einem Rückgang
Prozent. Die Arbeitslosenquote
Mitteilung der Bundesanstalt
beitsvermittlung und Arbeitsl
sicherung von 2,9 auf 1,9 Pro
rückgegangen. Im Vorjahr be
0,4 Prozent. Auch die Zahl d
arbeiter hat sich verringert. C
tig wurden mit 325 700 offene
17 100 mehr als im Mai angebote
im Wirtschaftsteil.)

Ausnahmezustan im Kongo

KINSHASA, 5. Juli (dpa). K

Zu ſparſam geſtrichen

Kg. Die freilich zunächst nur vorläufigen Entscheidungen der Bundesregierung zum Sozialetat machen deutlich, daß die Bundesregierung ihre gewiß schwere Aufgabe, die Finanzpolitik grundlegend neu zu ordnen, nicht bewältigen wird. Zu sparsam ist der Rotstift

verdienenden Angestellten entstehen eines Tages ebenfalls Rentenansprüche, die honoriert werden müssen, wie auch das Geld, das nun durch den Verzicht auf Beitragserstattungen gespart wird, später in Form von Renten ausgezahlt werden muß. Damit werden die Finanzfragen der Rentenversicherung nicht gelöst. Die dynamische Rentenlast wird

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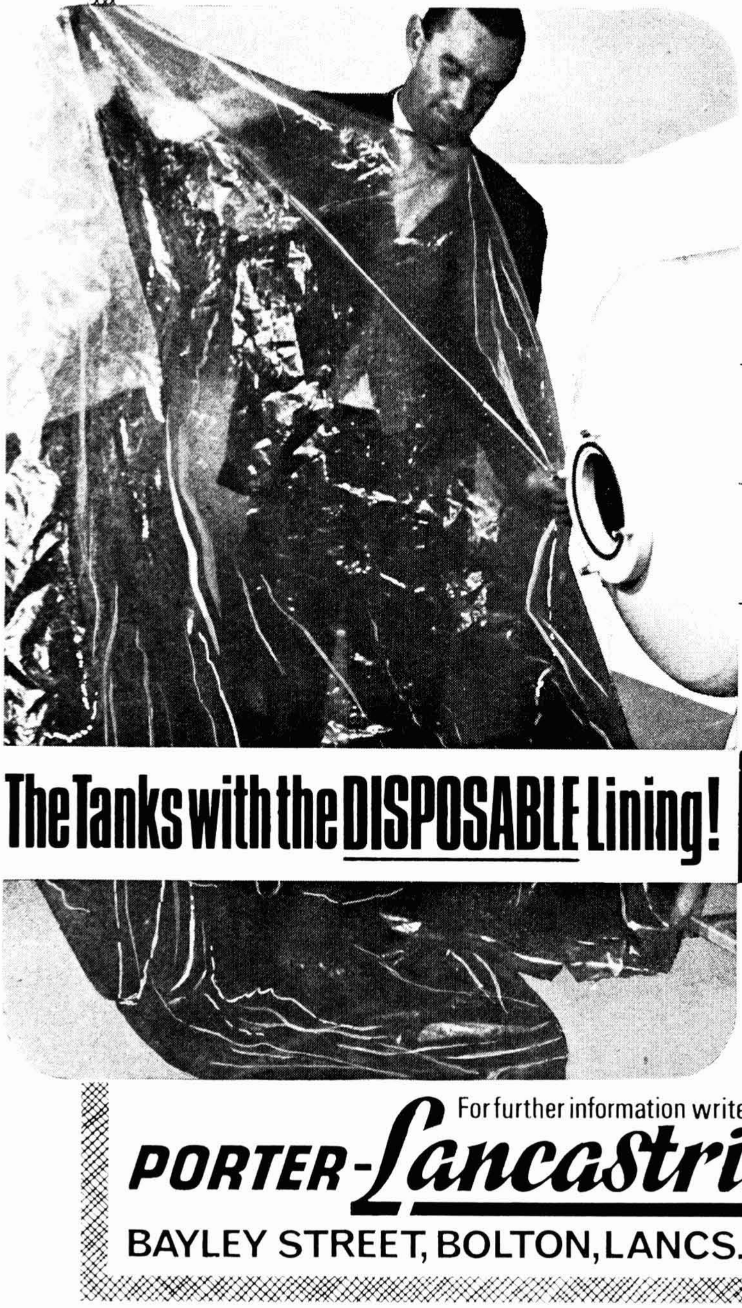
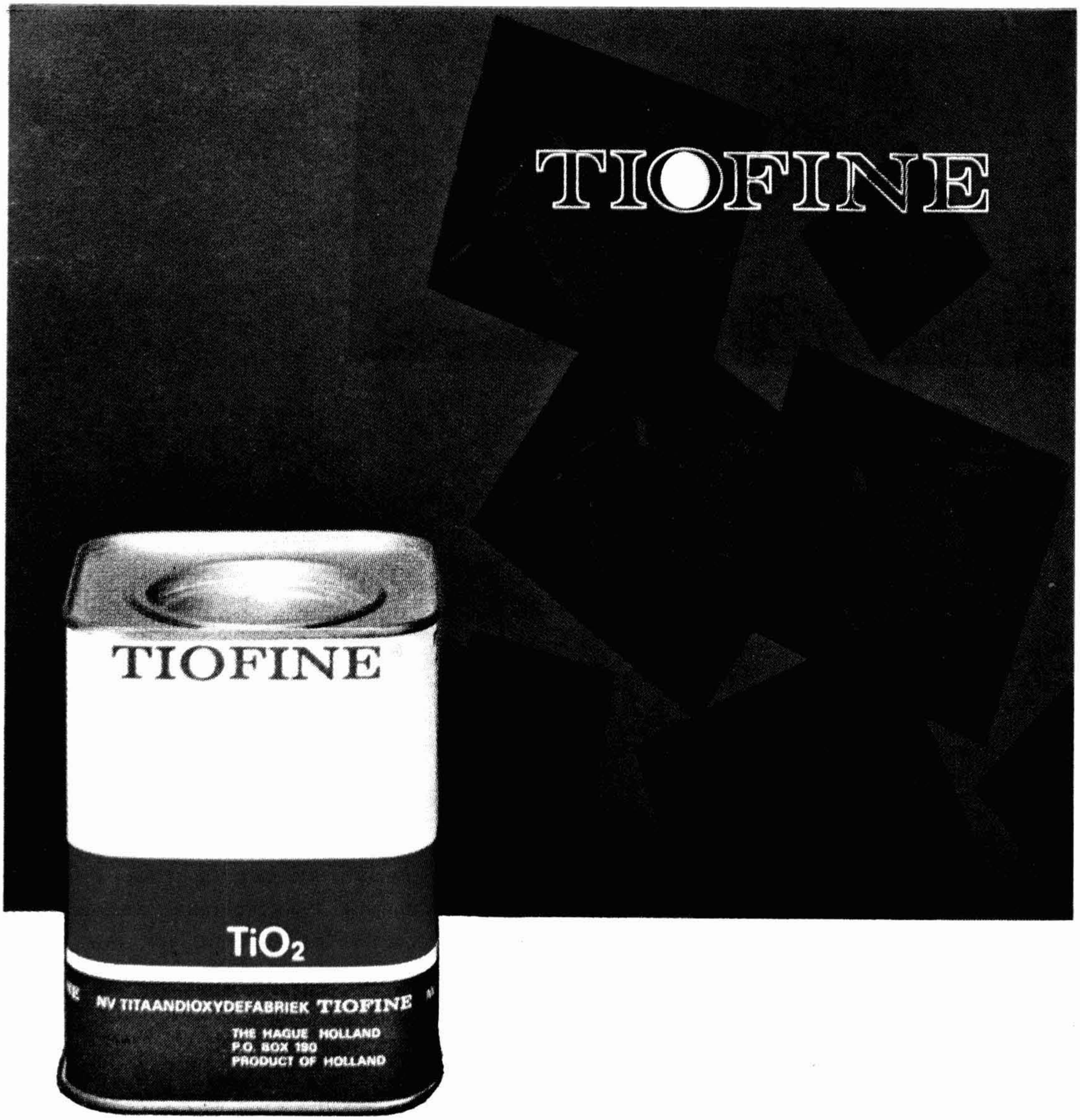
FW 200	64	0,73	540	for thermosetting acrylic finishes
S 170	71	0,98	650	for leather finishes
Special Black 4 . . .	80	0,86	300	for dip and electrophoretic coatings high quality printing and duplicating inks
Special Black 4 A . .	80	0,86	230	for high quality printing inks, carbon paper and tape compounds
Printex V	83	0,95	400	for industrial and decorative paints, gravure and rotary news inks
Printex 140/V . . .	84	0,91	360	for decorative paints, carbon papers, gravure and rotary news inks
Printex 30	90	0,91	400	medium black, rotary news inks
Printex 300	94	0,94	360	for gravure and low cost offset printing inks
Printex A	94	0,73	300	for gravure printing
Printex G	98	0,64	250	for tinting purposes and matt gravure prints
Lamp Black 700 . . .	93	0,66	400	for tinting purposes
Lamp Black 101 . . .	102	0,21	280	tinting pigment, stable in mixture, for lacquer finishes and paints

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†*The Twenty-first takes place* 24-28 *March* 1969

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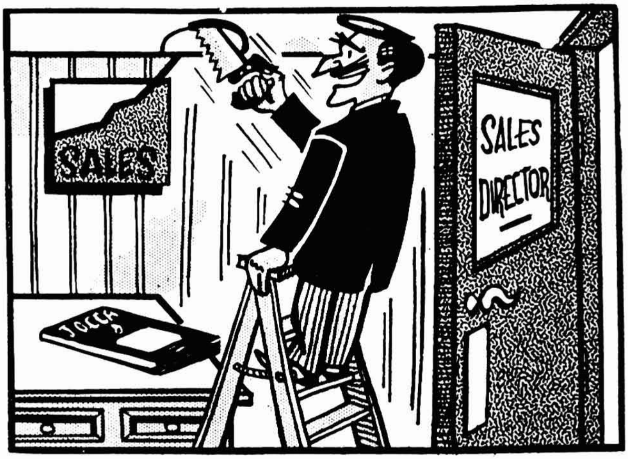

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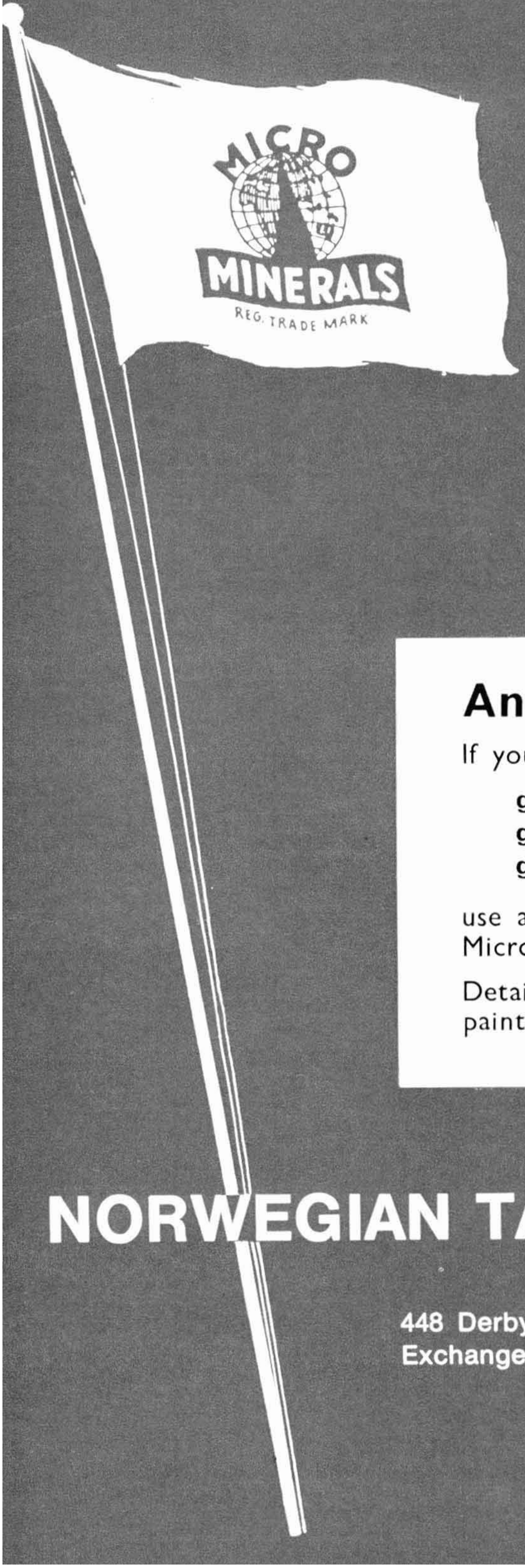

MICRO
MINERALS
REG. TRADE MARK

J. Oil Col. Chem. Assoc. 1968, **51**, 861-874

Physical testing of printing ink*

By C. C. Mill

The Research Association for the Paper and Board, Printing and Packaging Industries,
Randalls Road, Leatherhead, Surrey

Summary

The properties considered are viscosity and tack. Viscosities are often measured with the Ferranti-Shirley or Laray (falling rod) viscometers. Experiment shows that there is reasonable agreement between the two instruments, and the distortion of the rheograms obtained when using automatic recording with the Ferranti instrument is shown to be caused by the inertia of the rotating member. Several different tackmeters are now available and for the three types available there is a linear relationship between the tack obtained on one machine and that on another for the same ink at the same peripheral speed.

L'épreuve des caractéristiques physiques d'encre d'imprimerie

Résumé

On considère la viscosité et le tack. Les viscosités sont souvent déterminées au moyens soit du viscosimètre de Ferranti-Shirley ou soit de Laray (du type tige descendante). On démontre expérimentalement qu'il existe un accord raisonnable entre les deux appareils. La distortion des rhéogrammes obtenues lors de l'utilisation de l'appareil Ferranti avec un enregistreur, on peut démontrer d'être provoquée par l'inertie de l'élément rotatif. Plusieurs de différents tackmètres sont actuellement disponibles dont les trois types donnent un rapport linéaire entre le tack enregistré par un appareil et par un d'autre type pour la même encre à la meme vitesse périphérique.

Physikalische Prüfung von Druckfarben

Zusammenfassung

In Betrachtung gezogen werden Viskosität und Klebrigkeit. Viskositäten werden häufig mit den Ferranti-Shirley oder Laray (fallender Stab) Viskosimetern gemessen. Versuche ergeben ziemliche Ubereinstimmung zwischen den beiden Instrumenten; ausserdem wird aufgezeight, dass die Verzerrung des Rheogrammes, welches man bei Benutzung des automatisch registrierenden Ferranti Instruments erhält, durch die Inertanz des rotierenden Gliedes verursacht wird. Es gibt jetzt einige verschieden arbeitende Klebrigkeitsmesser. Zwischen den drei zur Verfügung stehenden Typen besteht eine lineare Beziehung bezüglich des Haftwertes, der auf der einen oder anderen Maschine gefunden wird, und zwar bei Prüfung der gleichen Druckfarbe und mit derselben peripherischen Geschwindigkeit.

Физические испытания печатных красок

Резюме

Рассматриваются свойства вязкости и клейкости. Вязкость часто измеряется посредством вискозиметров типа Ферранти-Шерлей или Ларей (с падающим стержнем). Опыты показывают что существует удовлетворительное согласие между этими двумя приборами и что искажение реограмм, полученных при применении автоматической записи с прибором Ферранти, причиняется инерцией вращающегося элемента. Ряд различных измерителей клейкости имеется в настоящее время в распоряжении и для трех применимых типов прибора существует линейная зависимость между значениями клейкости полученными на той или иной машине, для тех же чернил при той же периферийной скорости.

---

*Presented to the London Section on 15 February 1968.

Introduction

The tests considered in this paper are ones to measure the flow properties of printing inks. Two types of test are discussed. In one, a rheogram is obtained for the ink and the relevant constants read off the resultant graph. In the other, the ink is distributed over a system of rollers and the tack is measured. The object of the paper is to show that equivalent results are obtained on different instruments and to show how some instrumental characteristics can be used profitably.

The instruments to be discussed are the Ferranti-Shirley viscometer, the falling rod viscometer and tackmeters in general.

The Ferranti-Shirley viscometer

The Ferranti-Shirley viscometer is a cone-plate apparatus in which the cone has a large semi-vertical angle. With this arrangement the rate of shear at all radii is given by ω/ψ where ω is the angular velocity of the cone in radians/sec and ψ is the angle in radians between cone and plate. With these conditions the torque developed by rotation of a cone of radius R is given by

$$\mathrm{G} = \int_{0}^{R} 2\pi r^{2}\eta\frac{\omega}{\psi}\mathrm{d}r = \frac{2\pi R^{3}\eta\omega}{3\,\psi} \qquad (1)$$

where η is the viscosity of the liquid.

The cone spindle is divided into two parts. The upper portion terminates in a gear wheel and is driven by the motor. The lower section carries the cone, and the two halves are connected by a torsion spring. The viscous torque acting on the cone is balanced by the torque exerted by the spring so that a relative rotation between the two sections of the spindle ensues. The relative rotation between the two portions is limited by a stop which defines the maximum torque T of the apparatus. It is arranged that this maximum is equal to 500 meter divisions. Hence for a meter reading m divisions the torque is

$$\mathrm{G} = mT/500 \qquad (2)$$

Equating (1) and (2), and using the relation $\omega = \pi v/30$ where v is the cone speed in rev/min, one obtains

$$\frac{2\pi R^{3}\eta}{3\,\psi}\cdot\frac{\pi v}{30} = \frac{mT}{500}$$

or

$$\eta = \left(\frac{3T}{50\pi}\Big/\frac{2\pi R^{3}}{3\,\psi}\right)\cdot\frac{m}{v} = F\cdot\frac{m}{v} \qquad (3)$$

This is the equation relating torque and speed when the latter is constant, and F is called the cone factor.

When the machine is run at constant speed the deflection soon attains a steady value and the two sections of the spindle rotate with the same angular velocity. However, when the automatic recording system is used the situation changes. The driven half of the spindle is accelerated and its instantaneous angular speed is recorded on the chart. The cone itself is dragged around by the action of the spring whilst its motion is resisted by its own inertia and the viscous resistance of the sample. It is to be expected, therefore, that the speed of the cone will not be the same as that recorded on the chart but will lag by an amount determined by the conditions of the experiment.

Let the angular movements from rest of the driven spindle and cone be α, θ radians respectively; then evidently the deflection, i.e. relative rotation, φ is given by

$$\varphi = \alpha - \theta \tag{4}$$

Differentiating this with respect to time gives

$$\dot{\varphi} = \dot{\alpha} - \dot{\theta}$$

That is, the angular velocity of the cone differs from that of the driven spindle whenever the deflection is changing.

The equation of motion of the cone, taking account of its inertia and the viscous drag, is

$$I\ddot{\theta} + \frac{2\pi R^3\eta}{3\psi}\dot{\theta} = \frac{T\varphi}{\varphi_o} \tag{5}$$

where T/φ_o is the spring constant in dyn-cm-rad^{-1}, φ_o is the angular deflection equivalent to 500 meter divisions and I is the moment of inertia of the cone given by

$$\tau = 2\pi\left(\frac{I\varphi_o}{T}\right)^{\frac{1}{2}}$$

where τ is the period of oscillation of the cone.

Using this relation and the definition of F in equ (3) the equ (5) becomes

$$\frac{T\tau^2}{4\pi^2\varphi_o}\ddot{\theta} + \frac{3T\eta}{50\pi F}\dot{\theta} = \frac{T}{\varphi_o}\varphi$$

or

$$\frac{T}{2\pi}\ddot{\theta} + \frac{\eta}{\eta_c}\dot{\theta} = \frac{2\pi}{\tau}\varphi \tag{6}$$

where $\eta_c = 25F\tau/3\varphi_o$ is a constant for a given cone.

Combining equs (4) and (6) θ can be eliminated to obtain

$$\frac{\tau}{2\pi}\ddot{\varphi} + \frac{\eta}{\eta_c}\dot{\varphi} + \frac{2\pi}{\tau}\varphi = \frac{\tau}{2\pi}\ddot{\alpha} + \frac{\eta}{\eta_c}\dot{\alpha} \tag{7}$$

It is convenient to denote $\dot{\alpha}$ by β. Then $\ddot{\alpha} = d\beta/dt = a$, where a is the angular acceleration of the spindle in rad/sec/sec. Also we can use the relations $d\varphi/dt = (d\varphi/d\beta)(d\beta/dt) = a\,(d\varphi/d\beta)$ to change the independent variable in (7) from time to spindle speed and obtain

$$\frac{\tau a^2}{2\pi}\varphi'' + \frac{a\eta}{\eta_c}\varphi' + \frac{2\pi}{\tau}\varphi = \frac{a\tau}{2\pi} + \frac{\eta}{\eta_c}\beta \tag{8}$$

where dashes represent differentiation with respect to β.

A similar equation was derived by Harris[1]. If the response φ is required for a complete cycle it is necessary to expand the RHS of equ (8) as a Fourier series and solve the resultant equation for each term. If one is content with a solution for the half cycle from zero to maximum speed, equ (8) can be solved directly for constant η to give

$$\varphi = \frac{\tau\eta}{2\pi\eta_c}\,\beta - \frac{a\tau^2}{4\pi^2}\left(\frac{\eta^2}{\eta_c^2} - 1\right) \tag{9}$$

together with transient terms which quickly become negligible.

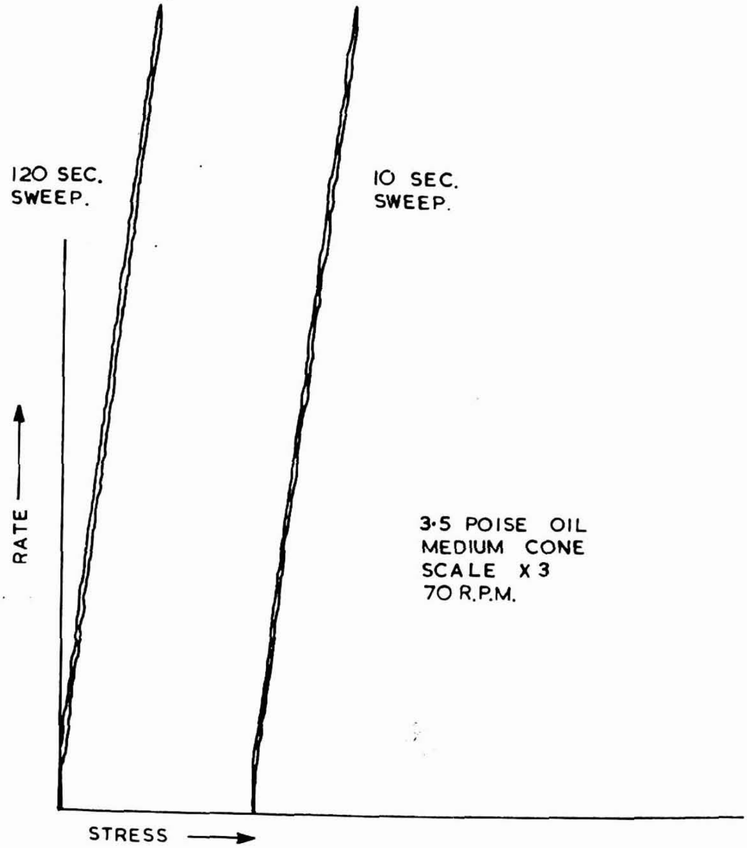
Converting equ (9) to observable quantities yields

$$m = \frac{\eta s}{F} - \frac{3\varphi_0\eta^2 b}{50\pi F}\left(1 - \frac{\eta_c^2}{\eta^2}\right)$$

where m = meter reading, s = spindle speed in rev/min and b = spindle acceleration in rev min^{-1} sec^{-1}.

This equation shows that, except in the special case $\eta = \eta_c$, the deflection m is less than the steady state value by an amount depending upon the sample viscosity and the acceleration. When the spindle is decelerating b is negative and the observed reading is too high by an equal amount. The complete cycle consequently shows a loop of the type associated with shear thickening even when the sample is Newtonian. Obviously the area of the loop can be decreased by using low values for the acceleration. Typical rheograms showing these effects are shown in Fig. 1.

1a



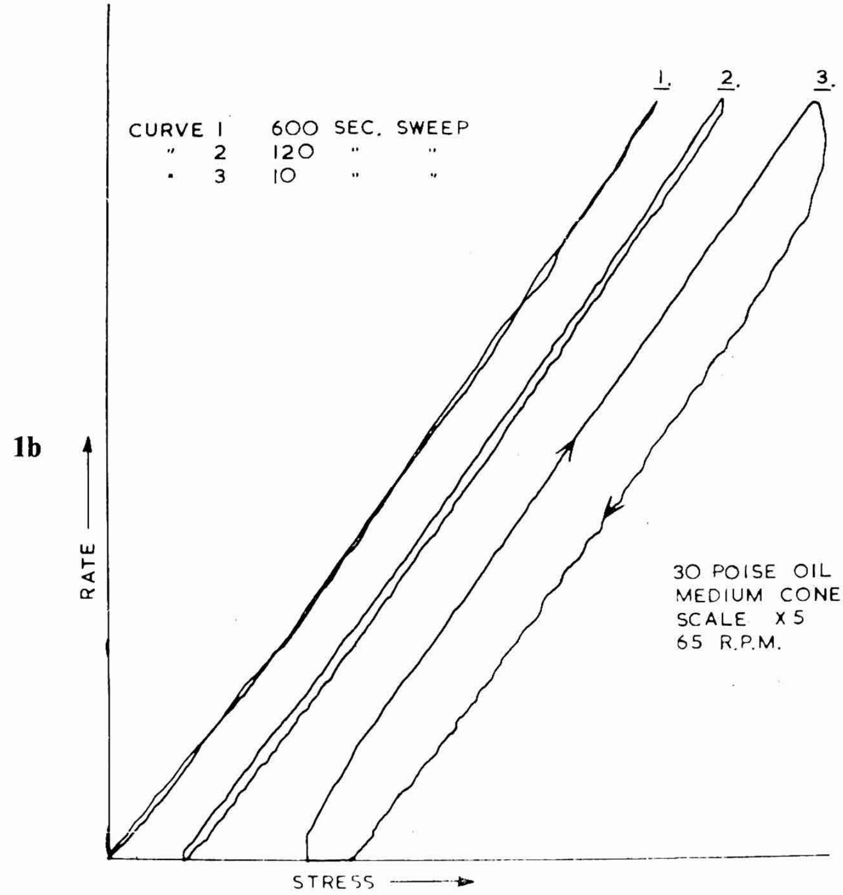


Fig. 1. Effect of sweep time on rheogram of mineral oils (a) viscosity nearly equal to η_c (b) viscosity greater than η_c

The values of η_c are about 0.9, 4.2 and 30 poise for the large, medium and small cones respectively and φ_o is $16\pi/9$ radians.

The foregoing analysis is valid for constant viscosity. If the latter varies either with duration or rate of shearing the equation no longer has constant coefficients, and it is doubtful if an analytical solution could be obtained even if the law governing the change of viscosity were known. Equ (8) is true at all times and can be solved for viscosity in terms of the other quantities. Writing this in terms of the observable quantities, i.e. cone speed in rev/min. and deflection in meter readings, gives

$$\eta = \frac{F\left\{m - \frac{b\tau\eta_c}{2\pi F}\left(1 - \frac{3\varphi_o b}{50\pi}\,\frac{d^2m}{ds^2}\right)\right\}}{s - \frac{3\varphi_o b}{50\pi}\,\frac{dm}{ds}} \qquad (9)$$

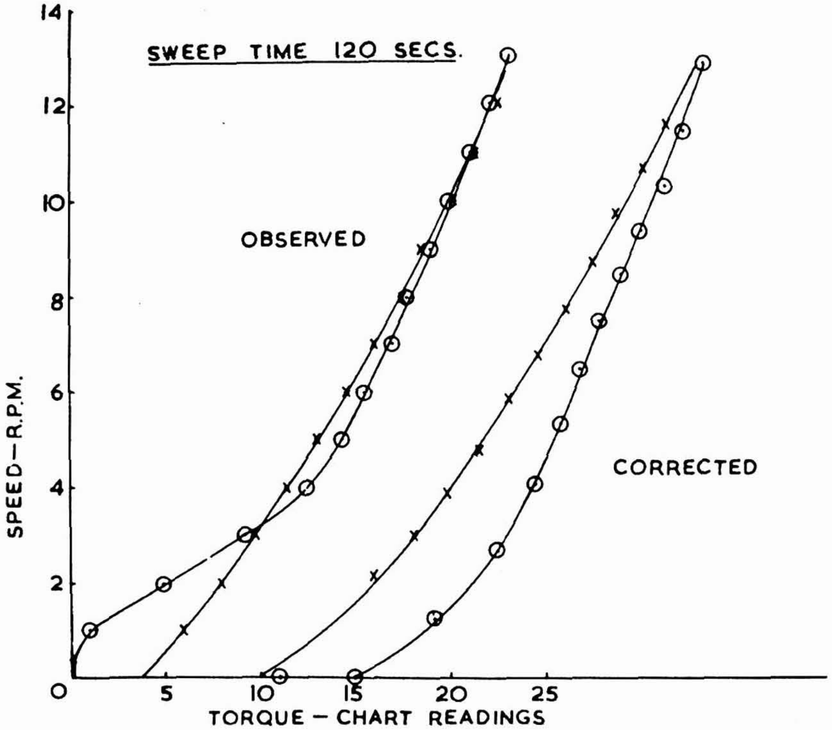
or, inserting the known values of the constants

$$\eta = \frac{F\left\{m - \dfrac{75b\tau^2}{32\pi^2}\left(1 - \dfrac{8b}{75}\,\dfrac{\mathrm{d}^2m}{\mathrm{d}s^2}\right)\right\}}{s - \dfrac{8b}{75}\,\dfrac{\mathrm{d}m}{\mathrm{d}s}} \tag{10}$$

In this equation the second term in the numerator is the portion of the deflection necessary to accelerate the cone against its own inertia and the denominator is the true speed of the cone. In order to obtain the correct flow curve for the material it is necessary to evaluate $\mathrm{d}m/\mathrm{d}s$ and $\mathrm{d}^2m/\mathrm{d}s^2$ and substitute in equ (10) to get the corrected speed and deflection. Probably the best way to do this is to obtain an analytical relation between the observed deflection and speed and to differentiate it as required. If this is done for various accelerations the differences between the resulting curves must be due to the different shear histories. Alternatively, it can be seen that the deviation from the true curve becomes smaller at low accelerations, so that it is advantageous to use long sweep times to avoid lengthy analyses. Rheograms for a single ink at different sweep times and the corrected curves are shown in Fig. 2.

It is possible also to predict a little about the shape of the rheogram if something is known about the sample. For example, if the material has a yield stress no flow occurs until the yield value is exceeded. Hence the cone velocity is zero up to this point. This is not exactly true because the sample must deform

2a



2b

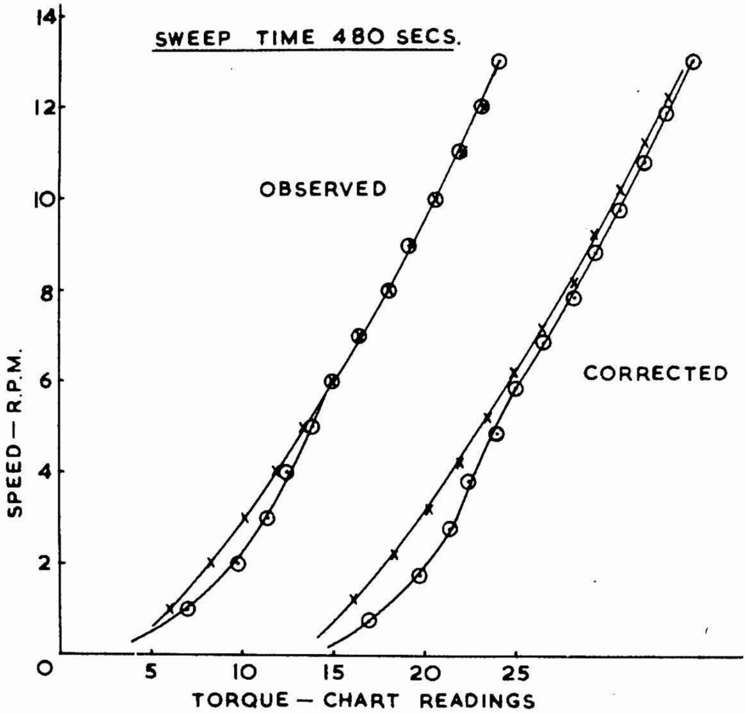


Fig. 2. Observed rheograms and corrected curves for a printing ink (a) sweep time 120 secs (b) sweep time 480 secs

elastically as the stress increases, but this rate of deformation is small enough to be neglected. Setting $\dot{\theta}$ equal to zero in the differentiated form of equ (4) gives

$$\dot{\varphi} = \dot{\alpha} = \beta$$

Changing the independent variable and integrating gives

$$\varphi = \beta^2/2a$$

or

$$m = 75s^2/16b \qquad (11)$$

when expressed in observed quantities i.e. m = meter reading, s = rev/min and b = rev min^{-1} sec^{-1}. Hence if the material has a yield value the initial portion of the curve is parabolic as in Fig. 3. If m is plotted against s^2 a straight line is obtained up to the value of m which equals the yield stress. Beyond this value the curve bends away from the straight line as flow commences. If the yield stress is an absolute constant then the critical value of m should be independent of the acceleration. Tests at different accelerations should therefore give information about the rigid part of the structure.

The falling rod viscometer

This apparatus consists of a long rod and a steel block with a hole drilled through it. The diameter of the hole is slightly greater than that of the rod.

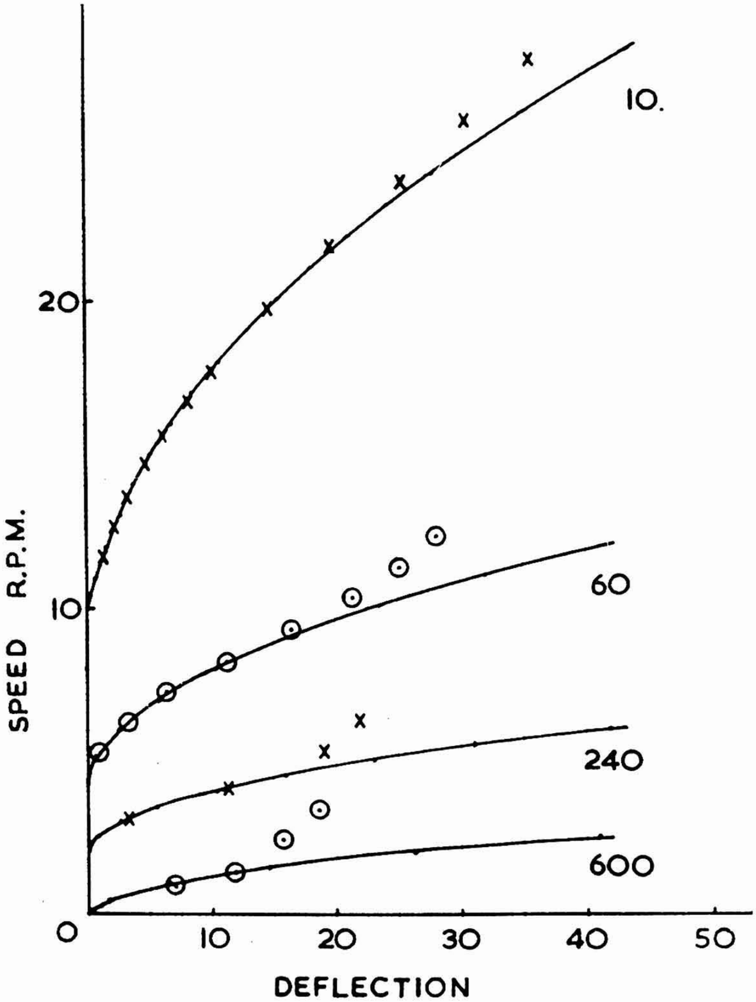


Fig. 3. Comparison of initial portions of rheograms for a plastic material at different sweep times. Solid lines—theoretical. Experimental values x or ○

The rod is coated with the sample under test and forced through the hole either under its own weight or with additional masses placed on its top end. The time, t, taken for the rod to fall a fixed distance is measured and a plot of $1/t$ against the load on the rod gives a rheogram for the material.

The theory of the apparatus assumes that the velocity of fall of the rod is constant, U. Under this condition the velocity distribution in the sample is given by

$$u = U \ln b/r / \ln b/a \tag{12}$$

where b is the hole radius, a the rod radius and r the radius of any lamina between the two surfaces. The shear stress at the surface of the rod just balances the load on it, so it follows that

$$M'g = 2\pi a l \eta U / a \ln b/a \tag{13}$$

where l is the length of the hole and M' is the total load on the rod and is equal to its own mass m plus the added mass M. If b is nearly equal to a, then $\ln b/a$ can be written as $(b\text{-}a)/a$. The velocity U is obtained by timing the fall over a fixed distance S and is given by $U=S/t$. Substituting these relations in equ (13) and rearranging gives

$$\frac{(m+M)g}{2\pi al} = \eta \cdot \frac{S}{t(b-a)} \qquad (14)$$

where η is the viscosity of the sample.

It is evident in equ (14) that the LHS represents the shear stress and the RHS is the product of viscosity and rate of shear. The factors $g/2\pi al$ and $S/(b-a)$ are the instrumental constants.

There is not much to say about the actual use of the apparatus but one aspect merits discussion, especially when an automatic timer is used. The theory assumes that the rod velocity is constant, but full analysis of its motion indicates that this is not so. Under the right conditions the rod very nearly reaches its terminal velocity well before the start of the measured distance, but when the fall times are short, less than 1 sec, this may not be the case. It is easier to restrict the load so that the fall time is of reasonable length.

Errors may occur if the experimental results are plotted on the chart paper supplied with the apparatus. On this paper there is a fixed relation between M and stress; $M = 0$, and, therefore, m is a fixed value on the stress scale and the lines of constant viscosity lead to a definite relationship between time of fall and rate of shear.

Referring to equ (14) these fixed points on the chart imply

$$g/2\pi al = \text{const}; \qquad m = \text{const}; \qquad \text{and } S/(b\text{-}a) = \text{const}.$$

If any of these are not true then the graph of the experimental results may show anomalous features. An example of such erroneous results is shown in Table 1. The oils were samples of standard viscosity oils. On the Ferranti-Shirley viscometer the viscosities obtained were 191.4 and 59.8 poise respectively, whilst on a Laray viscometer of known dimensions the values obtained were 182 and 60 poise respectively. It appears very probable that the erroneous values given in Table 1 were due to wrong dimensions in the apparatus. Errors in timing can be excluded because some of the measurements were taken with an automatic timer.

An aspect of interest to many is the correlation between results on the Laray viscometer and those on the Ferranti-Shirley viscometer. A straightforward correlation between results for an oil showed reasonable agreement (see Fig. 4). For printing inks the viscosity depends upon the rate of shear. With the Ferranti viscometer the shear rates available are very high, but this is not so with the Laray viscometer. Here the highest rate of shear is roughly $2500/t$ where t is the fall time at the highest shear stress. To make comparisons between the two instruments it is necessary to work over the same range of shear rate in each case, and if this is done the agreement between them is reasonable. Rheograms for two typical inks are shown in Fig. 5.

Table 1

Viscosities measured with LARAY viscometer

Oil Viscosity	Collar No.	Rod No.	Viscosity	Intercept
200 P	23	23	150 P	0
	7	7	173	- ve
60 P	23	23	45 P	0
	7	7	48	0
	7	W*	41.5	1,000
	7	A*	45.5	0
	7	B*	45	500

*Glass rods.

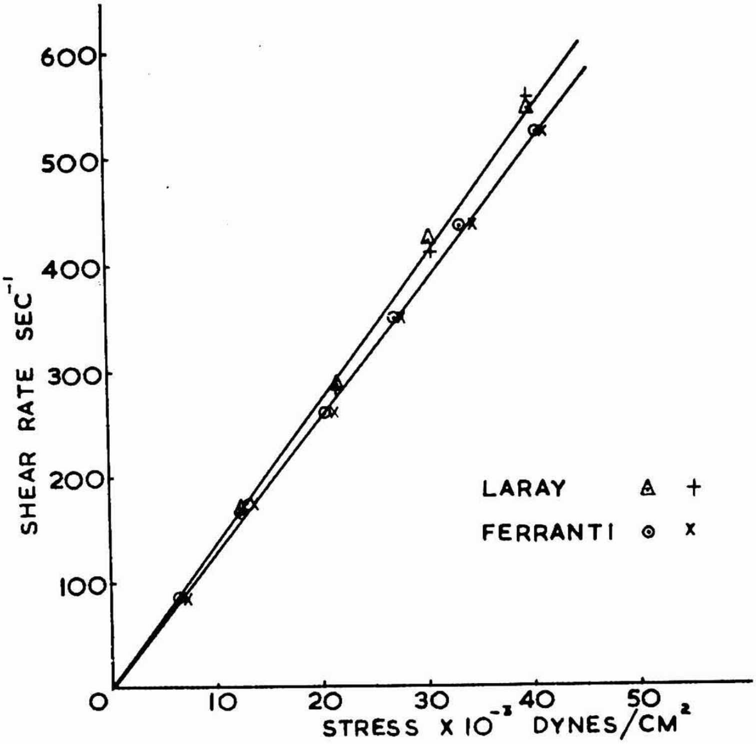
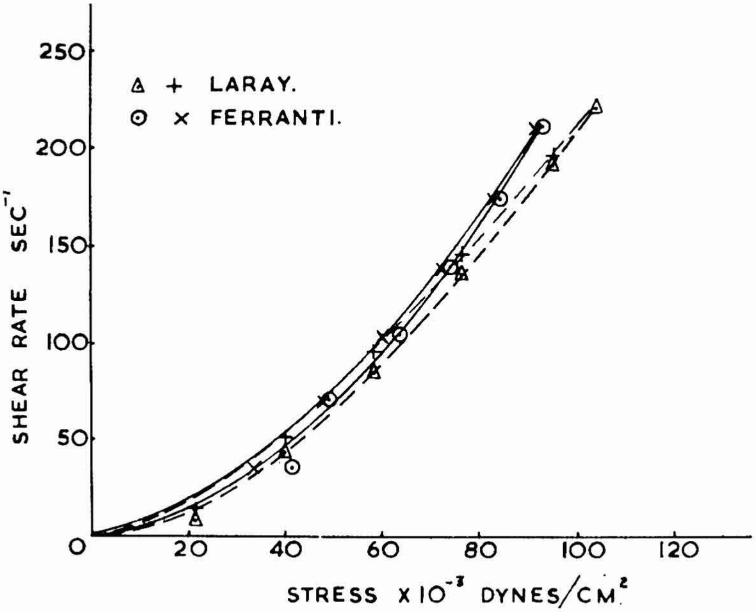


Fig. 4. Rheograms for a mineral oil with Ferranti-Shirley and Laray viscometers

5a



5b

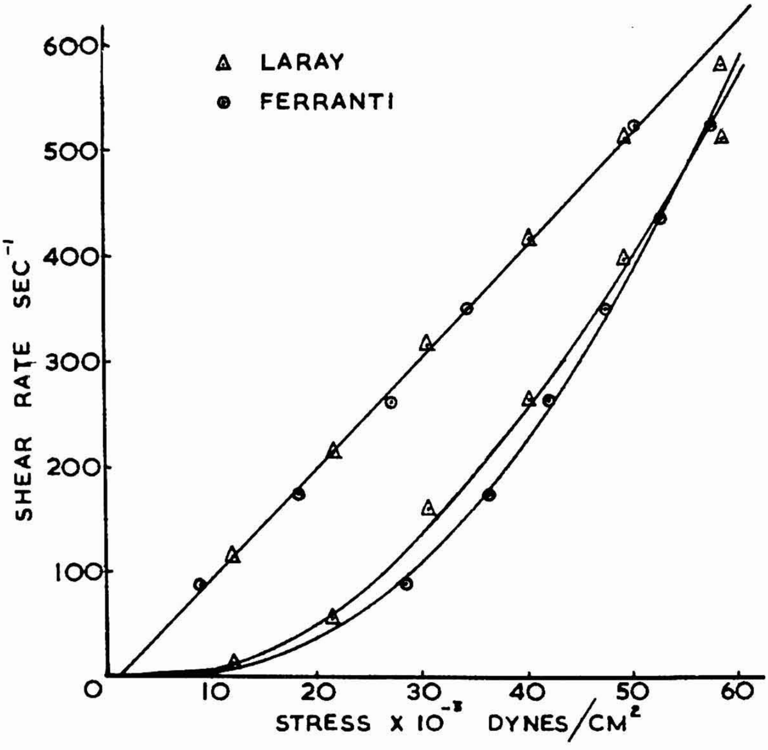


Fig. 5. (a & b) Rheograms for two printing inks obtained with Laray and Ferranti-Shirley viscometers

Tackmeters

The other rheological parameter commonly measured is tack, i.e. the resistance to splitting of an ink film. A tackmeter consists of three rollers of which one is used to measure the shear force and the two remaining rollers are simply distributors. The main drum is water cooled to minimize temperature increase during the experiment.

For many years the Inkometer was the only model but a few years ago there was a spate of new machines within the space of a few months. With all the machines the same basic design was retained but details such as roller diameter, roller length and inter-roller load were different. With such variability it was natural to inquire whether a simple correlation existed between the various models.

A simplified theory[2] gives the following relation for the shearing stress, S, between the rider roller and main drum

$$S = \frac{\pi r_1}{r_1 + r_2}\left(2\eta \; ULT\right)^{\frac{1}{2}} + \frac{F}{r_2} \tag{15}$$

where r_1, r_2 are the radii of the drum and rider roller respectively, T is the thrust between the rollers, L the length of the rider roller and F the frictional torque in its bearings. The equation shows fair agreement with experiment but there is evidence[3] to suggest that an additional term is required to allow for the elastic properties of the ink. As it stands, however, equ(15) indicates that different results will be obtained with the various machines because of dimensional variations.

In order to compare instruments it is necessary to examine a number of inks on the various machines. A convenient way to make the comparison is to plot the tack reading on one machine against that on another at the same speed. For the first set of experiments samples of ink were sent to a number of ink makers. The analysis of these results indicated possible variations between different samples of the same ink, so a further series was made in which the same ink samples were taken around and used on different instruments. The three types of tackmeter considered were the Inkometer, Metal Box-Churchill and PATRA Tackmeters. A number of machines of each type was employed so that variability within a type as well as between types could be tested.

To reduce the amount of analytical work it was decided to adopt as standard one machine of each type and to calculate regression lines for its data and those for other machines. A further account of this work is to be published elsewhere[4].

The results can be summarised briefly by drawing the regression lines for each group. For the Metal Box-Churchill tackmeters five machines were tested and four regression lines calculated. These show some variability both in slope and intercept on the axis. Five machines of the PATRA type were also used and four regression lines calculated. Two of these had slopes close to unity and zero intercept. The other two, both older models, had low slopes and large intercepts. These machines were both mechanically imperfect and one of them has since been corrected. Later models are better controlled before despatch and do not have these faults.

Four Inkometers were examined and three regression lines calculated. These three lines are all close to the ideal line slope = 1 and intercept zero.

The further test of comparison between types was effected by using the data for the "standard" machines. When plotted the points were scattered reasonably close to a straight line so the calculation of regression lines was justified. Writing I for Inkometer, P for PATRA and C for Churchill the calculated lines were

$$\begin{aligned} I &= 0.38_2\,P - 2.61 & \sigma &= \pm 0.75 \\ C &= 0.61_0\,P & \sigma &= \pm 1.48 \\ I &= 0.54_6 C & \sigma &= \pm 1.79 \end{aligned}$$

σ is the standard deviation from the regression line.

Conclusion

Experiments have shown that there is reasonable correspondence between the various standard tests used for printing ink providing due note is taken of the characteristics of the equipment used.

Acknowledgment

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4. South, G. R., *Brit. Ink Maker*, 1968, **10**, 150.

Discussion at the London Section Conversazione

MR C. J. BOULTER asked Mr Mill whether the composition of the distribution roller of the Metal Box Tackmeter was specified when he reported inaccurate repeatability on the instrument. In his experience varying results could be obtained using different distribution rollers; this was probably due to a film splitting effect.

MR C. C. MILL said that he did not consider that the inks were likely to be affected by contact with differing types of roller, unless significant differences in the film thicknesses on the three rollers resulted.

MR J. L. PROSSER asked whether the falling rod viscometer was self-centering.

MR MILL said that the system would be more stable if the weights were at the bottom of the rod. It had been found that the ink tended to have a centering action as the rod fell through.

DR N. CASSON said that in deriving equation (15) the only forces on the tackmeter which were considered were those arising from the viscous nature of the material. Did this indicate that while other factors such as viscoelasticity might contribute, viscosity was dominant in controlling tack as measured by the tackmeter?

MR MILL said that the simplest case to treat theoretically was that depending only on viscosity. Experiment showed that this case was inadequate for tack measurements and the proper course would be to solve the relevant differential equations using the correct constitutive equation for the printing ink.

MR T. A. TURNER referred to the preceding discussion about the suitablity of the falling rod viscometer for routine testing, and particularly the measurement of yield value. He said that, when making measurements with offset inks, only a restricted portion of the shearing force/rate of shear range was used. These materials were usually pseudoplastic and did not in fact have true yield values.

It had been shown that, using the Casson equation with falling rod viscometer data, it was possible to deduce an apparent yield value which represented a region where an appreciable reaction to shearing force occurred. This point could be obtained repeatedly and used in routine testing, and was related to printing machine performance of the inks. Experiments in which the viscometer rod was counterpoised showed that many offset inks did not have true yield values.

Mr Mill said that one could get a true yield stress on the Laray instrument with some inks. Other inks did not have a real yield value, but in effect only a high viscosity at low shear rates. Extrapolation of the linear portion of the graph to the stress axis would give an apparent yield value.

Mr V. J. Turner asked about the heating effects occurring within the sample on the Ferranti-Shirley viscometer, and whether Mr Mill considered they could be serious.

Mr Mill said that one could get a response from the thermocouples in the plate, indicating that the surface temperature was rising. One would in fact find a temperature gradient, usually very small, at whatever shear rate was being used. The temperature rise could be one or two degrees in the worst cases, which could well be serious.

Mr T. R. Bullett said that such heating was particularly dangerous when calibrating the Ferranti-Shirley viscometer with high viscosity hydrocarbon oils at high shear rates. Temperature coefficients of viscosity for these oils could be as high as 10 per cent per °C, and errors of up to 10-15 per cent had been found.

Mr Mill said that in the work he had reported he had had no evidence of changes due to temperature.

Dr N. Casson said that Mr Mill had shown that plots of shear stress F against rate of shear D, obtained from measurements on non-Newtonian materials on the Ferranti and Laray viscometers were in reasonable agreement. The method of treating the results recommended by the manufacturers of the Laray assumed that the materials were Bingham plastics, giving a linear relation between F and D, allowing values of plastic viscosity U and yield value f to be obtained from the results. An alternative was to use the equation $F^{\frac{1}{2}} = k_0 + k_1 D^{\frac{1}{2}}$, when by plotting in the appropriate manner the flow properties of the material could be expressed in terms of the constants k_0 and k_1. Clearly for routine control purposes such simple numerical characterisation was very desirable. He asked if Mr Mill could give any information on how the two instruments compare when the results are expressed in these ways.

Mr Mill said that his experiments had shown that, if the strain histories were similar, comparable values of stress at a given shear rate were obtained in the two viscometers. Whether one plotted F/D or $F^{\frac{1}{2}}/D^{\frac{1}{2}}$ curves was a matter of choice and the agreement between the experimental data did not depend on the type of relationship assumed.

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Suitable tests to ensure the economic use of titanium dioxide in emulsion paints*

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Technical Service Department, Titangesellschaft mbH, Leverkusen, Germany

Summary

Taking as an example two titanium dioxide grades, a universally applicable standard grade and a quality especially developed for use in emulsion paint, several test methods are discussed which permit a quantitative comparison of a number of properties. It is found in particular that the special grade in comparison with the standard grade possesses an elevated surfactant and water demand which, when allowed for, will nevertheless guarantee perfect dispersion of the titanium dioxide in the mill base as well as good viscosity stability of the emulsion paint. The use of the special grade in the region of higher pigment volume concentrations also leads to a somewhat greater film porosity. However, scrub and chalk resistance are not adversely influenced by this circumstance. The strength of the special pigment lies in its superior optical properties (tinting strength, hiding power, tone) which allow either the production of emulsion paints of improved quality or else a lowering of the raw material costs by saving titanium dioxide.

Essais convenables à assurer, en peintures-émulsions, l'utilisation économique du dioxyde de titane

Résumé

On discute, au point de vue de deux qualités de dioxyde de titane, l'une normale pour l'usage général et l'autre mis au point spécialement pour peintures-émulsions, plusieurs méthodes d'essai permettant une comparaison quantitative de quelques propriétés. On a trouvé en particulier que la qualité spéciale auprès de la normale possède des prises élevées de surfactant et d'eau, dont si l'on en tient compte peuvent rendre quand même une dispersion parfaite du dioxyde de titane dans la masse broyante et une bonne stabilité de viscosité dans la peinture-émulsion. Vers des concentrations pigmentaires en volume plus élevées, le type spécial occasionne-t-il une augmentation de la porosité du feuil. Pourtant la résistance au farinage et au frottement humide ne sont pas réduites par cette circonstance. Les avantages du pigment spécial restent dans ses meilleurs propriétés optiques (pouvoirs colorant, couvrant, et clarté) qui permettent soit la fabrication des peintures-émulsions de meilleur qualité, soit une diminution du prix de matière première par l'économie en dioxyde de titane.

Geeignete Prüfungen zur Sicherung des wirtschaftlichen Einsatzes von Titandioxid in Dispersionsfarben

Zusammenfassung

Am Beispiel zweier Titandioxid-Pigmente—eines universell einsetzbaren Standardtyps und einer speziell für den Einsatz in Dispersionsfarben entwickelten Qualität—werden einige Prüfmethoden besprochen, die einen quantitativen Vergleich einer Reihe von Eigenschaften gestatten. Im einzelnen ergibt sich, dass das spezielle gegenüber dem Standardpigment einen erhöhten Netzmittel-und Wasserbedarf besitzt, bei dessen Berücksichtigung jedoch eine einwandfreie Dispergierung des Titandioxids im Mahlgut und eine gute Viskositätsstabilität der Dispersionsfarbe gewährleistet ist. Ebenso führt der Einsatz des speziellen Pigmentes im

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*Presented to the London Section on 15 February 1968.

Bereich höherer Pigmentvolumenkonzentrationen zu einer etwas grösseren Filmporosität. Scheuerbeständigkeit und Kreidungsresistenz werden dadurch aber nicht negativ beeinflusst. Die Stärke des speziellen Pigmentes liegt in seinen überlegenen optischen Eigenschasten (Aufhell und Deckvermögen, Farbstich), die es erlauben, Dispersionsfarben entweder mit verbesserten Qualitätsmerkmalen auszustatten oder aber durch Einsparung an Titandioxid die Rohmaterialkosten zu senken.

Подходящие испытания для обеспечения экономного применения двуокиси титана в эмульсионных красках

Резюме

Рассматривая в качестве примера два сорта двуокиси титана, обще-применяемый стандартный сорт и сорт специально предназначенный для применения в эмульсионных красках, обсуждается несколько испытательных методов которые позволяют провести количественное сравнение ряда свойств. Найдено в частности что специальный сорт, по сравнению со стандартным, обладает повышенной поверхностной активацией и абсорбцией воды, которые будучи учитаны, все-же гарантируют отличную дисперсию двуокиси титана в мельнице и также удовлетворительную вязкостную устойчивость эмульсионной краски. Применение специального сорта в области более высокой объемной концентрации пигмента также приводит к несколько большей пористости пленки. Однако это обстоятельство не оказывает отрицательного влияния на сопротивление против терки и мела. Эффективность специального пигмента лежит в его лучших оптических свойствах (интенсивность окрашивания, покрывающая способность, тон), которые либо дают возможность изготовления эмульсионных красок более высокого качества или же снижают стоимость сырых материалов путем сбережения двуокиси титана.

Introduction

Economy in the manufacture of paints has become a factor of maximum importance, since the cost of labour has risen steeply during recent years. Both the makers of machinery and the raw material suppliers to the paint industry have contributed to economic paint production by the development of more effective dispersion apparatus and of raw materials with improved properties.

In a number of countries it is the producer of emulsion paints in particular who must counterbalance higher costs and, sometimes, maintain sales prices by greater economy in formulation and production.

Therefore, it is important to make the most economic use of the titanium dioxide pigment—one of the main constituents of emulsion paint—and, to this end, various test methods are employed in order that manufacturing and raw material costs may be reduced to a minimum, commensurate with the desired properties of the material produced.

The first requirement for a titanium dioxide pigment to be used in emulsion paints is good dispersibility in water. This property is, however, not easy to assess because, unlike stoving or air drying enamels, the pigment is used here in combination with considerable quantities of extender. As the average particle size of a conventional extender surpasses that of a titanium dioxide pigment by one or two powers of ten, tests like the "Hegman fineness of grind" cannot be employed. In severe cases of poor dispersion, scraping the surface of a tinted emulsion paint film with the edge of a glass panel may be used to decide whether the irregularities in the surface are formed by coarse extender particles or by TiO_2 agglomerates, because in the latter case white traces will ensue. There is also the possibility of drawing conclusions from indirect methods like optical measurements. Here, an unsatisfactory state of dispersion may be detected because the hiding power of the paint is deficient. Or, alternatively, the viscosity during storage may be studied and, if a viscosity increase is observed, pigment flocculation may be regarded as the cause. But such observations, apart from the fact that they can only be made after the damage has been done, need not even be conclusive.

Dispersion and rheological properties

Thus, it is necessary to make sure that the main prerequisite for good dispersion, the surfactant demand, is determined as precisely as possible. If the surfactant is incorporated in the right quantity one may safely expect not only optimal dispersion but also the best possible utilisation of the optical properties inherent in the pigment, and good storage stability of the paint as well.

Surfactant demand (viscosity method)

A method widely used to determine the surfactant demand comprises the preparation of aqueous pigment suspensions with graduated percentages of surfactant, and viscosity measurement of these suspensions. In this way, curves will be obtained with a viscosity minimum, and the percentage needed to obtain the lowest viscosity is regarded as the surfactant demand of the pigment.

Using sodium polyphosphate as surfactant, such determinations were carried out with a universally applicable titanium dioxide grade—in this paper called "standard grade"—as well as with a pigment especially developed for use in emulsion paint.[1] It may be seen from Fig. 1 that curves resulted with a typical shape in which the decreasing values represent a state where the system still contains agglomerates. At the minimum point it is fully dispersed, and upon addition of more surfactant, reflocculation occurs which reveals itself by an increase in viscosity.

Results: The viscosity minima were found at 0.15 per cent surfactant, calculated on pigment, for the standard, and 0.8 per cent for the special grade. This is of course a vast difference, but as these figures refer to the pure pigments only, their significance is more or less a theoretical one. If the experiment is repeated with pigment-extender mixtures as used in practice, then the value in the case of the standard grade rises to 0.3 per cent and in the case of the special grade it is lowered to 0.5 per cent. These figures are, of course, now based on the mixtures, and they indicate that, through the addition of extender, the differences between the two pigment grades become less extreme. The blend used here was composed of 50 per cent TiO_2, 45 per cent microdolomite, and 5 per cent talc.

The two figures, 0.3 per cent and 0.5 per cent, give a great deal of information, but more is required. To achieve a state of dispersion as complete as possible with a minimum of energy, it is important not only to know how much surfactant is needed but also how much water should be present in the mill base. As can readily be seen, there exists a difference between the two pairs of curves: with the standard grade suspensions of 70 per cent solids were used, and with the special grade the concentration was lowered to 67 per cent. This had to be done because the special grade possesses a greater water demand. The greater water demand is also reflected here by the fact that, although the concentration is lower, the viscosity minima lie higher.

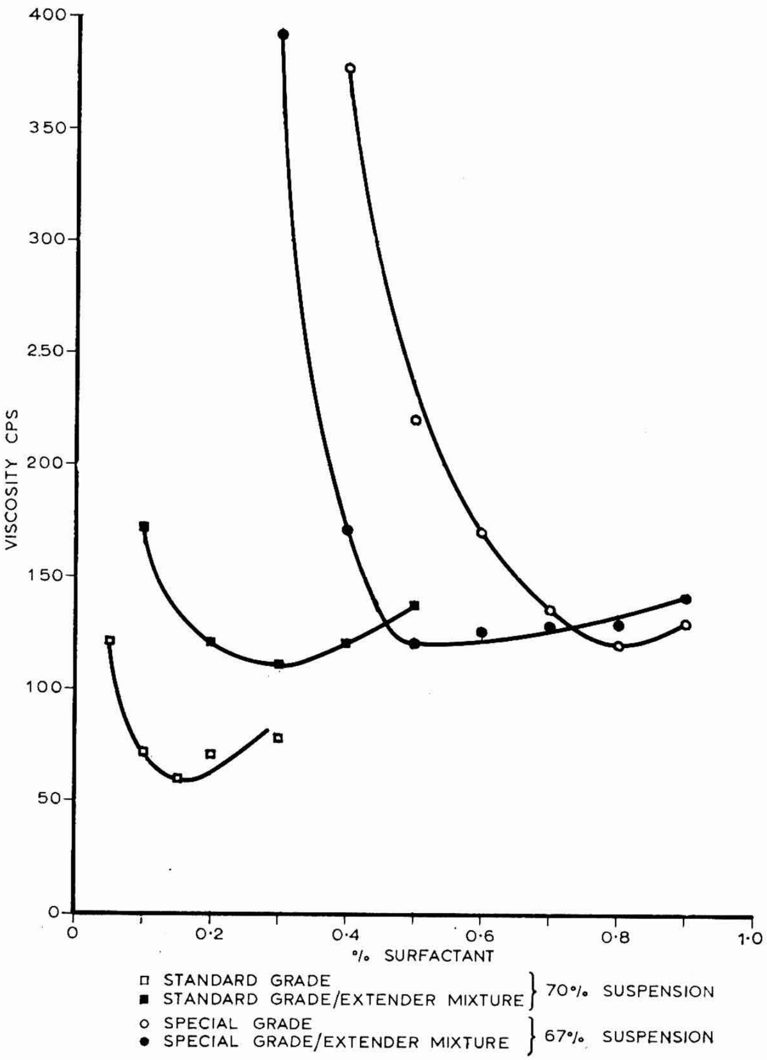


Fig. 1. Surfactant demand of titanium dioxide pigments and TiO_2/extender mixtures determined by the viscosity method

Similar experiments—this time with the pure pigments only—have also been carried out at lower solids concentrations, as is shown in Fig. 2. Here it will be noticed that, when moving from 67 per cent to 60 per cent solids, the figure for the special grade drops from 0.8 per cent to 0.5 per cent, and at 50 per cent solids it is only 0.3 per cent whereas with the standard grade it stays unaltered, with 0.15 per cent.

Discussion of Results: If this is so, then this method is disadvantageous, because there are obviously pigments for which a high, medium or low surfactant demand can be found, depending on what solids concentration was chosen for

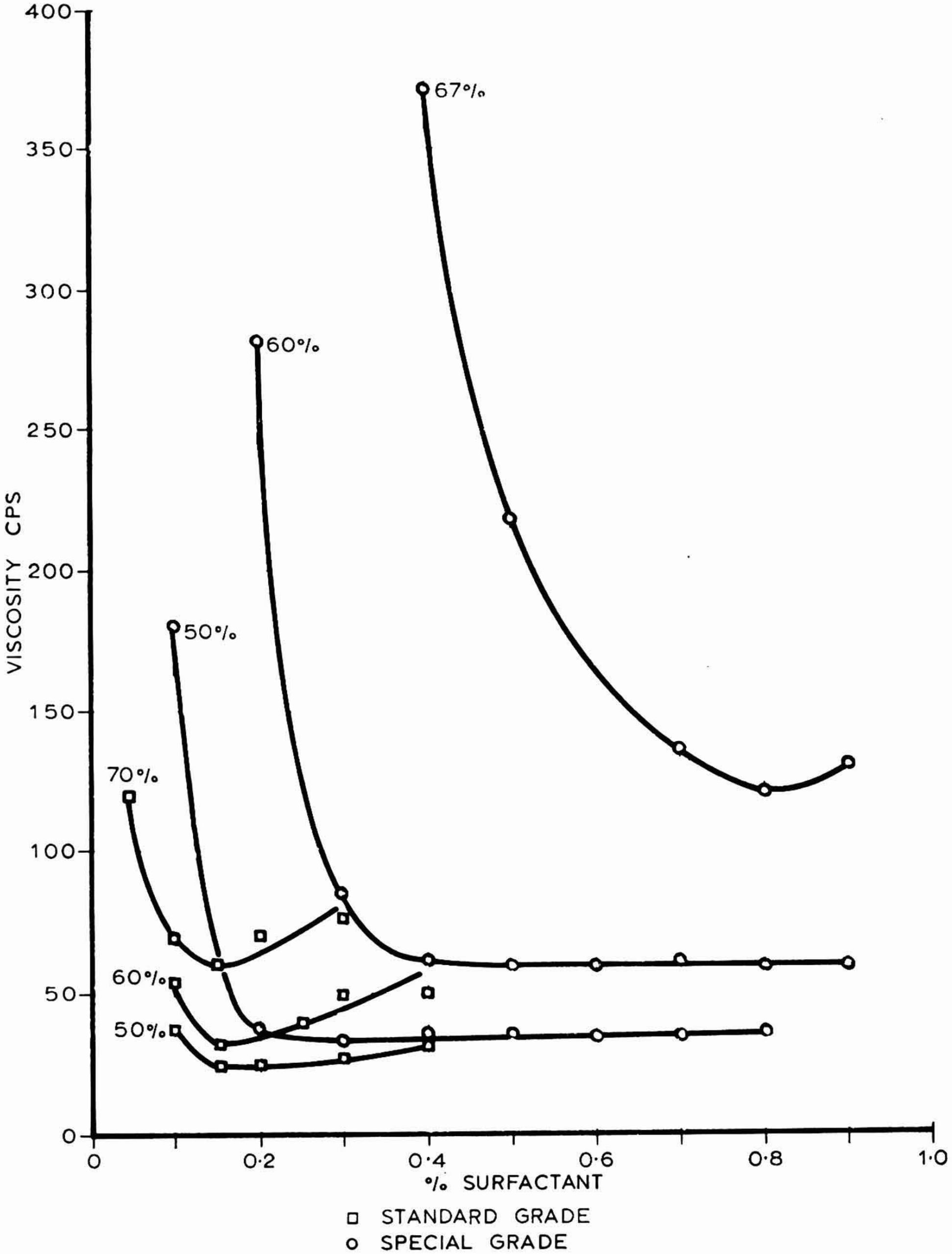


Fig. 2. Surfactant demand of titanium dioxide pigments determined by the viscosity method at lowered concentrations

the experiment, and there are other pigments which do not show this dependency. But apart from this, it is not thought that dispersion in a diluted slurry can be carried out in an economic way. From a theoretical standpoint, it should be better to have as much solid material present in the suspension as possible, because the pigment and extender agglomerates which must be dispersed act as grinding media themselves, especially in high speed dispersing equipment. This grinding action will, of course, be improved the closer the particles come to each other. As far as the surfactant is concerned, only as much is required in

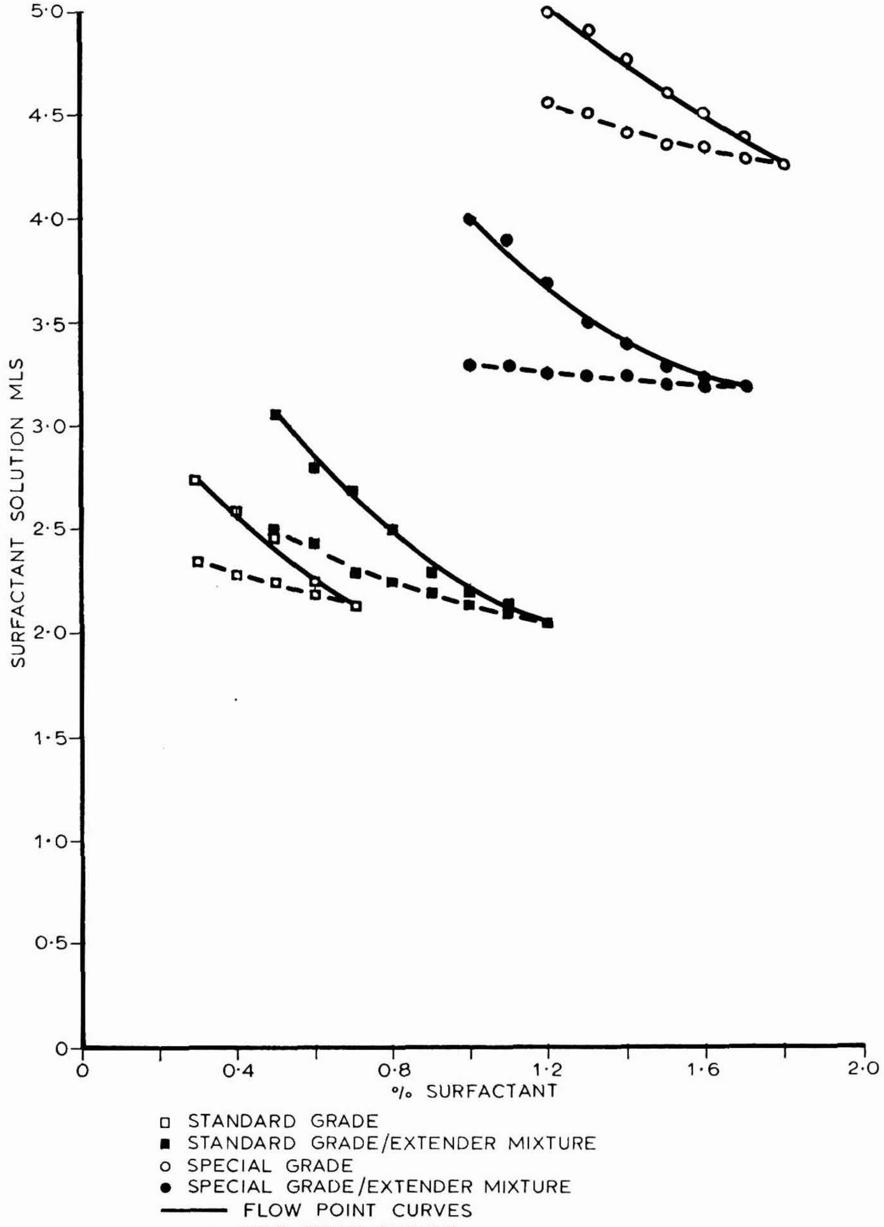


Fig. 3. Surfactant and water demand of titanium dioxide pigments and TiO_2/extender mixtures determined by the titration method

the system as is necessary to obtain complete dispersion; neither an excess nor a deficiency will give any benefit.

In other words, a method should be available to determine the solids/water/surfactant composition of such a theoretically ideal mill base at the same time. This method does exist in the so-called "wet point—flow point titration."

Surfactant demand (titration method)

This requires the preparation of a series of aqueous surfactant solutions of concentrations graduated in steps of, say, 0.1 per cent, and also of a series of pigment or, better, pigment-extender samples of 10g each.

The determination is started by titrating the first sample with a surfactant solution of low concentration. The titration is interrupted as soon as the "wet point" is reached. This is the point at which the sample first forms a coherent, putty-like mass. During titration, the sample is thoroughly kneaded with a glass rod or spatula. The volume of surfactant solution used to reach the wet point is noted, and then the titration is continued until the "flow point" is reached, i.e. the point when the material for the first time flows from the glass rod when withdrawn. Both points are recorded in a graph in which the ordinate is divided in mls surfactant solution, and the abscissa in per cent surfactant concentration, as is shown in Fig. 3.

The next titration is carried out with a new powder sample and the surfactant solution of a concentration one step higher. It will be noticed that both the wet and the flow point are reached earlier, i.e. after consumption of a lower quantity of surfactant solution. As a rule, the depression of the flow point is greater than that of the wet point.

With the subsequent titrations, wet point and flow point approach each other in value, and eventually coincide. By joining up both the wet and the flow points, two convergent curves result which meet at a certain concentration and quantity of surfactant.

According to the explanation submitted by Daniel and Goldman[2], the coincidence of wet point and flow point means that the suspension no longer contains agglomerates. It is, therefore, in a fully dispersed state, the state one wants to achieve in practice. The fact that the point of coincidence is reached moving from the lower to the higher concentrations and also from the dry to the liquid state ensures that complete dispersion is achieved with neither excess surfactant nor water.

Results: The values obtained in these tests will be found in the first three columns of Table 1. If these results are transformed into per cent of the total composition, the values shown in the fourth, fifth and sixth columns result.

Discussion of Results: The table also reflects—but more precisely—what has been seen earlier, viz. that the special grade possesses a higher water demand.

A further calculation to express the surfactant demand as a figure based on titanium dioxide or titanium dioxide-extender mixture leads to the results shown in the second last column of Table 1. In the last column, the values obtained by the viscosity method are recorded for comparison. It can be seen that both methods show good agreement, although divergent solids concentrations are involved: 70 per cent for the standard grade in the viscosity method

Table 1

Surfactant and water demand of titanium dioxide pigments and TiO_2/extender mixtures determined by the titration method

	Solids	Surfactant solution		Total composition			Surfactant demand	
	Solids gm	Consumption ml	Concentration %	Surfactant %	Water %	Solids %	Titration method %	Viscosity method %
Standard grade	10	2.15	0.7	0.12	17.57	82.31	0.15	0.15
Standard grade/Extender mixture ..	10	2.05	1.2	0.20	16.81	82.99	0.25	0.3
Special grade	10	4.25	1.8	0.54	29.25	70.21	0.77	0.8
Special grade/Extender mixture ..	10	3.20	1.7	0.41	23.83	75.76	0.54	0.5

against over 80 per cent here, and 67 per cent for the special grade in the viscosity method against more than 70 per cent here. Unlike the observations made when lowering the solids concentrations to 60 per cent and 50 per cent it must be said that here, in the region of high concentrations, the results are practically uninfluenced by variations in the solids contents.

However, it is not the coincidence between the two methods which is to be demonstrated. It is the fact that the titration method contributes all the figures needed to compose a mill base. This mill base has been called earlier a "theoretically ideal" one. Why theoretical and not practical? If it is tried to disperse a mill base of the calculated composition in a high speed dissolver, for instance, then it will soon be found that such a system possesses too high a degree of thixotropy to allow it to flow properly in the dispersion vessel. To obtain a satisfactory flow, additional water is required. This, however, is in the region of only a few per cent, and it is not necessary to increase the quantity of surfactant. With such mill bases, slightly off the calculated composition, it has been found that fully satisfactory dispersion is achieved with a minimum of time and energy.

Viscosity stability

The next major step in emulsion paint making is the addition of vehicle to the dispersed pigment/extender slurry. Further additions follow and, after all this has taken place, the surfactant must fulfil a second task, viz. impart stability to the finished paint. Storage trials continued over several weeks both at 20 and 40°C have proven that a deficiency in surfactant, apart from being undesirable as far as dispersion is concerned, can also lead to an intolerable viscosity increase during storage. If the optimum percentage, as derived from the method described before, is incorporated in the paint, the increase in viscosity is so greatly reduced that the paints are certain to retain their workability. For example, with an emulsion paint containing the optimum surfactant quantity, an initial viscosity of 70 Krebs units was found. The viscosity was still 70 KU after two weeks, and 73 KU after ten weeks storage at 20°C, whereas the same paint, but containing only half the surfactant quantity, rendered the following figures: 84, 96 and 124 KU.

Optical properties

From what has been shown so far it seems as if the titanium dioxide pigment especially designed for the pigmentation of emulsion paints only offered a disadvantage against the standard grade. Elevated demand for an auxiliary substance will hardly serve to make a raw material attractive for the user. However, in the case of special emulsion paint pigments, the increased surfactant demand is the consequence of a particular aftertreatment the titanium dioxide must undergo to make it more resistant to what is known as the "crowding phenomenon" or the "packing effect."

Crowding is brought about by the presence of extender particles which are considerably larger than those of the pigment. During film formation, when the water leaves the freshly applied coat by penetration into the substrate and by evaporation, the extender particles approach each other and, in the voids between them, a proportion of the pigment is hidden. It can no longer fulfil the task for which it was employed, namely to interact with the light and thus produce hiding power. One way to counteract this undesirable behaviour would be the use of extenders with particle sizes similar to that of the pigment. However, such materials are not too well known in practice, and with the few that are available, the high price is sometimes prohibitive, or technical disadvantages, like high vehicle demand, limit their use.

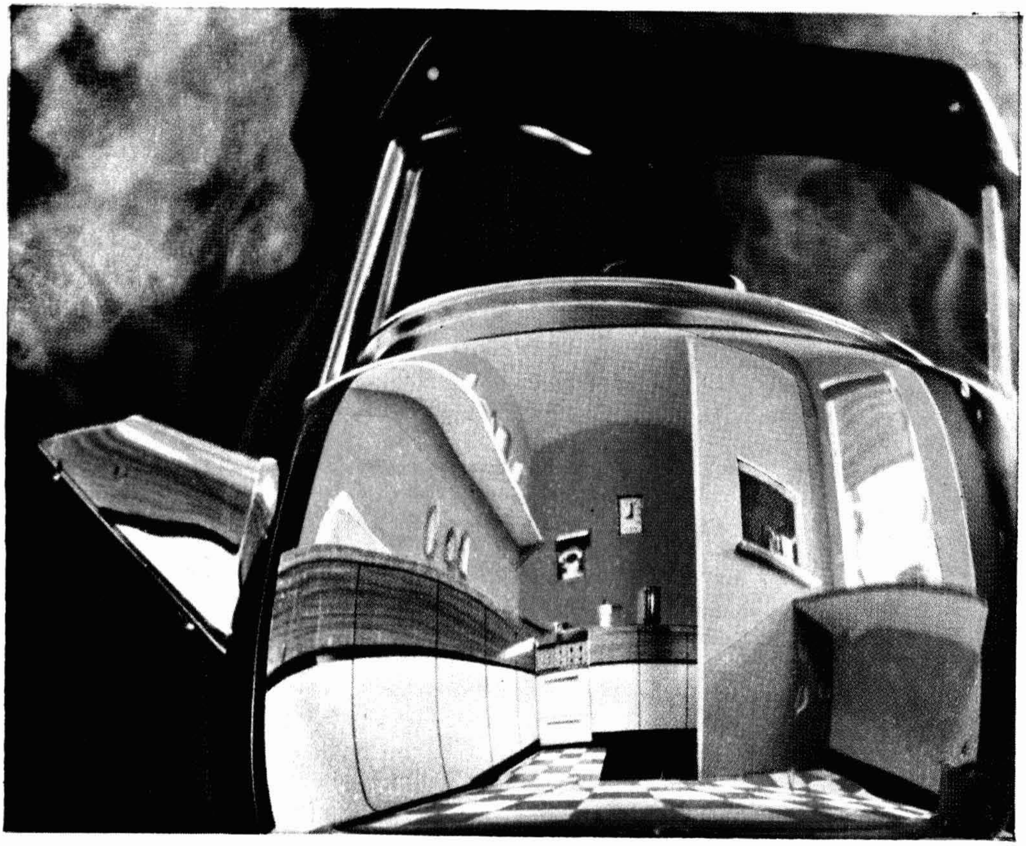
Successful attempts have therefore been made to aftertreat titanium dioxide with a high percentage of inorganic material, with the result that a coating of considerable thickness is formed on the pigment surface. Such a coating should act better than a fine particle extender because it is attached to the pigment and should always keep the pigment particles at a certain distance from each other no matter how much they are pressed by the extender particles. Thus the effect described as crowding should be prevented or at least minimized. The result should be that of two pigments, the one more uniformly distributed in the paint film, i.e. the one that is better spaced, yields superior optical properties.

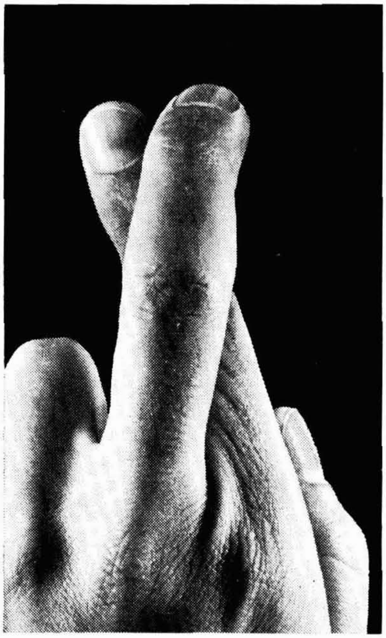
This leads to a consideration of test methods employed in the measurement of optical properties. It is proposed to describe how the two pigment grades may be compared optically and how a quantitative value may be placed on any differences which may occur. The techniques described will also indicate the percentage saving which may be expected from the special grade without lowering tinting strength and hiding power beneath the level represented by the standard grade.

It may or may not be sufficient to test the optical properties in only one formulation. But if one wants to study the performance of titanium dioxide pigments at graduated pigment volume concentrations, one should consider that in the lower PVC region formulations of paints are found which are mainly meant for exterior application, being characterised by a high TiO_2 and a low extender percentage, and *vice versa*. So, to gain a picture of the performance of the pigment over a certain PVC range, it would not be very close to practice if one worked at a constant titanium dioxide:extender ratio and regulated the PVC with smaller or greater quantities of emulsion. A better technique would be to keep the partial volume concentration of the titanium dioxide constant and use different quantities of both extender and emulsion to get a variation in the pigment:extender ratio as well as in the total PVC. This would better comply with practical conditions.

Following this line of thought, there arises yet another point worth consideration. Due to the different aftertreatment, there exists a difference of 13 per cent in the specific gravities of the two grades: $4.06 g.cm^{-3}$ for the standard, and $3.59 g.cm^{-3}$ for the special grade. Using identical weight quantities of either grade would, therefore, result in divergent pigment volume concentrations, solids concentrations, total paint volumes, etc. In other words, if one wishes to keep the PVC constant when switching from one grade to the other, a lower pigment quantity by weight must be used in the case of the special grade. This is particularly important where emulsion paints are sold by volume.

In order to demonstrate what happens if either equal weights or equal volumes of the two TiO_2 grades are employed, two series of emulsion paints were prepared. In the "equal weight" series, the partial volume concentration in the





case of the standard grade was kept constant at 20.0 per cent while the total PVC was increased stepwise from 30.0 to 40.0, 50.0, 60.0, and 70.0 per cent. This was achieved through the addition of graduated quantities of extender and emulsion. Using the same weight quantity of the special grade resulted in a partial PVC of 22.0 per cent throughout the series, with total PVCs of 31.8, 41.6, 51.3, 61.1, and 70.8 per cent. In the "equal volume" series, where the quantity of the special grade employed was less by weight, the same straight partial and total PVC figures apply to the special grade as to the standard quality.

Table 2 lists the weight as well as the volume composition of all the batches prepared. Water and minor ingredients are excluded from the calculation, therefore the composition figures are those of the dried films. Also quoted are the TiO_2: extender ratios both by weight and volume as well as the partial and total PVCs.

The figures of Table 2 first of all indicate to what extent such characteristics as partial and total PVC, total weight and total volume are altered if the special grade is used instead of the standard one either at equal weight or equal volume. More interesting results are, however, obtained when such paints are tested for their optical properties.

To this end, batches were prepared according to the basic formulations given in Table 2, but, based on the TiO_2 pigment weight, constant quantities of black pigment were added to each batch. The black pigment was included to obtain grey paints which could be tested for tinting strength, a property related to hiding power but which is able to be assessed more precisely.

Tinting strength

These paints were applied at a wet film thickness of 100 microns to white cardboard substrates using an automatic applicator. A smooth movement of the applicator blade is necessary if one wants to obtain drawdowns of uniform thickness. After drying at 20°C and 65 per cent RH for 24 hours, the remission values of these drawdowns were measured with a remission photometer. The remission photometer works with three coloured filters: blue, green and yellow. For the assessment of the brightness or luminous reflectance which is used as the measure of the tinting strength, only the green filter is needed. This is because the human eye has its highest sensitivity in the region of green light. The instrument is so constructed that the scale readings refer to a magnesium oxide standard whose luminous reflectance is 100 per cent by definition.

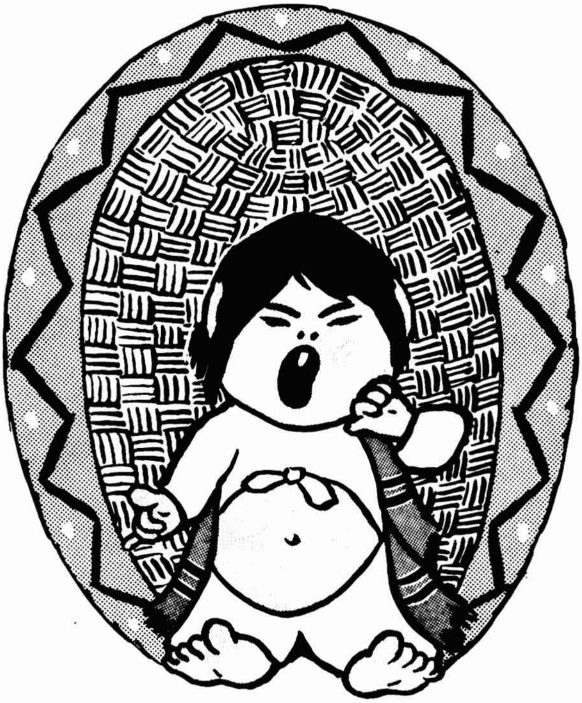
Results: The differences in tinting strength resulting from the use of the special instead of the standard grade either at equal weight or equal volume can be read directly from Fig. 4.

Discussion of results: Now it is seen quite clearly where the merits of the special grade lie. It is indeed better suited to contribute to the optical properties of emulsion paints than is the standard grade. This holds true for the whole range of TiO_2: extender ratios from about 75:25 to roughly 34:66, and certainly also beyond either limit.

Table 2

Solids composition of emulsion paints incorporating the special TiO_2 grade at equal weight or at equal volume to the standard TiO_2 grade

	Standard grade		Special grade		Extender		Vehicle solids		Total		TiO_2: Extender ratio		TiO_2– P.V.C.	Total P.V.C.
	gms	mls	gms	mls	gms	mls	gms	mls	gms	mls	Weight	Volume		
“Equal weight” series	—	—	812	226	280	100	770	700	1862	1026	74.4:25.6	69.3:30.7	22.0	31.8
	—	—	812	226	560	200	660	600	2032	1026	59.2:40.8	53.0:47.0	22.0	41.6
	—	—	812	226	840	300	550	500	2202	1026	49.1:50.9	42.9:57.1	22.0	51.3
	—	—	812	226	1120	400	440	400	2372	1026	42.0:58.0	36.1:63.9	22.0	61.1
	—	—	812	226	1400	500	330	300	2542	1026	36.7:63.3	31.1:68.9	22.0	70.8
“Equal weight” series “Equal volume” series	812	200	—	—	280	100	770	700	1862	1000	74.4:25.6	66.7:33.3	20.0	30.0
	812	200	—	—	560	200	660	600	2032	1000	59.2:40.8	50.0:50.0	20.0	40.0
	812	200	—	—	840	300	550	500	2202	1000	49.1:50.9	40.0:60.0	20.0	50.0
	812	200	—	—	1120	400	440	400	2372	1000	42.0:58.0	33.3:66.7	20.0	60.0
	812	200	—	—	1400	500	330	300	2542	1000	36.7:63.3	28.5:71.5	20.0	70.0
“Equal volume” series	—	—	718	200	280	100	770	700	1768	1000	71.9:28.1	66.7:33.3	20.0	30.0
	—	—	718	200	560	200	660	600	1938	1000	56.2:43.8	50.0:50.0	20.0	40.0
	—	—	718	200	840	300	550	500	2108	1000	46.1:53.9	40.0:60.0	20.0	50.0
	—	—	718	200	1120	400	440	400	2278	1000	39.1:60.9	33.3:66.7	20.0	60.0
	—	—	718	200	1400	500	330	300	2448	1000	33.9:66.1	28.5:71.5	20.0	70.0



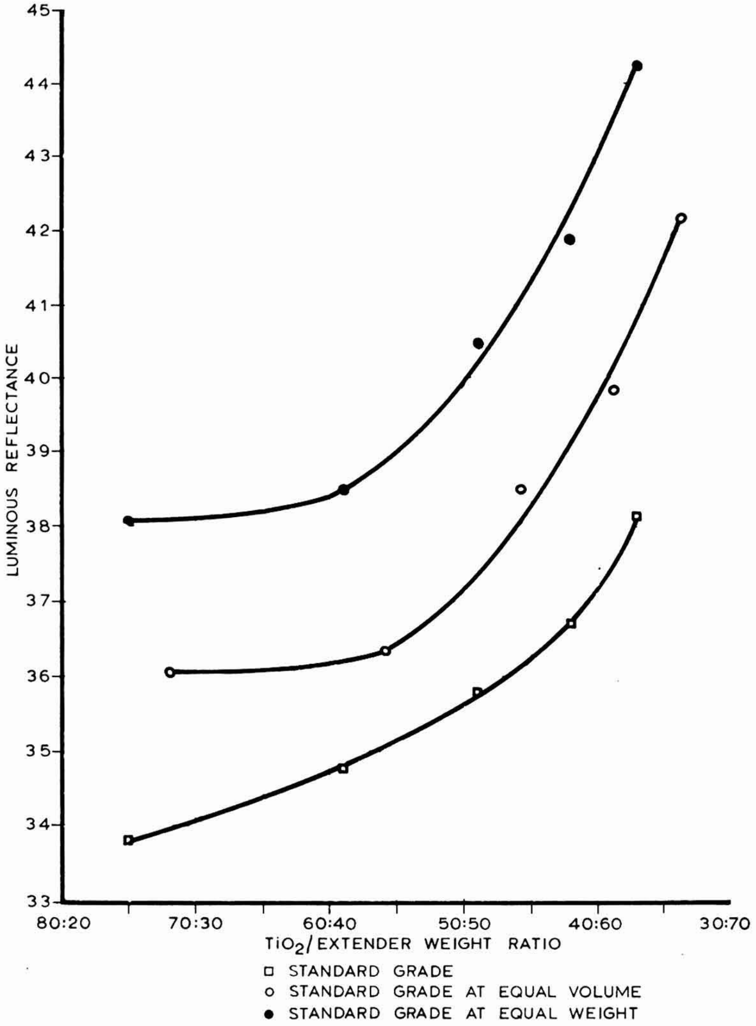


Fig. 4. Tinting strength of grey emulsion paints

The differences between the two grades in the "equal volume" series are of course smaller than those in the "equal weight" series, but it must not be forgotten that a proportion of 13 per cent titanium dioxide pigment was saved in the latter case by leaving it out of the formulation. But, although less pigment was employed, there remains a considerable advantage in tinting strength.

It will certainly be of interest for the emulsion paint manufacturer to know how much of a special TiO_2 grade he can save (and replace by extender) in a given formulation when using it instead of a standard grade. From what has been demonstrated here, it is clear that already in the region of TiO_2: extender ratios around 34:66 more than 13 per cent may be saved, and savings will certainly become greater as the TiO_2: extender ratio increases. In a supplementary evaluation it has been found that at the other end of the scale—around a ratio of 75:25—as much as 25 per cent pigment can be replaced by extender without lowering the optical characteristics beneath the level represented by the standard grade. It has, however, also come to light that, if the TiO_2: extender ratio becomes as unfavourable as 5:95 which is the case in some cheap interior emulsion paints, the special grade will practically no longer surpass the standard one.

Quotation of more precise figures has been deliberately avoided because the main intention is to describe a method of which the accuracy has been found to be very good indeed. As far as the results are concerned, there are many variations possible in practical formulations with influences from the extenders and, to a lesser degree, the emulsions used, which may alter the results within certain limits. Therefore, the actual savings to be realised in a given formulation must be found out using exactly that formulation and not a mere approximation.

Tone

Besides tinting strength, a second optical property of a paint film is of interest, this is its tone which, in the case of grey or white films, is more or less identical with its degree of yellowness or blueness. To assess the tone of a paint film, the values obtained with the two other filters of the remission photometer in addition to the green one are required. Measurements are normally carried out with the same grey drawdowns as used for the tinting strength determination. It might be thought that the difference or maybe the ratio of the blue and the yellow filter readings would be suited to express the tone in figures, but in fact the visual impression of tone is also influenced by the brightness of the paint film. To allow for this contribution, an equation is used which will be found in Fig. 5.

It is the difference between the blue filter remission, R_z, and the yellow filter remission, R_x, divided by the green filter remission, R_y, and multiplied by 100, which is taken as the measure for the tone. The result of this calculation is termed "blueness index." A positive value for the blueness index means that the sample possesses a blue tone, whereas negative figures indicate certain degrees of yellowness. This is of course a convention to account for the fact that blueness in this context is regarded as something desirable, and should therefore be expressed in positive figures.

Results: In Fig. 5 a tone comparison of the two series will be found. Again the superiority of the special grade is obvious, and it is particularly noteworthy that this superiority is only marginally affected when switching from equal weight to equal volume.

Hiding power

Also, without going into too much detail, mention should be made that remission measurements from white drawdowns are sometimes used for the determination of hiding power. In this case, the green filter remission of the paint over a black substrate divided by that over a white one, called the contrast ratio, is taken as the measure. Practically complete hiding is obtained at a contrast ratio of 0.98.

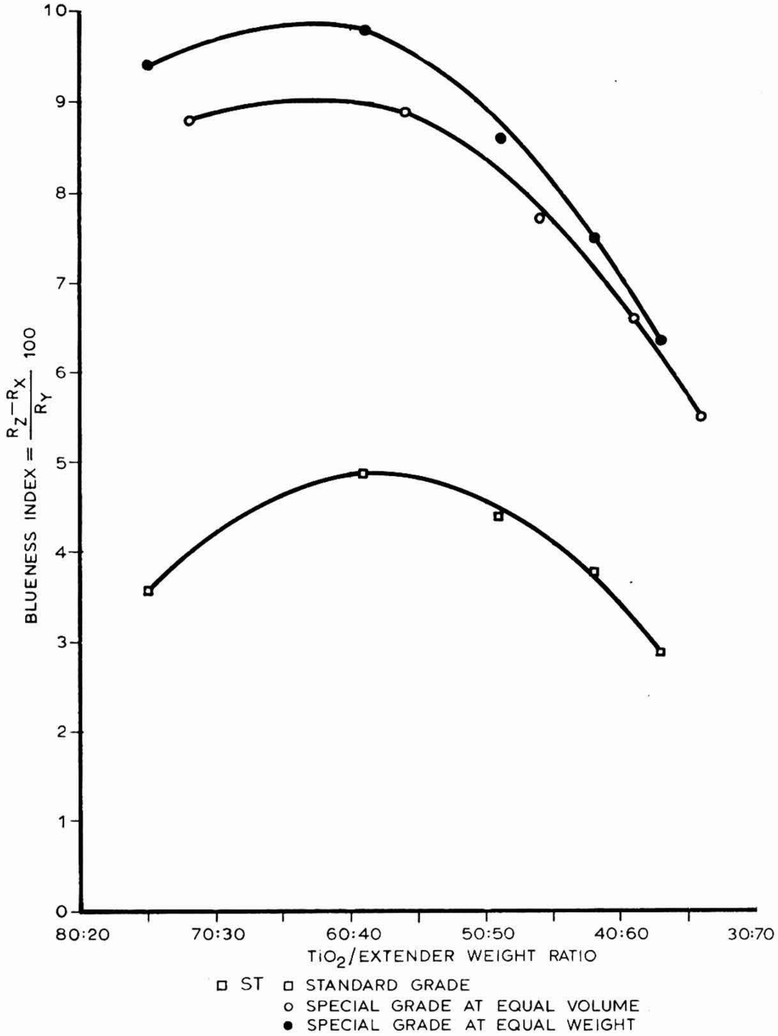


Fig. 5. Tone of grey emulsion paints

Generally, good agreement is found between tinting strength and hiding power, but, as far as hiding power determinations themselves are concerned, there are a few exceptions where the visual impression differs from the instrument reading. This is particularly the case with emulsion paint films of a high sheen. Here, the visual impression depends greatly on the angles of illumination and observation, and these can of course be varied whereas in the instrument they are fixed. Therefore, a comparison between instrumental and visual determinations can lead to inverted results.

Other properties

After having covered the subjects of dispersibility and optical properties, some words remain to be said about several other properties of emulsion paint films which are influenced by the titanium dioxide pigment.

Film porosity

The question could be asked whether the better optical performance of the special grade is something obtained at the expense of some other property which is not required to be sacrificed. How is, for instance, the film coherence influenced? If porosity—or rather lack of porosity—is taken as a measure of film coherence, then the "Gilsonite stain removal test" is a suitable method to reveal even small differences. For this test a 10 per cent solution of the dark coloured natural asphalt, gilsonite, in white spirit is used. The solution is brushed across the emulsion paint drawdown—a white drawdown is required this time—and rinsed immediately afterwards with white spirit from a squeeze bottle until the liquid runs off uncoloured. Gilsonite has the property of penetrating very quickly into a porous film, and causes a permanent discoloration. The intensity of such a discoloration can be used as a measure of film porosity.

Results: Porosity comparisons between the two TiO_2 grades carried out at closely graduated pigment volume concentrations have revealed the following: up to a PVC of 50 per cent there is practically no porosity detectable, irrespective of whether the special or the standard grade was used for pigmentation. From 50 per cent PVC upwards, the paint films begin to show porosity, and they show it to a different extent. It may be said that the discoloration of the film containing the special grade at 55 per cent PVC is equal to that containing the standard grade at 60 per cent PVC. Then, beyond 60 per cent PVC, with the porosity increasing further, the rating becomes more and more uncertain. This might be connected with the formation of large pores from which a part of the gilsonite is removed in the rinsing operation. However, the impression has been gained that at PVCs higher than 60 per cent the difference in porosity is no greater than that in the 50 to 60 per cent PVC bracket, where the method shows its highest reliability.

Scrub resistance

If a difference in porosity exists, does it have further consequences? Is the scrub resistance reduced by higher porosity? For the determination of scrub resistance a mechanically operated nylon brush and white paint drawdowns of 200 microns wet film thickness, applied to special black plastic sheets, are employed. Throughout the scrubbing operation, a 1 per cent soap solution is added dropwise. If the PVC is 50 per cent, no film breakdown is found after 10,000 brush strokes either with the standard or the special grade. At 60 per cent PVC, breakdown starts after 7,000 strokes, and the substrate begins to shine through after 9,000 strokes. The figures for paints at 70 per cent PVC are 900 strokes for the breakdown to begin, and 1,200 for a more or less complete abrasion. In no case could a difference resulting from the use of the two different pigments be detected.

Chalk Resistance

Exposure tests have shown that, in respect of chalk resistance also, the special grade is the equal of the standard grade. With an exposure series now 20 months old, for the standard grade in copolymer PVAc a value for the accumulated chalking[3] of 79 has been found, and also 79 for the special grade. For the standard grade in polyvinyl propionate the accumulated chalking is 73, and for the special grade, 72. The last measured chalk ratings are 6, in the PVAc paints, and 5, in the PVP paints. These figures are valid for either pigment. They are based on a scale running from 1 to 10 with 10 meaning no chalking, and 1, strongest chalking. For taking the chalk prints, the Kempf method[4] was used. The values quoted refer to paints of 40 per cent PVC and a TiO_2: extender weight ratio of 50:50. Those paints pigmented with the special grade contain 0.5 per cent surfactant, based on pigment plus extender, and those pigmented with the standard grade, 0.3 per cent.

Hence, it can be said that the elevated surfactant demand of the special grade does not cause any danger as far as weather resistance is concerned.

Conclusion

The test methods described and the results quoted in this work refer only to the comparison between two particular titanium dioxide grades, and from the results it can safely be concluded that the special grade offers genuine technical or, if so desired, economic advantages over the standard material.

It is, however, almost unnecessary to say that also the influence of other emulsion paint constituents, for instance that of extenders, on the dispersion, optical or mechanical properties can be studied by these methods. The tests may further assist if one is concerned with reformulation work where various characteristics must be kept constant while the composition is changed. An example would be changing the PVC without affecting the film coherence, or some similar exercise.

Acknowledgment

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Discussion at the London Section Conversazione

MR I. C. R. BEWS was interested in Dr Wagener's comment that at very high extender/pigment ratios, the differences between the titanium dioxide pigments were minimised. It was difficult for titanium pigment manufacturers in that, while they were trying to improve pigments to achieve greater economy in use, the paint industry was making more and more very cheap paints of a quality in which technical considerations of materials were relatively unimportant.

On a point of detail on the paper Dr Wagener stated that one could expect the full utilisation of the optical properties of the pigment. He later spoke of the crowding phenomenon, and in view of this did he really consider that he was achieving full utilisation?

DR F. WAGENER agreed that the full benefit of special grades was frequently not attained, but one naturally attempted to obtain the maximum efficiency. Concerning the crowding phenomenon, the special grade was surface treated to a considerably higher extent, and therefore the TiO_2 content was lower. He concluded that it must be much more evenly distributed in the film, since one obtained improved optical properties.

Mr I. Berg said that the "theoretically ideal" base was stated to possess too high a degree of thixotropy to allow it to flow properly in the dispersion vessel. He would have thought that a thixotropic base would be ideal for dispersion by high speed mixing. Would it not therefore be likely that the theoretically ideal base was in fact dilatant?

Dr Wagener said that in the vicinity of the impeller the millbase flowed very easily, while there was a tendency for it to stick to the walls of the vessel. He therefore concluded that it could not be described as dilatant.

Mr D. G. Dowling expressed the view that a disperse system and thixotropy were inconsistent. The paste was probably dilatant, and the phenomenon described in the high speed disperser arose from lack of adhesion at the impeller surface.

Dr Wagener said that the millbase had all the appearance of being thixotropic.

Mr T. E. Adams asked how the particle size of other extenders influenced the optical properties of the films.

Dr Wagener said that he had examined a very wide range of extenders, of differing particle size, and that they could be classified into three groups: (a) those of 5-20 microns mean diameter, which did not affect the optical properties, (b) those in the range of 0.1-5 microns diameter, the use of which resulted in improved optical properties (of this group those in the range of 0.1-0.5 microns diameter, i.e. the order of magnitude of the titanium dioxide pigment, gave the greatest improvement in optical properties, but their water or vehicle demand was too high), (c) those in the range of 0.01-0.1 microns diameter. (Only a few materials of this nature were available, and they were generally used in admixture with other extenders (e.g. 50 per cent TiO_2/40 per cent extender/10 per cent fine particle extender) because their water demand was extremely high).

One needed extenders of the size range of titanium dioxide pigments with a moderate water or vehicle demand. The effect of certain extenders was only shown with standard grades of titanium dioxide pigments; with the special grades no significant improvement was shown because with these the spacing was already so good that it could not be much improved through the admixture of fine particle extenders.

Mr J. Taylor asked which black pigment was used in the tinting strength determination.

Did the variations in surfactant content in the emulsion paints over the range of PVCs examined have any effect on the dispersion of the black pigment?

It had been his experience that the relationship between tinting strength and scattering coefficient and hiding power was not as simple as Dr Wagener appeared to have found.

Dr Wagener said that the black pigment was Helio Fast Black. The surfactant demand of the extender paste was determined separately and, as the quantity of black pigment used was very small, the same amount of surfactant was used as in an uncoloured paste.

Mr T. R. Bullett asked why the blueness index passed through a maximum. The fall at high PVC would be expected because scattering coefficients in air were less wavelength dependent but the maximum was difficult to understand.

Dr Wagener said that he had no satisfactory explanation to account for the observed maximum. With some grades of titanium dioxide there was a progressive fall with no maximum.

Mr J. Mackinlay expressed his appreciation that work was being done which would bring UK paint manufacturers more into line with those in the US, where a rather lower figure of titanium dioxide per gallon of paint was currently used. Were UK manufacturers merely inefficient, or were they public benefactors?

Referring to the wet point/flow point test, the work involved would not be sufficient to release all the available surface area, such as would be the case in milling or high speed dispersion equipment. Consequently the water, vehicle, and surfactant demands would not be absolute figures.

Recent work by Dr Carr had shown that, for coloured pigments at least, there was a factor described as "texture," obtained by relating the oil adsorption to the nitrogen adsorption surface area. Those pigments with a lower oil absorption than that expected from surface area measurement were described as hard-textured. Would not this kind of effect influence the wet point/flow point test?

DR WAGENER said that he considered that the UK paint industry was extremely charitably inclined. Titanium dioxide/extender ratios of 70/30 or 60/40 were quite exceptional in Germany.

Concerning the wet point/flow point determinations, there was an operator factor involved, but with some training reproducible results could be obtained, which were also in accord with practical dispersion experience.

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Durability of paint*

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Summary

The underlying philosophy of attempts to predict the durability of surface coatings from relatively short term tests is discussed. A distinction is drawn between the intrinsic durability of the coating material and the durability achieved in a practical application where factors such as defects in the substrate may outweigh the resistance of the coating itself. Artificial weathering techniques are reviewed. It is suggested that erosion type failure leading to chalking of pigmented systems can now be predicted satisfactorily, but that liability to cracking or adhesion failure cannot be assessed purely visually. Mechanical tests made during short term weathering periods may be useful, but the test methods must be chosen carefully and results interpreted with some caution.

La durabilité des peintures

Résumé

On discute la philosophie sous-jacente des tentatives à prévoir la durabilité de revêtements au moyens des épreuves de durée assez courte. On fait une distinction entre la durabilité intrinsèque du revêtement et celle achevée dans une application pratique où des facteurs, telles que les imperfections du support peuvent avoir une influence plus importante que la permanence du revêtement lui-même. On passe en revue les techniques de vieillissement artificiel. On suggère que les échecs où il s'agit d'érosion et du farinage des systèmes pigmentés peuvent être prévus maintenant d'une manière satisfaisante. Pourtant la probabilité de fendillement ou de perte d'adhérence ne peut pas s'apprécier seulement par moyens visuels. Des essais mécaniques effectués au cours des périodes de courte durée de vieillissement peuvent être utiles, mais on doit choisir avec soin les méthodes d'essai et également interpreter les résultats avec prudence.

Die Dauerhaftigkeit von Anstrichen

Zusammenfassung

Die den Versuchen, die Dauerhaftigkeit von Anstrichmitteln nach kurzfristigen Prüfungen vorauszusagen, zugrunde liegende Philosophie wird besprochen. Zwischen der Haltbarkeit des Anstrichmittels als solchem und der Haltbarkeit bei praktischer Anwendung, worin Faktoren wie z.B. Fehler im Substrat gegenüber der Widerstandsfähigkeit des Überzugsmittels selbst das Resultat überwiegend beeinflussen können, wird ein Unterschied gemacht.

Künstliche Bewitterungstechniken werden besprochen.

Es wird die Ansicht vertreten, dass man nunmehr bei Fehlern vom Typ Erosion, die zum Kreiden pigmentierter Systeme führen, eine befriedigende Voraussage machen könne, eine solche aber für Neigung zum Reissen oder Verlust der Haftfähigkeit nicht lediglich mit Hilfe der Augen möglich sei. Während kurzer Bewitterungsperioden vorgenommene mechanische Prüfungen könnten nützlich sein, die Versuchsmethoden müssten aber sorgfältig gewählt, und die Resultate mit einer gewissen Vorsicht interpretiert werden.

Устойчивость красок

Резюме

Обсуждаются соображения лежащие в основе попыток предсказания устойчивости поверхностных покрытий по сравнительно краткосрочным испытаниям. Делается различие между действительной устойчивостью материала покрытия и устойчивостью

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*Presented to the London Section on 15 February 1968.

полученной в практическом применении, где такие факторы как дефекты в субстрате могут превзойти сопротивление самого покрытия. Рассматривается техника искусственного выветривания. Предполагается что разрушение эрозии ведущее к известкованию пигментированных систем можно сейчас удовлетворительно предсказать, но что склонность к образованию трещин или разрушению на основе слипания не может быть оценено чисто визуально. Механические испытания с краткосрочными периодами выветривания могут оказаться полезными, но методы испытания должны быть избраны осторожно и результаты испытания должны интерпретироваться с известной предосторожностью.

Introduction

Many papers have been written over the last 40 years on the assessment of the durability of paints, or, more specifically, the prediction of durability from relatively short-term tests. One might have hoped, particularly in view of the progress made by Harley Nelson in the first years of that period, that by now the subject would have been worked out and procedures would be firmly established.

Over the last ten years the author has been one of a group which has carried through a great deal of co-operative work on artificial weathering. This was a panel convened under the Joint Services Research and Development Paints Committee which was later constituted as a Sub-Committee. The work of this panel, which has been reported in *JOCCA*, led to the test method now set down in BS 3900 Part F3, which has also been provisionally accepted as the basis for an ISO method.

It is felt that in BS 3900 Part F3 a method has been developed that, for certain classes of paint, has reached a reliability lacking in earlier methods, but it is certainly not the universal answer to all durability testing problems. There remain paints that give anomalously good results. Moreover, on the highest classes of materials the BS 3900 method is still too slow. No one who has used the method carefully would claim an acceleration over outside British exposure of more than some 10 to 30 times (according to the type of paint). Thus, even if such ratios can be expected to hold for highly durable paints, a system with a 20 year life (and such claims are becoming common) would entail a test ranging between eight months and two years in length. Clearly this is unacceptable for development work, let alone batch testing.

Hipwood, in a number of lectures to various sections and branches of the OCCA, has detailed very ably the work leading to the adoption of the BS 3900 method and has demonstrated the type of results obtained with it, so that it is not necessary to recapitulate this. Rather, the present paper attempts to consider some of the factors involved in weathering and paint film degradation and to discuss how one might hope to improve methods of assessment. This will also involve some discussion of other artificial weathering equipment commercially available or proposed elsewhere. Despite the 40 years of background referred to earlier, all who are working in this field are still seeking new ideas, so that to a considerable extent this paper is intended to start a discussion rather than to offer solutions to all the problems.

Intrinsic and achieved durability

First, it should be recognised that there are two ways a paint system may fail; there may be intrinsic failure of the material in the film, or there may be disruption of the coating, either by adhesion failure or by some failure of the substrate, such as corrosion of steel. In considering durability as a paint property we are perhaps mainly concerned with the first aspect, but too often on a practical painting job the second is dominant. This amounts to saying that because of bad preparation or bad application the intrinsic durability of paint is seldom realised entirely. This fact raises the question of whether it may not be of greater practical significance to test under deliberately depressed conditions of surface preparation rather than on a perfect substrate. J. B. Harrison has vigorously supported this view for tests on metal primers. Certainly such tests are needed; in particular we want to develop standard methods for producing contaminated surfaces, which may be regarded as typifying the real surfaces to be painted in practice but will avoid the gross lack of reproducibility to be expected on surfaces exposed to "natural" contamination. For example, we would like to be able to produce steel panels, pitted to a reproducible degree and holding controlled amounts of ferrous sulphate in the pits.

The approach to assessment of paints by deliberately selecting imperfect, but typical, conditions can be carried further. In practice, on a window frame, for example, failure almost always occurs first on lower rails or from sharp edges on glazing bars. Can useful information be obtained more quickly by designing test pieces which incorporate the relevant features of these areas? It must be admitted that most previous attempts to develop ideas of these kinds have not been very successful; moreover this approach can be expensive. However, for paint systems that involve very long tests, before failure shows on conventional panels, the expense of a complex test piece might well be tolerated. Moreover, a more correct reflection would be obtained of natural performance in those critical areas that are likely to determine the frequency of repainting.

There are two other possible ways to try to overcome these difficulties:

1. to incorporate into weathering test schedules the sorts of constraints that may cause failure in practice; these could be mechanical impact, vibration, sudden temperature changes, swelling of a substrate by water or osmotic pressure due to soluble salts under the film.
2. to concentrate more on full-scale service trials, with careful record keeping and analysis, rather than to rely on extrapolation from panel tests.

Modes of failure

It is instructive to consider again what is meant by durability, a consideration which will involve assessment of modes of failure. Assuming that the coating does not fail quickly in adhesion and peel or flake from its substrate, several things may happen. In many cases the binder is slowly lost, particularly from the surface, gloss deteriorates and, ultimately, the film chalks. Again the film may shrink by loss of components of the binder or by chemical changes involving a tightening of the structure; this shrinkage may result in a general cracking pattern, usually called checking. A third method of failure develops on substrates, such as wood, which are dimensionally unstable and involves stressing of the coating until it splits or cracks. There are further possibilities of disruption by blisters and corrosion pustules. However, the first three methods of breakdown are the most important in the general case.

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Chalking

Chalking has been studied widely. It is most often caused by oxidative scission of the binders, induced or accelerated by ultraviolet radiation. Provided that the correct radiation is used and that heat and water-washing are provided at levels comparable to those in natural exposure, it is to be expected that chalking could be reproduced satisfactorily in the laboratory. Indeed it might have been predicted that chalking breakdown could be assessed simply by measuring the rate of loss of weight of exposed films. The author's experience over many years, and that of many other workers, shows this to be so for artificial weathering cycles; natural weathering is complicated by seasonal and day to day weather variations that make the establishment of weight loss rates difficult for all but the most durable materials, where measurements can be made over a period of years, rather than weeks. The application of the weight loss technique to highly durable paints has been discussed in a most useful recent paper by Berg et al[1]. They found variations in loss rate over a range of at least 100:1, between oil-based house paints that lost 22.9 per cent of a 0.001in coating in one year, and fluorocarbon organosols which lost only 0.1 or 0.2 per cent over the same period. Correlation with the results of accelerated weathering exposure was fairly good although the laboratory apparatus (carbon arc) tended to be relatively slower on the more durable coatings. An interesting result was that little advantage in correlation was obtained by running long laboratory exposures because the first few hundred hours gave a reliable index. Work at the Paint Research Station[2] had given similar indications.

In the early stages of breakdown, chalking tendencies can also be predicted from loss of gloss or, as shown in another American paper, by loss of colour of tinted paints.[3]

Effective techniques are thus available to assess this type of breakdown quantitatively so that it should only be a matter of varying lamps and artificial weathering cycles to establish conditions correlating with any particular exposure site. Logical arguments suggest that the lamps should give radiation similar in quality to sunlight, at least in the effective region, which is almost certainly 300-450 nm. At longer wavelengths the quanta of energy are too small to produce bond failure and shorter wavelengths are absent from sunlight. A xenon arc, suitably filtered, probably gives the best approximation to sunlight energy distribution[4] over the 300-450 nm region but, unfortunately, this type of source is inefficient, initially expensive, of rather short life (1,000-1,500 hours) and rather difficult to maintain at constant output.[5] Whilst it is widely used for light fastness tests it does not appear to have become popular for artificial weathering. The carbon arc, still most widely used, in various modifications, gives radiation mainly in a strong band, about 390 nm, and might thus be expected to produce different results from sunlight. In practice the carbon arc appears to suffice, at least for most building paints, possibly because the combination of the absorptive properties of the media and screening by rutile titanium dioxide reduces the waveband effective for degradation to a narrow region around 390 nm. At present the most promising sources are the UV fluorescing mercury vapour lamps. By suitable choices of phosphors, and using combinations of lamps, it is possible to get a fair match to solar UV with high efficiency in relation to electrical power input and with very little heat radiation.

Apparatus based on these lamps has given very encouraging results on paints based on a wide range of types of media. Unlike the xenon lamps, which follow the solar distribution reasonably well through the visible as well, the UV fluorescent mercury lamps, being deficient in visible output, do not reproduce fading of coloured paints very well.

Checking and cracking

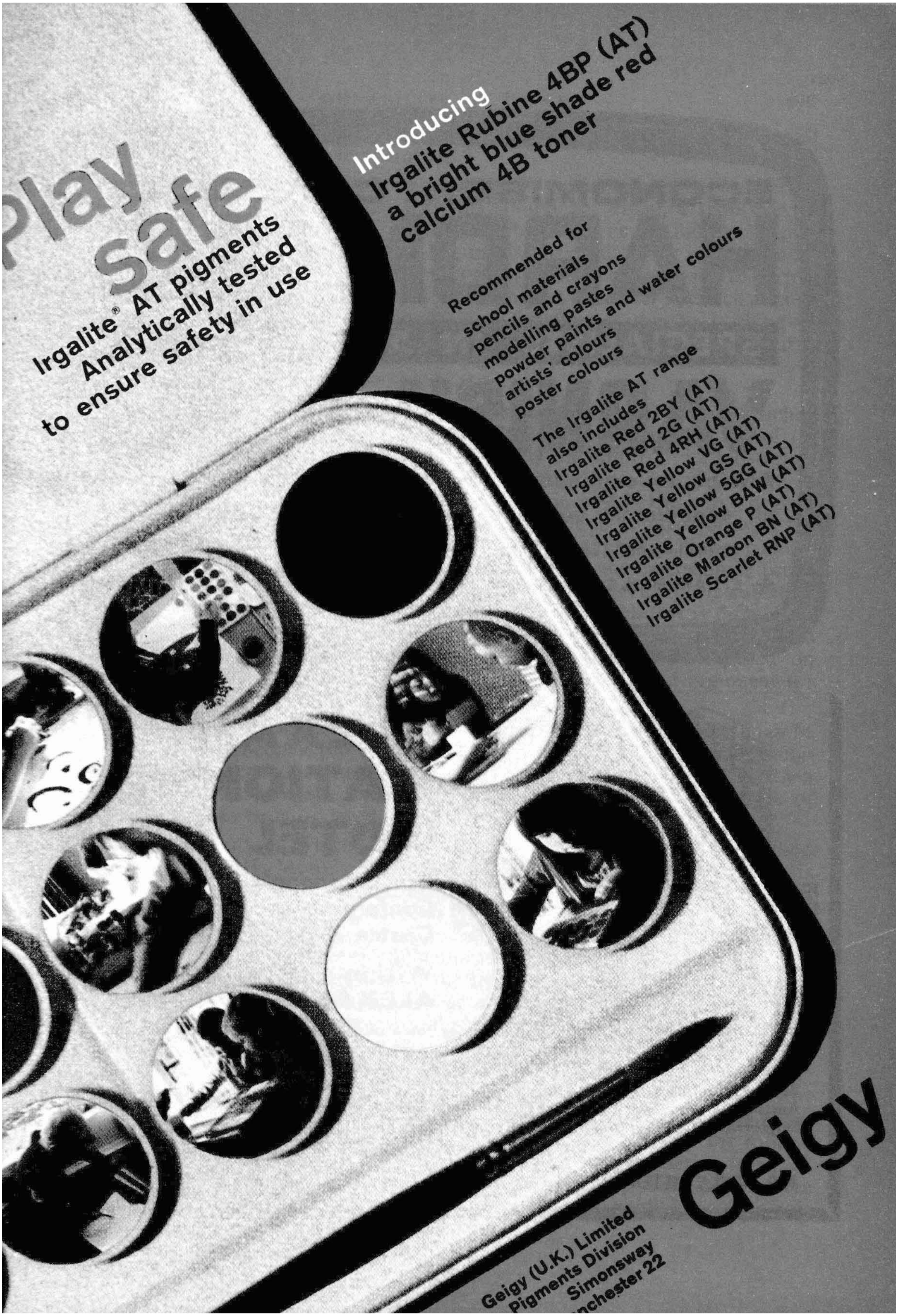
Checking and cracking breakdowns are more complex in origin. Checking results from shrinkage of the film, producing stresses greater than its tensile strength so that cracks develop, often only through a stressed surface layer. Whether or not stresses reach failure level may often depend on the rapidity of creep processes, which can relax stresses. A slow, gentle weathering cycle can result in ultimate failures by chalking and erosion whilst the same film may check under a fiercer treatment. Somewhat surprisingly cycles involving fairly high temperatures, say 60°C, appear to favour checking more than colder cycles. Cracking generally results from differential movement of film and substrate, a condition that is not likely to occur in most artificial weathering cycles, at least on metal substrates. This is where additional mechanical tests during weathering seem to be required.

Checking and cracking breakdowns are also much more difficult to reproduce. This is because almost all paints are visco-elastic materials in which stresses can be relaxed by molecular flow or rearrangement, which may be assisted by heat or by temporary plasticisation by water. The stresses developed in a coating depend in a complicated manner on the history of temperatures, humidities and degrading radiation to which it has been exposed. To these factors can often be added the consequent dimensional changes of the substrate. Thus to produce the same appearance of failure in artificial weathering as in natural exposure might well involve exact reproduction of the weather. Here, immediately, one comes up against the variability of weather so that for general testing use the exercise is impractical.

Two approaches seem to be open, (a) to adjust conditions so that checking or cracking occurs in those coatings, and only those, that fail in these ways during natural exposure, without too much regard to exact pattern, or (b) to assess the danger of failure purely by mechanical tests on intact films. With some of the older paints, for example certain oleoresinous types, there was no great difficulty in reproducing checking, but many of the newer types of resins have proved more difficult to assess. The present tendency appears to be to concentrate on evaluation through measurements of changes in mechanical properties.

What mechanical properties should be measured? The chief suggestions have been, (a) second order transition points, (b) tensile strength and (c) extension at break.

The second order transition point of a polymer of simple structure is the temperature, T_g, corresponding to a more or less sudden change from brittle, glassy properties to rubbery properties. Stress concentration may only be expected to build up to a rupture level below T_g so that, on weathering, the rise of T_g into the normal operating region or above is a danger signal. Unfortunately many coatings do not show a single sharp transition in properties and



certainly many can be used safely on metal substrates at temperatures well below their major transition temperature.

Tensile strength changes have been suggested in a recent paper[6] as a criterion of durability. It is difficult to see why this should be, unless a reduction in strength after the attainment of a peak can be taken as an indication that cracking on a micro-scale has already begun. Extension at break seems a more logical criterion but must be assessed under the right rates of extension to correspond with natural cracking; for stresses due to impact this is very fast (characteristic time of the order of milliseconds) and for stresses due to swelling of substrates probably slow (characteristic time of the order of minutes or hours).

Attached or detached film tests

Most measurements of mechanical properties have been made on detached films, usually freed from substrates after weathering by amalgamation of tin with mercury. It may be argued that in separating the film from its substrate a fresh situation is created, not necessarily corresponding to that of the film as normally weathered. Thus, in the weathering film, or even in the initial drying, stresses and strains develop that may not be negligible in comparison with the tensile strength or extensibility of the free film. If, for example, a linear strain of 9 per cent has developed in an attached film for which the extension at break is 10 per cent when detached, then a strain of only 1 per cent in the substrate could produce cracking. This case may be an extreme one but it is difficult to account for cold checking unless it is assumed that the small differential strains due to differential contraction of film and substrate are superimposed on strains already present in the coating. Is there not then a good argument for making mechanical tests on attached films?

Probably the most logical test is a simple bend test, but even here it may be dangerous to try to become too quantitative. Results are probably only meaningful where failure occurs at extension of less than 5 per cent, because only then can the substrate be expected to strain uniformly. Temperature and rate of straining must also be considered in relation to practical conditions.

One development of attached film tests is the micro-indentation method described by C. J. H. Monk[7]. The best method for applying this apparatus is perhaps still to be worked out. However, it represents a decided advance in technique. Much useful information can also be obtained from simple mandrel bend tests, particularly if these are made over a range of temperatures, or from graduated impact tests. One of the difficulties is that the results of all destructive tests on attached films are sensitive to the level of adhesion attained, which in turn depends on substrate preparation so that these tests are often of poor reproducibility. Nevertheless they would seem to be more relevant to practical performance than are tests on free films.

Conclusion

This paper has been an attempt to consider where durability testing of paint films stands at present and how it is developing. Except possibly for routine acceptance testing, it is thought that the type of artificial weathering in which breakdown is assessed purely by visual change will gradually give place to more scientific measurements. The quantitative assessment of chalking, where this involves a process of molecular erosion, does not offer great theoretical problems, although more knowledge of the photochemistry is desirable. Assessment of susceptibility to the more microscopic cracking and checking types of failure will always be difficult until more basic knowledge has been built up of the mechanical processes involved in the initiation and propagation of cracks in pigmented polymer films.

Acknowledgments

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Discussion at the London Section Conversazione

MR E. OAKLEY commented on Mr Bullett's suggested use of weight loss measurements as a means of assessing paint film performance, and the need for accuracy in measurement and care in selection of substrates. He suggested that, rather than gross weight loss, the more important factor was the rate of film erosion which would be considerably affected by the specific gravity of the paint.

MR T. R. BULLETT agreed that it was essential to take careful precautions when making this type of measurement. A surprising reproducibility had in fact been achieved with artificial weathering tests. With natural weathering, however, there were major problems of corrosion, dirt deposition, etc. He also agreed that it was better to convert results into microns of film thickness lost, rather than leave them as weight losses. Dealing with oleoresinous and alkyd media, weight loss and volume change measurements corresponded to loss of material of unit density, i.e. 1mg.cm^{-2} loss corresponded to 10 microns reduction in film thickness.

MR E. J. WEST commented that the effect of the titanium dioxide pigment on UV absorption was not really a significant factor, since the surface layers of the film did not contain the full amount of pigment. Absorption of UV by the binder occurred at about the correct level for the carbon arc to have the maximum effect.

The second order transition point T_g might be relevant to performance on mobile substrates, where a change of T_g from 15°C to 40°C might have a profound effect.

MR BULLETT agreed with the first point; for example, with a soya alkyd paint the absorption of solar energy was mainly in the 300-350nm region.

Concerning the effect of the second order transition point, he agreed that on a dimensionally unstable substrate, e.g. wood, this would be so. On a metal substrate dimensional changes were unlikely to exceed 1 per cent so that films might not crack even in the glassy state.

MR A. L. MCKELVIE said that before one attempted to develop a standard method for preparing contaminated surfaces it would be advisable to be sure that one was able to prepare a standard surface.

Mr Bullett agreed that it was difficult both to prepare standard "clean" panels, and to produce a standard "soiling" of panels. Presumably some form of mechanical treatment, e.g. grit blasting followed by a fine abrasive, would be needed. However, did one want to do this? Panels prepared in this manner gave results which were too good, with most paints.

Mr McKelvie said that Mr Bullett had not stressed the effect of film thickness on ultimate durability. If one was going to design special test pieces to reproduce features such as the sharp edges of glazing bars, would it not be better just to test at known differences in film thickness?

Mr Bullett agreed that one could make some progress in this direction, but on going down to thicknesses of, e.g. 0.0005in, control became extremely difficult and the results were very variable.

Mr McKelvie referred to the plasticising effect of water absorption on defects such as checking and cracking, and asked whether Mr Bullett considered that the effect of early morning dew followed by a bright sunrise was likely to play an important part in breakdown. Could not this be reproduced in an artificial weathering cycle?

Mr Bullett said that this had been done, and a dew cycle weatherometer was available. One obtained an acceleration of chalking type failures under these conditions; he was doubtful about the effect on cracking types of failure.

Mr McKelvie asked Mr Bullett for his opinion on the effects of severe stress in the early life of the film on its ultimate life span. He had found that on exposing a range of white and black alkyd finishes in October of one year and again in the following June, that those exposed in June broke down by checking and cracking long before those exposed the previous October.

Mr Bullett agreed that the early life history was very important. He could confirm this type of result, especially for oleoresinous media. He was not sure how true this was of the more modern types of paint.

Mr F. Armitage suggested that the paper had hardly done justice to the work of Van Loo and his colleagues, who had in fact shown that a particular type of tensile strength/ exposure time relationship could be associated with early breakdown. He also asked Mr Bullett for his opinion on the value of ozone in accelerated weathering tests.

Mr Bullett agreed that in his brief review he had not discussed Van Loo's work fully. He suggested that a sharp fall in tensile strength after a maximum, noted by Van Loo, might be due to the growth of micro cracks in the film.

He was uncertain about the value of ozone in tests on paint, particularly because this was probably not an important factor in most natural exposure environments.

A Speaker asked whether it was possible to determine separately the factors responsible for breakdown; in particular the relative importance of pigment and medium.

Dr F. Wagener said that one could draw conclusions about the effect of the pigment, e.g. anatase was more likely to accelerate oxidative breakdown than rutile. With modern coated pigments, however, it was more difficult to make predictions, as one did not know how much of the pigment surface was covered by the after-treatment material.

Mr H. A. Shelton, referring to the relation between the radiation source and natural sunlight, asked whether there was any real reason for not using sources containing radiation below 3000 Å, as this did cause breakdown of the type obtained in practice on certain types of stoving finishes. The usual reason given was that no radiation below 3000 Å reaches the earth's surface.

Mr Bullett said that as one went to lower wavelengths the quantum energies become greater, and such radiation might be expected to cause chemical effects which would not occur in sunlight.

Mr T. K. Batty amplified the remarks made by Mr Bullett on the dew cycle procedure. Work was done on this by Stieg of the Titanium Corporation of America. A carbon-arc light source was used and dew was simulated on the exposed surface by the spraying of refrigerated water on the reverse of test panels. Weatherometers were also now available to include provision of effects of atmospheric contaminants such as ozone and sulphur dioxide.

Also on a point of somewhat academic interest, the Americans had found that in space the spectral energy distribution of sunlight was more akin to that produced by the carbon arc than that of the xenon arc light source.

Mr G. Lederer referred to the comments made on the Atlas dew cycle weatherometer and quoted his experience of this appliance. One of these weatherometers had been available in his laboratory for about seven weeks and it was therefore too soon to give firmly based conclusions; nevertheless some indications had been obtained: air drying alkyd finishes degraded extremely rapidly, severe loss of gloss and appreciable loss of weight and chalking being obtained after only 70-100 hours total exposure. So far, however, it had not been possible to establish any relationship between the performance of air drying alkyd paint films in the dew cycle weatherometer and outside exposure either at Florida or in this country. His work suggested that there might be more correspondence between results obtained when rather more durable paints systems were exposed. The evidence so far, however, was not conclusive.

Next month's issue

The Honorary Editor has accepted the following papers for publication and these are expected to appear in the November issue:

"The formulation of fungus-resistant paints: Zinc oxide in latex paints," *by E. Hoffmann, C. J. Lancucki, G. F. Moss and A. Saracz*

"Temperature/humidity fluctuations and the formation of condensate on ships hulls in drydock," *by D. W. Singleton.*

"The problem of quality control in antifouling," *by P. de Wolf.*

Editorial

"When everyone is somebody"

The Dainton Report, published earlier this year provided yet another spate of recommendations for the "improvement" of higher education. It calls for, *inter alia*, a broader sixth form curriculum, with mathematics as a compulsory subject for all students. With the latter we would not cavil for, as Professor K. W. Sykes has remarked, it is surely necessary in this day and age to encourage the climate of opinion that it is as uncultured not to be numerate as it is not to be literate. By the same token, one can argue a strong case for the study of the humanities by those who seek ultimately to specialise in science.

The Dainton Report is not the first to deplore early specialisation and particularly the current onus on the student to choose his stream two years before sitting his O-levels. One can sympathise with his need to attain a more mature appreciation of life in general before having to decide what to make of his own; never more, perhaps, than when one faces across the interview desk a prospective employee who is not at all sure how he came to be there. Easier still is it to be carried away on a tidal wave of emotional idealism and to say that the idea of broadening the student's outlook is wholly admirable and that all this is good for the soul of man and the uncertain future of mankind. Unfortunately, what seems to have been lost in this welter of cultural platitudes is an awareness of what they imply towards the factual, if sordid, business of earning a living in an increasingly technological society, not to mention (or is this another platitude?) the survival of a nation.

Many of us thought that, with the emergence of the CATs, the needs of industry had at last made some impact on the academic educationists, despite the doubts expressed by our sandwich-eating, philatelic predecessor. Unhappily, we are now obliged to bow to our elders and betters and to admit that their doubts were well founded. Some of the CATs have emerged as technological universities which appear to be discharging their brief to found technology in science, but as many others have only succeeded in aping Oxbridge with meagre success. Others among the great established colleges have brought original thought (a rare commodity) to bear in creating schools of learning which cut profitably across the traditional disciplines—several new Masters degrees in, for example, polymer technology, molecular science and rheology come to mind in this connection.

Our greatest concern is for the systematic destruction of so many erstwhile proud qualifications. Indeed, it seems that the definition of "qualification," if there ever was one, has been lost. The London Matriculation gave place to the General Schools Certificate. This was followed by the GCE-O and now since, in the words of Gilbert, everyone must be somebody, we have the CSE for the poor little dears who cannot manage anything better. To what purpose? If we want a bright boy on our staff we are not interested in an also-ran, and if we do not, it doesn't much matter anyway.

The picture presented at a higher level is equally disturbing. One now has to ask more questions than ever in order to determine what a BSc means; for whilst some qualifying bodies have raised their sights to such an extent as to put their first degrees beyond the reach of the part-time student, others seem to be catering with mixed success for those less academically inclined. We would hasten to support first degree courses with a substantial content of technology but we are far from convinced that they lead to an adequate level of attainment at present. Again, we encounter the conflict between teaching a man his job and making him a cultured personality. Unless degree courses are to be extended in duration, the search for breadth is bound to mean a loss in depth; ultimately the student will learn nothing about everything.

One answer to this problem, which seems to be gaining in popularity, is the establishment of more and more MSc courses in which the qualification is obtained by examination in a specialised subject. If this is to be the necessary goal of the science undergraduate bent on an industrial career, an extra year or two at college must be accepted. What we have seen of such MSc courses so far is very encouraging, but there is a real danger that they will foster the topping-up of bad first degrees by something that sounds rather better.

The coatings industry, in its wisdom, once thought that the LRIC in the form of a topped-up HNC would meet its requirements, but we have not met many people recently who are at all happy about it. Those Licentiates who have deliberately aimed at the qualification as a mark of their attainment in applied chemistry certainly, and rightly, do not regard themselves as failed Associates; but that is the label which is being increasingly hung round their necks—again because the LRIC can mean so many different things.

Are we so self-satisfied in our industry that we will not learn from others like the engineers, surveyors, architects, plastics technologists and textile workers, who have sought and found an answer to this sort of problem? It may not be the only answer, it may not even be the best, but the establishment of a professional qualification for coatings technologists would go a long way to meeting the needs of both employer and employee, and would, moreover, be attainable while the Utopian educationists are still trying to make up their minds about what they think would be good for us.

Reviews

TECHNOLOGY OF PAINTS, VARNISHES AND LACQUERS

Edited by CHARLES R. MARTENS. London: Reinhold Book Corporation. Pp. vii+744, price £12 16s. 6d.

This book is directed principally to technical personnel working in the coating field and to scientists and technicians employed outside the paint industry. It offers a clear presentation of up-to-date technical data relevant to the preparation and use of paints, varnishes and lacquers, according to the dustcover.

Fifteen chapters, 270 pages, are devoted to resins and vehicles. Chemistry, typical preparation and uses are fully described and supported by comprehensive reading references. Unsaturated polyester resins and insulating varnishes are omitted and there is no discussion of inorganic coatings, zinc/silicate, cementitious paints, etc.

The properties and uses of pigments are dealt with from a technological rather than chemical viewpoint. Emphasis is placed on their properties rather than preparation and chemistry, there are useful tables summarising advantages and disadvantages of the various coloured pigments described.

Supplemental pigments, or extenders, are dealt with rather briefly. Whilst there are tables showing chemical composition, refractive index, oil absorption, specific gravity, etc., there is not a great deal of information available on the properties conferred on paints by the inclusion of these materials.

The chapters on colour and paint application are of particular interest. The theory of colour, leading to instrumental colour match prediction and matching, is written in a particularly easily read style. Mechanical and electrostatic spray painting are very fully described in the chapter on application. Curtain coating as an industrial application method is omitted.

The chapter "Paint Testing" contains discussion and criticism of paint tests but does not indicate tests to be employed for particular properties. This chapter is of value to the paint technologist but offers little assistance to engineers, architects or other specifiers of paint requirements.

There is an interesting chapter on fire protection, safety and health.

The chapters on paint formulation provide substantial information on the requirements of various types of coatings, with typical formulations. There is, however, no chapter on marine paints, and the chapter describing preservatives and fungicides does not deal with anti-fouling.

In the chapter on pigment dispersion the author fully describes the use of the sand mill and high speed disperser but for information on older types of pigment dispersing equipment the reader must seek elsewhere.

A notable omission is a chapter on dispersing agents, and surfactants in general. The use of surfactants is briefly discussed in the chapter on emulsion paints. Under pigment dispersion, wetting agents are mentioned, references are provided to assist in studying their use, but there is no information provided in the book.

The index is inadequate for a reference book of this type. It is particularly disturbing to find references in the glossary which cannot be followed up by use of the index.

The paint formulations provided are, of course, orientated towards the requirements of consumers in the USA. The book is possibly more valuable for its treatment of media, plasticisers and solvents than for its treatment of pigments.

This is a good attempt to treat such a vast subject in less than 800 pages, a book which would be of value to the paint technologist for day-to-day reference, and a useful text book for more advanced students, particularly in the USA.

L. TASKER

An Introduction to the Chemistry and Biochemistry of Fatty Acids and their Glycerides

By F. D. Gunstone. London: Chapman & Hall Ltd., 1968. Second Edition, Pp. 209. Price 63s.

Some ten or fifteen years ago a new book on glyceride oils would not have been so uncommon as it is now. This book may be officially the second edition but to all intents and purposes it is a new book. The general pattern of chapters has been maintained but very extensive rewriting and re-allocation of subject matter has been undertaken.

In the last ten years, since the first edition appeared, there have been considerable developments in enzyme chemistry and in thin-layer and gas-liquid chromatography. They have been the impetus to renewed activity on the elucidation of glyceride compositions. A chapter on the component acids and glycerides of natural fats has been added to cover this new work. The chapter dealing with biosynthesis and metabolism has been greatly enlarged with the increasing biochemical interest in fats and oils. This is also reflected by the addition of "biochemistry" in the title of the book.

A major part of the book deals, as before, with the physical and chemical properties of the naturally occurring fatty acids and their esters.

The text is remarkably free from errors and provides an excellent and most readable critical survey of the chemistry of the glycerides. Full opportunity is provided for further reading by the use of references at the end of each chapter and a list of reviews and text books in an Appendix. It is refreshing to find that the references are all recent, mostly dating from 1960 with a very considerable number in 1967.

G. L. HOLBROW

Information Received

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

The Association of Fatty Acid Distillers has recently issued a publication giving recommended analytical techniques for laboratories handling fatty acids. This is claimed to be the first publication specifically dealing with fatty acids to be produced by an independent authority in the United Kingdom. Copies are available free of charge from the association's headquarters in Bebington, Wirral, Cheshire.

Bakelite Xylonite Limited, Plastics Materials Group, has recently issued the fifth booklet in the series dealing with plastics in the building industry.

The booklet, which runs to eight pages, describes the range of plastics and rubbers used for gaskets and jointing in building components.

A new series of dipolyoxypropyl itaconates, intended as monomers for manufacture of PVA copolymers, has been developed by **Pfizer Limited.** The monomers, known as *DPOPI-500*, *1000*, and *1300* are now in production in development quantities. Greatly improved adhesion and plasticising power are claimed for PVA when the itaconates are used as internal plasticisers, and significant improvements in emulsion paint, adhesive, glass fibre size and glass mat binder applications are expected.

Coulter Electronics Limited has recently announced a new type of centrifuge which uses light obscuration to give an automatic weight against time analysis in the 50 to 0.4 micron size range.

The instrument, the *Coulter Disc Centrifugal Photosedimentometer*, has a hollow transparent bowl mounted on a metal frame. A quartz iodine source gives white light which is chopped and separated into two paths, one through the bowl and sample, and the other through a reference wedge. The wedge moves to balance the intensity of the reference beam with that of the beam passing through the sample, and in doing so records a trace of weight, i.e. photodensity, against time.

A monograph on aliphatic amines and some of their derivatives has just been published by **Armour Hess Chemicals Limited.** Dealing with the *Armeens*, *Duomeens*, *Armacs* and *Duomacs*, the monograph describes their chemistry and applications in many fields.

A new range of highly concentrated pigment chip dispersions has recently been introduced by **International Colloids Limited.** Known as the *Microsperse S* range, the dispersions consist of very finely ground particles in a protective resin carrier. The resin coating renders the pigment inert to other chemicals which may be present, and enables the use of the pigment in combination with soluble dyestuffs. The dispersions are normally supplied in chip form consisting of 66⅔ per cent pigment and 33⅓ per cent resin. Easy dispersion in most organic solvents without the need for grinding is claimed.

The Glycerine Producers' Association has recently published a booklet entitled *Glycerine—miscellaneous uses*, listing uses of glycerine in most of the chemistry-based industries. Copies are available from the GPA.

Compounding Ingredients Limited has recently announced the availability in the United Kingdom of a range of high white micronised talcs suitable for the paint, resin and allied industries.

The range consists of five materials, three of which are held in quantity. The highest particle size material, *Mistron 139*, is claimed to have 85 per cent less than 10 microns with a top particle size of 30 microns, and the finest, *Mistron Super Frost*, to have 100 per cent below 10 microns and 80 per cent below 2 microns. Extreme purity and consistently high colour, GE brightness 94-97, are claimed for the entire range.

Fine Dyestuffs and Chemicals Ltd. has recently published an eight-page booklet containing specifications of, and suggested formulations using, its *Rocsol* range of oxidised waxes.

A new company, **TT Containers Ltd.**, has recently been formed by **Technical Treatments Ltd.** to centralise and streamline its activities in the manufacture and supply of plastics containers.

The range of containers offered, which is claimed to be the widest available within the United Kingdom, is fully described in an illustrated eight-page brochure, available from TT Containers.

A new plant has recently come on stream at the Four Ashes site of **Columbian International Limited.** Designed primarily to complete Columbian's range of rubber blacks, it will also extend their colour range of furnace blacks. Beaded equivalents of the standard fluffy *Statex E 12* and *Raven 30* will now be available.

The latest technical bulletin issued by **Farbwerke Hoechst AG,** *Pigment No. 3*, gives a brief description of the most important fastness properties of Hoechst's organic pigments for colouring the most common types of plastics.

The Carborundum Company Ltd., Chemical Products Branch, has recently introduced two new types of 100 per cent phenolic resins, *CS114* and *CS115*, to its range of resins and adhesives. The resins, which are based on *p*-substituted phenols, *p*-tertiary butyl phenols and *p*-octyl phenol, are oil reactive, and have been evolved specifically to improve bodying and drying rates, colour, chemical and water resistance.

CS114 is said to be suitable for medium and long oil varnishes and insulating varnishes, and *CS115* is recommended for chemical resistant varnishes, stoving lacquers, long oil alkyds and insulating varnishes.

Farbenfabriken Bayer AG has recently announced that a holding company has been formed in the United Kingdom. The new company, **Bayer (UK) Ltd.,** has Registered Offices at Kingsway House, Richmond, Surrey, and has an authorised share capital of £700,000. Bayer (UK) Ltd. will act as holding company of the shares of the various UK subsidiaries of Farbenfabriken Bayer. The subsidiaries of Bayer Germany which have traded in the UK for many years will continue to do so as separate companies under their present management.

J. M. Steel & Co. Ltd., who distribute Bayer chemicals, pigments, synthetic rubbers and plastics, is said to intend to change its name to **Bayer Chemicals Ltd.**

Two new pigments have been added to the *Vulcatex* range of masterbatch colours for rubber and rubbery polymers, **ICI Ltd.** has recently announced.

The new pigments are *Vulcatex Fast Green GS*, based on a phthalocyanine green not previously available in powder form for use in rubbers because of its inherently poor dispersibility, which has only recently been overcome, and *Vulcatex Fast Orange GS*, an azoic pigment giving bright mid-orange colorations.

Also new from ICI is a fluorescent whitening agent for paper, *Fluolite PS* liquid, which is claimed to give excellent and economical super-whites of a neutral blue-white tone.

Plans for 14 training courses for members have recently been issued by **PIRA.** Each course is residential, and lasts two days, with the exception of a computer course, which lasts three days. A brochure giving full details of all courses is available from PIRA.

As from 3 September 1968 the sales of all PVC stabilisers manufactured by **Novadel Ltd.** in the UK will be handled by **Pure Chemicals Ltd.** from their Kirkby offices, it has recently been announced. The Novadel range will complement and widen the range of stabilisers already produced by Pure Chemicals.

Normal production of all Novadel stabilisers will continue at the Gillingham factory. There will be no change in the sales and production of Novadel organic peroxides, organic acids and products for the surface coatings industries.

Two new surface coating resins have recently been introduced by **BP Chemicals (UK) Ltd.** Known as *Epok A5000/60* and *Epok A5001/60*, these are oil-free saturated polyester resins, of basically the same structure, but marketed in different solvent compositions.

When crosslinked with an amino resin, preferably a melamine, the resins become thermosetting, and good hardness and flexibility, coupled with outstanding colour retentive properties, are claimed.

BP Technigram E155 contains information on the properties of these resins, and on typical paint formulations.

Three new products, specifically designed for reflow operation, have been added to the *Scopacron* range of hydroxyl containing thermosetting acrylic resins, announce **Styrene Copolymers Ltd.** The new products are *Scopacron 52*, a hard rigid co-polymer comparable with the existing *Scopacron 50* in all but reflow properties, *Scopacron 77*, a flexible copolymer similar to the existing *Scopacron 75*, and *Scopacron 82*, combining the hardness of *Scopacron 52* with the flexibility of *Scopacron 77*, and having similar properties to the existing *Scopacron 80*.

The British ceramic industry, in collaboration with the British Ceramic Research Association, the National Physical Laboratory and the Society of Dyers and Colourists, has produced a set of 12 coloured tiles for the calibration and control of colour measuring instruments, it has recently been announced.

The tiles, which cover a wide range of colour space and include three neutral greys, have been chosen to give the most useful set for checking the accuracy and reproducibility of colorimeters, and were made under the most stringent possible control. A thousand tiles were selected for general sale, and of these 50 sets were selected for sale as NPL-calibrated standards. The NPL have retained a master set, the calibration data of which will be determined accurately, and supplied with each uncalibrated set of tiles.

The Welding Research Institute has recently issued a revised edition of the document "Welding of steel coated with priming paint: recommended standard welding and cutting tests for the assessment of the toxicity of paint primer thermal decomposition products."

Joyce Loebl & Co. Ltd. are to hold an exhibition of their instruments for colour measurement and size analysis of particulate systems in London on 29, 30 and 31 October. The exhibition will be at the Prince of Wales Hotel, De Vere Gardens, Kensington, from 10.00 a.m. to 6.00 p.m. each day, and technical representatives of the company will be in attendance.

Scottish

Eastern Branch

We regret that the list of Officers and Committee in the August issue was incorrect. The correct list is given below.

Scottish (Eastern Branch)

Chairman: G. H. Hutchinson, ARIC, AFInstPet, c/o A. B. Fleming, 170 Glasgow Road, Edinburgh 12.

Vice-Chairman: P. A. Gower, c/o Lorilleux & Bolton Ltd., Sighthill, Edinburgh 11.

Hon. Secretary: R. Webster, 19 Bowling Green Street, Edinburgh 6.

Hon. Treasurer: R. Harvie, 8 Dean Park Crescent, Edinburgh 4.

Hon. Publications Secretary: J. H. Stewart, AHWC, c/o A. B. Fleming & Co., 170 Glasgow Road, Edinburgh 12.

Representative on Section Committee: G. H. Hutchinson, ARIC, AFInstPet, c/o A. B. Fleming & Co., 170 Glasgow Road, Edinburgh 12.

Committee:

E. A. Bullions, 11 Comiston View, Edinburgh.
C. G. Cochrane, BSc, FRIC, AHWC, c/o Craig & Rose, 172 Leith Walk, Edinburgh 6.
D. I. Muirhead, c/o Wm. Sim & Sons (Paints) Ltd., 40 Jane Street, Edinburgh 6.
R. W. Miles, MA, ARIC, 22 Wester Broom Terrace, Edinburgh 12.
P. R. Phillips, 10 Craigbrook Park, Edinburgh 4.
C. N. Henderson, BSc, ARIC, c/o Samuel Jones Ltd., Tillicoultry.

Hon. Auditor: G. A. Pringle, BSc, ARIC, c/o A. B. Fleming & Co., Ltd., 170 Glasgow Road, Edinburgh 12.

Notes and News

21 OCCA TECHNICAL EXHIBITION

24-28 March 1969

The Exhibition Committee is pleased to report that the space allocated to exhibitors at 21 OCCA (the Association's Twenty-First Technical Exhibition) at Alexandra Palace, London N22, exceeds that at any previous Exhibition. There will be 106 stands, including exhibitors from ten overseas countries —Belgium, Denmark, Finland, France, Germany, Holland, Italy, Sweden, Switzerland and the United States of America. Of the companies showing, 8 have never shown at previous OCCA Technical Exhibitions, whilst 21 others did not show at the 1968 Exhibition.

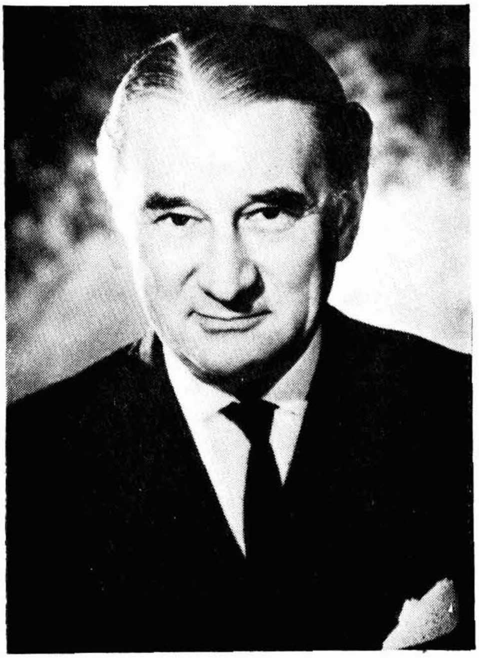
In every copy of the *Official Guide*, a map is reproduced in order to assist those who propose to visit the Exhibition. Copies of the *Official Guide* will be sent without charge to all members of the Association early in 1969. Further copies will be despatched individually to chemists and technologists on the Continent of Europe, to technical colleges and, through the courtesy of the trade associations, to companies in the paint, printing ink and pigment industries in the United Kingdom.

The map is also being reproduced separately in a folder, with directions in six languages (French, German, Italian, Russian, Spanish and English) and copies of these will be included with the copies of the *Official Guide* sent to Europe. Copies are available for any person intending to visit the Exhibition, and can be obtained without charge from the Association's offices. These six language cards will also be sent to many paint and printing ink manufacturing companies in Europe.

For visitors from abroad, the Association has arranged with Grand Metropolitan Hotels to provide a service for hotel accommodation at a 10 per cent reduction. A booking leaflet will be enclosed with every *Official Guide* sent abroad. However, anyone wishing to make use of this service should apply to the Director & Secretary at the address given below.

A free bus shuttle service will once again be operated by the Association between Wood Green Underground Station and Alexandra Palace. For those travelling by car, there are free car parking facilities at Alexandra Palace.

The Exhibition Luncheon will be held at the Savoy Hotel, London WC2, at 12.45 p.m. on Monday 24 March. Principal officers of other scientific bodies, industrial research associations and organisations representing both suppliers and consumers will be invited to attend. Over 300 members, exhibitors and guests attended the 1968 Luncheon.



Lord Kings Norton

The principal guest will be Lord Kings Norton, Chairman of the Council for National Academic Awards, who will reply to the Address of Welcome by the President, Mr F. Sowerbutts.

On Thursday 28 March, after the close of the Exhibition, a lecture, which has been arranged by the London Section as their European Liaison Lecture, is to be given by Dr Karl-Heinz Frangen. The title of the paper will be announced in a later issue of the *Journal*, and an application form for tickets will be enclosed in each copy of the *Official Guide*.

The Exhibition will be open on five days; it is felt that this arrangement will benefit companies, particularly those overseas and in the provinces, wishing to arrange rotas for their technical staff to visit the Exhibition.

The hours of opening will be as follows:

Monday 24 March	15.00-18.30.
Tuesday 25 March	10.00-18.00.
Wednesday 26 March	10.00-18.00.
Thursday 27 March	10.00-18.00.
Friday 28 March	10.00-16.00.

Over 12,000 visitors attended the 1968 Exhibition, including representatives from 32 overseas countries, and in order to assist the increasing number of overseas visitors and exhibitors, interpreters will again be in attendance (French, German, Italian, Spanish.) There will be no charge for admission to the Exhibition, nor for copies of the *Official Guide*, which will be available from the Association's Information Centre at the Exhibition or from the Association's offices prior to the Exhibition.

Any person or company wishing to obtain a copy of the *Official Guide* upon publication early in 1969 should write to the Director & Secretary, Oil & Colour Chemists' Association, Wax Chandlers' Hall, Gresham Street, London EC2.

Alphabetical List of Exhibitors—21 OCCA

Allied Chemicals Corporation
Amalgamated Oxides Ltd.
AMF International
Amoco Chemicals Europe
Anchor Chemical Co. Ltd.
† Armour Hess Chemicals Limited.
Ashby, Morris Ltd.
† Bakelite Xylonite Limited
BASF United Kingdom Limited
Berk Limited
BIP Chemicals Limited
† Blagden, Victor & Co. Ltd.
Boehm, Fredk, Limited
Boulton, William, Limited
BP Chemicals (UK) Limited
British Celanese Limited

British Oxygen Chemicals Ltd.
British Titan Products Co. Ltd.
**** Buckman Laboratorie Inc.
Bush Beach & Segner Bayley Ltd.
† Byk-Gulden Lomberg GmbH
Carless, Capel & Leonard Limited
Chemische Werke Huels AG
Ciba (ARL) Limited
Ciba Clayton Limited
Columbian International (Great Britain) Ltd.
† Controsion Limited
† Cornelius Chemical Co. Limited
† Daniel Products Co.
Degussa
D. H. Industries Limited
Diaf A/S
**** Eastman Chemical International AG
Elcometer Instruments Limited
Farbenfabriken Bayer AG
Ferranti Limited
Geigy (UK) Limited
Grampian Press Ltd.
† Hercules Powder Co. Ltd.
**** Heydon, Harold, & Co. Ltd.
Hoechst Chemicals Ltd.
Hygrotherm Engineering Ltd.
Imperial Chemical Industries Ltd.
† Industrial Colours Ltd.
International Colloids Ltd.
Jenag Equipment Limited
Joyce, Loebl & Co. Ltd.
Kingsley & Keith (Chemicals) Ltd.
Kronos Titanium Pigments Ltd.
† Lancashire Tar Distillers Ltd.
Laporte Industries Ltd.
Lennig Chemicals Ltd.
Little, J.H., & Co. Ltd.
Marchant Bros. Ltd.
Mastermix Engineering Co. Ltd.
Meazzi, Dr. E.
Meyer's, Rudolph, Inc.
Microscal Limited
† Millroom Acc. & Chemicals Ltd.
† Mitchell, W.A., & Smith Ltd.
Molteni Off. Mecc. of Milan
† Norsk Spraengstofindustri A/S
† A/S Norwegian Talc.
Novadel Limited
Paint Oil & Colour Journal
The Paint Research Station
† Plastanol Limited
**** Porter-Lancastrian Limited
† Premier Colloid Mills Ltd.
Research Equipment (London) Ltd.
**** Revai, A., & Co. (Chemicals) Ltd.
Rhone-Poulenc/Société Redis
**** R. K. Chemical Co. Ltd.
Sachtleben AG
Sawell Publications Ltd.
Scado-Archer-Daniels N.V.
† SCC Colours Ltd.
**** Scholven-Chemie A.G.
Sheen Instrument (Sales) Ltd.
Shell International Chemical Co. Ltd.
Silver, Peter, & Sons (Eng.) Ltd.
Silverson Machines Limited
Smith, Herbert, & Co. (Grinding) Ltd.
Spelthorne Metals Ltd.
Surface Coating Synthetics Ltd.
† Swada (London) Limited
Synthese N.V.
N. V. Tiofine
Titanium Intermediates Ltd.
Torrance & Sons Ltd.
**** Unilever-Emery N.V.
Union Carbide Europe Inc.
† United Coke & Chemicals Co. Ltd.
Vinyl Products Limited
Vuorikemia Oy.
VVB Lacke und Farben
Winkworth Machinery Limited
† Wolf, Victor, Limited
† Younghusband Stephens & Co. Ltd.

**** Denotes companies who have not previously exhibited at OCCA Exhibitions.

† Denotes companies who did not exhibit at 1968 Exhibition.

Meeting of Council

The meeting of Council on Thursday 11 July was attended by 19 members under the chairmanship of the President, Mr F. Sowerbutts, at Wax Chandlers' Hall, Gresham Street, London EC2.

This being the first meeting after the Annual General Meeting, the President welcomed new members of the Council. Committees and Working Parties of Council and representatives on other organisations for the session 1968/69 were appointed.

Arising from a recommendation by the Working Party on Forward Thinking, the Council resolved that Hon. Officers of the Association and members of Council Committees would normally retire at the end of six years' service but under very special circumstances Council might see fit to extend their term of office.

The President reported on his visit to FATIPEC Congress.

It was reported that arrangements for the 1969 Conference at Eastbourne and the 21st Technical Exhibition were in hand, that the meeting of Section Hon. Secretaries would take place on 17 July, that the revised editions of the first two Paint Technology Manuals would appear in November and that the first Student Review had appeared in the July issue.

Further information was available concerning the joint SCI/PI/RI/OCCA/SDC Conference, 29 September-1 October 1970, and this information has now been released and is printed in this issue.

The Association's representative on the Colour Group had reported that the First Congress of the International Colour Association would take place in Stockholm, 9-13 June 1969, and inquiries should be addressed to Mr Tonnquist, FOA2, S—104 50 Stockholm 80, Sweden.

The capitation fee for 1969 in respect of the Oil and Colour Chemists' Association Australia was discussed and agreed. Reports were received of Section activities and attention was drawn to the forthcoming symposia by Manchester and Scottish Sections, the latter being planned to coincide with the Association's Annual General Meeting in 1970.

Jordan Award

The Committee appointed by Council to consider the applications received for the Jordan Award met in February and, after long and careful consideration, decided that it was not possible to make the Award on this occasion.

It is intended, therefore, to invite further applications to be received in 1968, and the Committee will consider these early in 1969, with a view to making the Award at the Eastbourne Conference, which will be held 17-21 June 1969. The rules of the Award are appended below for the benefit of new members.

1. The Award (which on this occasion will be £100) will be made for the best contribution to the science or technology of surface coating by a member of any nationality working in either the academic or industrial field who is under the age of 35 at the date of application.
2. The final date for submission of applications will on this occasion be 1 January 1969.
3. The selection of the recipient of the Award will be made by a Committee under the Chairmanship of the Association's Hon. Research and Development Officer.
4. There will be two methods of application. First, by the submission of a paper describing original work by the candidate which is offered for publication in the *Journal* or has been so published during the two years prior to the closing date for application. The alternative method will be by recommendation by a superior for work which for reasons of commercial secrecy cannot be published; in this case the candidate will be expected to submit a dissertation on a topic relating to his work and demonstrating his superior knowledge of the principles thereof. The Award is for *individual* merit and clear evidence of the candidate's own contribution will be required if a paper is offered under joint authorship.
5. Applications should be addressed to the Director & Secretary at the address shown on the front cover.

New Zealand Section

Annual Convention 1969

The New Zealand Section Annual Convention for 1969 will be held at the Wairakei Hotel from 13-15 June 1969.

The Section Committee would be pleased to hear from any technical or sales personnel who would be in New Zealand at this time and would be interested in presenting a paper at the Convention.

Any interested person should contact the Hon. Secretary:

D. W. Sell, Esq.,
4 Claude Road,
Manurewa, Auckland,
New Zealand.

Obituary

Mr T. W. Robinson

R. R. writes:

It is with deep regret that we have to record the death on 11 July of Mr Tom W. Robinson of the Newcastle Section.

Mr Robinson was educated at the Royal Grammar School, Newcastle upon Tyne, and Christ's Hospital, Sussex. On leaving school he proceeded to the Public Analysts, J. & H. S. Pattinson, and was trained under the late Dr J. T. Dunn; five years later, in 1928, he joined the Research Laboratory of International Paints Ltd., where he remained for the last 40 years of his life, specialising in corrosion and fouling investigations.

He served on many committees, including Newcastle Section of OCCA, the Technical Committee of the Research Organisation of Ships Compositions Manufacturers, of which he was deputy chairman, and the Cathodic Protection Committee of the SCI.

To discuss scientific matters with Tom was always stimulating and his analytical and mathematical approach to problems encouraged others to think more deeply as to where the solution might lie and by what means it might be attained. His wise counsel and guidance will be sorely missed by his colleagues and his many friends in both the paint and shipping industries who held him in high esteem.

He had a great sense of humour and a ready wit and when in his company one could be sure there was never a dull moment.

In his leisure time he was a keen golfer and was an ex-captain of the Whitley Bay Golf Club.

To his wife, daughter and sons we extend our deepest sympathy.

News of Members

Mr D. C. Colborn, an Ordinary Member attached to the London Section, has recently been appointed to the board of Ault & Wiborg Ltd. Mr Colborn has also been appointed Managing Director of Shuck Maclean & Co. Ltd., the Ault & Wiborg subsidiary.

Mr I. H. Ratcliffe, an Ordinary Member attached to the Thames Valley Section, has been appointed to the board of Shuck Maclean & Co. Ltd.

Mr R. McDowell, an Associate Member attached to the Manchester Section, has joined Compounding Ingredients Limited as Product Development Manager. Mr McDowell was previously with the Witco Chemical Company Ltd.

Third Joint Symposium

The third of a series of symposia organised jointly by the IRI, PI and SCI with the assistance of OCCA and SDC will take place in London, 29 September-1 October 1970. The sub-title of this 1970 meeting, "Chemistry of liquid polymers and thermoplastic copolymers," indicates the field of interest chosen, and it is the intention of the organising committee that the papers should be mainly of chemical interest. Methods of terminating polymer chains to give the liquid polymers, the subsequent chain building reactions, grafting and block polymer syntheses will form the principal subject matter.

Preliminary planning suggests that one day will be devoted to papers on liquid polymers. It is hoped that such papers will discuss the chemistry of these materials, alternative methods of chain termination and the cross-linking reactions. The third day will deal with thermoplastic homopolymers and with co-polymers such as the graft and block co-polymers now entering the commercial scene in bulk quantities. In the latter area, where rubber and plastics overlap, there is scope for chemical permutation in formulating the co-polymer. Polymerisation methods, grafting techniques and their influence on technology should offer an interesting opportunity for combining chemistry and technology.

The middle day will also involve the chemistry of these two sorts of relatively new materials but will bring in the particular interests of people using them in the surface coatings field and, it is hoped, involve some of the chemical reactions induced in the polymers by the action of light on the pigments and dyes which may be incorporated.

The Secretariat for this symposium passes on this occasion to the Institution of the Rubber Industry, 4 Kensington Palace Gardens, London W8, where Mr R. H. Craven will be pleased to answer inquiries and receive offers of contributions to the programme. It is intended to publish the papers of the conference in full.

Colour Group

It is proposed to form a Northern Section of the Colour Group and, to inaugurate this, a meeting is to be held at the Manchester University Institute of Science and Technology, Lecture Theatre C2, at 6.30 p.m. on 9 October 1968. A lecture entitled "The perception of colour" will be presented by Professor W. D. Wright, of Imperial College, and will be followed by a public meeting and election of committee.

Xth FATIPEC Congress

The next FATIPEC Congress will take place in Montreux (Switzerland) about the end of May/beginning of June 1970. The subject of the Congress will be: "Resistance and deterioration of modern paint films, related to paint formulation, manufacturing process, application methods and surface treatment."

A cycle of specialised conferences for printing ink chemists is planned during the Congress on the following subject: "The behaviour of printing inks in dependence of formulation, manufacturing, substrate and printing matters."

A new chairman of FATIPEC, Mr P. Castan, was elected during the last Congress in May 1968 in Brussels. Mr K. M. Oesterle is head of the Scientific Committee.

Federation of Societies for Paint Technology

Unit 9 in the Federation Series on Coating Technology, entitled "Organic color pigments," by J. G. Monc, has recently been published. Copies of the 36-page booklet, priced at 50c, are available from the FSPT.

Forthcoming Events

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

Thursday 3 October

Newcastle Section. "Gel Permeation Chromatography," by Mrs S. M. Rybicka of the Paint Research Station, to be held at the Royal Turks Head Hotel, Grey Street, Newcastle upon Tyne, at 6.30 p.m.

Saturday 5 October

Scottish Section—Eastern Branch. Student Lecture—"Fluid Handling in the Paint Industry," by Mr D. Muirhead of Wm. Sim & Sons Paints Ltd., to be held at the Wee Windaes Restaurant at 10.30 a.m., followed by lunch and a skittles match at the Hillburn Roadhouse.

Monday 7 October

Hull Section. Joint meeting with the Hull Branch of the National Federation of Master Painters and Decorators, to be held at the Bullock Lecture Theatre, Hull College of Technology, at 7.00 p.m.

Tuesday 8 October

West Riding Section. "Printing Inks for Plastics," by Mr J. Hastings-Long of Ultra Printing Inks Ltd., to be held at the Griffin Hotel, Boar Lane, Leeds 1, at 7.30 p.m.

Thursday 10 October

Scottish Section. "Developments in Paint Industry," by Mr J. M. Butler of Lewis Berger (GB) Ltd., to be held at the Whitehall Restaurant, Renfield Street, Glasgow, at 6.00 p.m.

Friday 11 October

Hull Section. Annual Dinner-Dance at the Hotel Eden, Willerby.

Manchester Section. "Recent Advances in the Technology of Painting of Ships," by Dr D. Atherton of John S. Craig & Co. Ltd., to be held at the Manchester Literary and Philosophical Society, 36 George Street, Manchester 1, at 6.30 p.m.

Saturday 12 October

Scottish Section—Student Group. "Dispersible Pigments," by Mr A. Gray of Geigy (UK) Ltd., to be held at the Lorne Hotel, Sauchiehall Street, Glasgow, at 10.00 a.m.

Monday 14 October

London Section—Southern Branch. "Thick Coatings," by Mr G. C. R. Russell of Shell Research Ltd. and Mr T. F. Birjenhead of ICI Mond Division, to be held at the Keppel's Head Hotel, The Hard, Portsmouth, at 7.30 p.m.

Thursday 17 October

London Section. "Management by Objectives in Research and Development," by G. S. Sanders of Urwick Orr & Partners Ltd., to be held in the New Engineering Block, University College, London WC1, at 6.30 p.m.

Friday 18 October

Manchester Section. Annual Dinner-Dance at the Piccadilly Hotel, Piccadilly Plaza, Manchester 1.

Midlands Section. Joint Meeting with Midlands Section, Plastics Institute, "Coatings on Plastics," by Mr E. Kubitza of Farbenfabriken Bayer, to be held at the Chamber of Commerce House, 75 Harborne Road, Birmingham 15, at 6.30 p.m.

Wednesday 23 October

Scottish Section—Eastern Branch. "Dispersible Organic Pigments," by Dr D. A. Plant of Imperial Chemical Industries Ltd., to be held in the Wee Windaes Restaurant, High Street, Edinburgh at 7.30 p.m.

Friday 25 October

Irish Section. "Printing on Plastic Materials," by Mr R. Ruttledge, to be held at the Clarence Hotel, Wellington Quay, Dublin, at 8.00 p.m.

Wednesday 30 October

Thames Valley Section. "Forensic Science," by Dr I. G. Holder of the Home Counties Forensic Science Laboratory, to be held at the Royal White Hart Hotel, Beaconsfield, Bucks, at 7.00 p.m.

Thursday 31 October

Midlands Section—Trent Valley Branch. Joint Meeting with Nottinghamshire, Derbyshire and Lincolnshire Society of Architects. Two half-hour talks, "The Problems which arise when dealing with Architects," by F. C. A. Hovey, and "The Problems which Architects encounter in connection with the Application of Paint," by an Architect, to be held at the British Rail School of Transport, London Road, Derby, at 7.30 p.m.

Monday 4 November

Hull Section. "Dispersible Organic Pigments," by Dr Smith of Geigy (UK) Ltd., Pigments Division, to be held at the Bullock Lecture Theatre, Hull College of Technology, at 7.00 p.m.

Thursday 7 November

Newcastle Section. "Some Factors influencing the Durability of Titanium Dioxide Pigmented Films," by Mr G. Willison of British Titan Products Co. Ltd., to be held at the Royal Turks Head Hotel, Grey Street, Newcastle upon Tyne, at 6.30 p.m.

Friday 8 November

Bristol Section. Joint Meeting with the BPVLC, "Liquid Seamless Systems Comprising High Build and High Performing Properties," by Mr D. H. de Rieu of Quentsplass Ltd., at the Hawthorns Hotel, Bristol.

Manchester Section. "Instrumental Analysis in the Paint Industry," by Mr V. W. Reid of Shell Research Ltd., to be held at the Manchester Literary and Philosophical Society at 6.30 p.m.

Monday 11 November

London Section—Southern Branch. "Aircraft Finishes," by Mr J. Scott of BAC Ltd., to be held at the Keppel's Head Hotel, The Hard, Portsmouth, at 7.30 p.m.

Tuesday 12 November

West Riding Section. "Efficiency in Production," by Mr R. English of Master-Mix Engineering Ltd., to be held at the Griffin Hotel, Boar Lane, Leeds 1, at 7.30 p.m.

Thursday 14 November

Scottish Section. "Fire Retardant Coatings," by Mr F. C. Adams of the Ministry of Technology, Fire Research Station, to be held at the Whitehall Restaurant, Glasgow, at 6.00 p.m.

Friday 15 November

London Section. "Ladies' Night" at the Criterion-in-Piccadilly, London W1, at 7.30 p.m.

Midland Section. "Instrumental Colour Matching," by R. Best of BIP Chemicals Ltd., to be held at the Chamber of Commerce House, 75 Harbourne Road, Birmingham 15, at 6.30 p.m.

Saturday 16 November

Scottish Section—Student Group. "Anti-fouling Paints" and "Painting the Queen Elizabeth II" (Film), by Mr T. Pisacane of John S. Craig Ltd., to be held at the Lorne Hotel, Sauchiehall Street, Glasgow, at 10.00 a.m.

Wednesday 20 November

London Section. "Crosslinks between Paints and Adhesives," by Dr W. C. Wake of the Rubber and Plastics Research Association of Great Britain, to be held in the New Engineering Block, University College, London WC1, at 6.30 p.m.

Scottish Section—Eastern Branch. "Colour Computers," by a speaker from the Paint Research Station, to be held at the Wee Windaes Restaurant, 142 High Street, Edinburgh, at 7.30.

Thursday 28 November

Midlands Section—Trent Valley Branch. "Painting and the New Code of Practice," by Mr F. G. Dunkley, to be held at the British Rail School of Transport, London Road, Derby, at 6.30 p.m.

Thames Valley Section. "Dispersymers —A new Technology for Paint," by Mr C. Cook of ICI Ltd., Paints Division, to be held at the Royal White Hart Hotel, Beaconsfield, Bucks, at 7.00 p.m.

Friday 29 November

Bristol Section. "Metal Pigments," by Mr G. W. Wendon of the English Metal Powder Co. Ltd., to be held at the Royal Hotel, Bristol, at 7.15 p.m.

Irish Section. "Epoxy Resins," by Mr Dennis Liff of Shell Research Ltd., to be held at the Clarence Hotel, Wellington Quay, Dublin, at 8.00 p.m.

West Riding Section. Annual Dinner and Dance at the Granby Hotel, Harrogate.

Oil and Colour Chemists' Association

President : F. SOWERBUTTS, B.SC.TECH.

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

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

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

Ordinary Membership is granted to scientifically trained persons, and Associate Membership to others interested in the industries covered. Student Membership, which is intended primarily for students, is open without restriction to persons under the age of 21 and to those up to 25 who are following a course of technical study. The annual subscription in each case is five guineas, except for Student Members whose subscription is one guinea. An entrance fee of 10s. is payable by all members. Applications for membership are invited from suitably qualified persons who are engaged or otherwise interested in the industries noted above. Applications, which should be supported by two members of the Association (one of whom must be an Ordinary Member), should be forwarded to the Director & Secretary at the address given below. Application forms and full details of membership may be obtained from the offices of the Association.

PUBLICATIONS

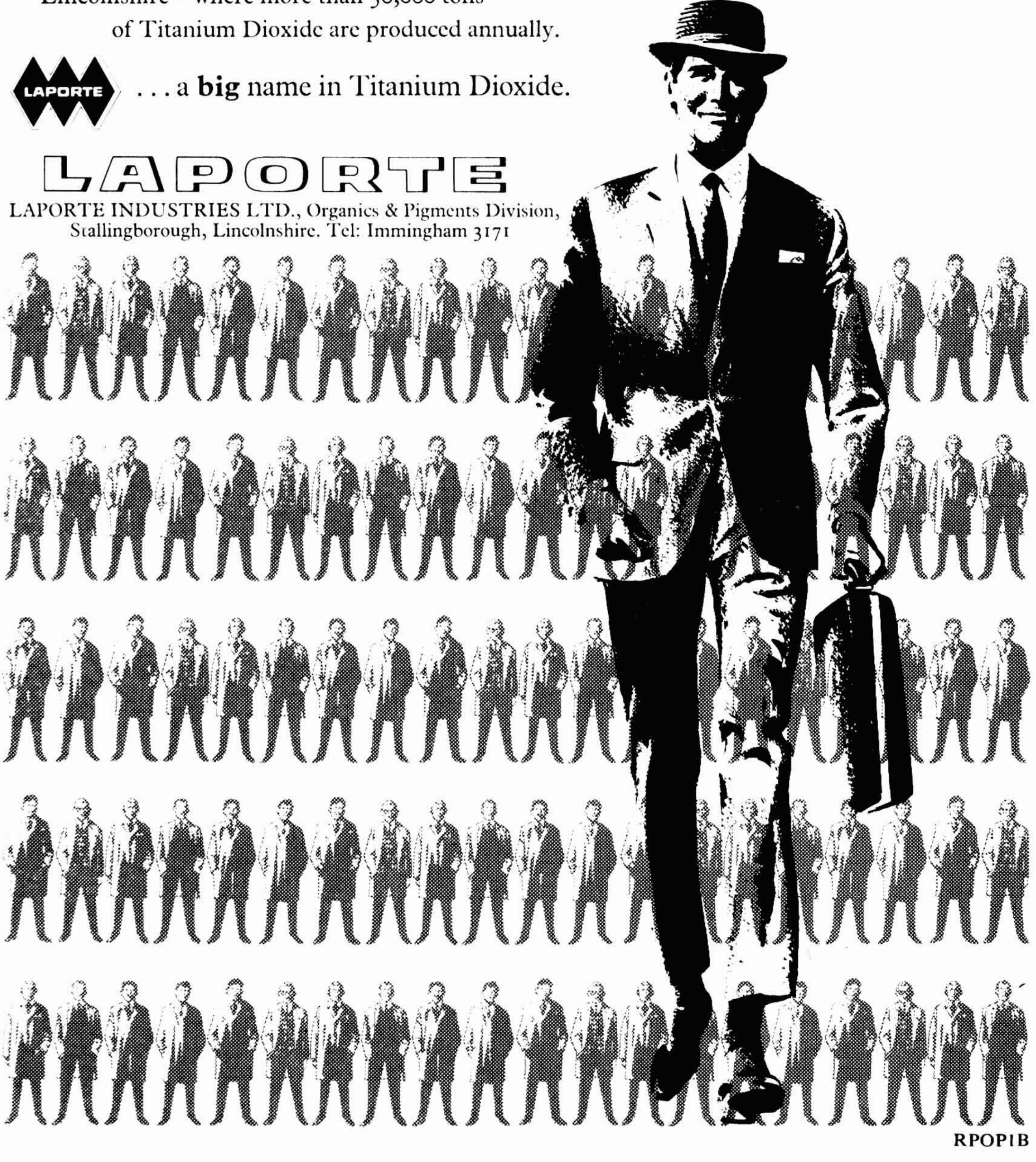
Journal of the Oil and Colour Chemists' Association. Published monthly. Subscription rate to non-members in UK and abroad, £7 10s. p.a. post free ; payable in advance.

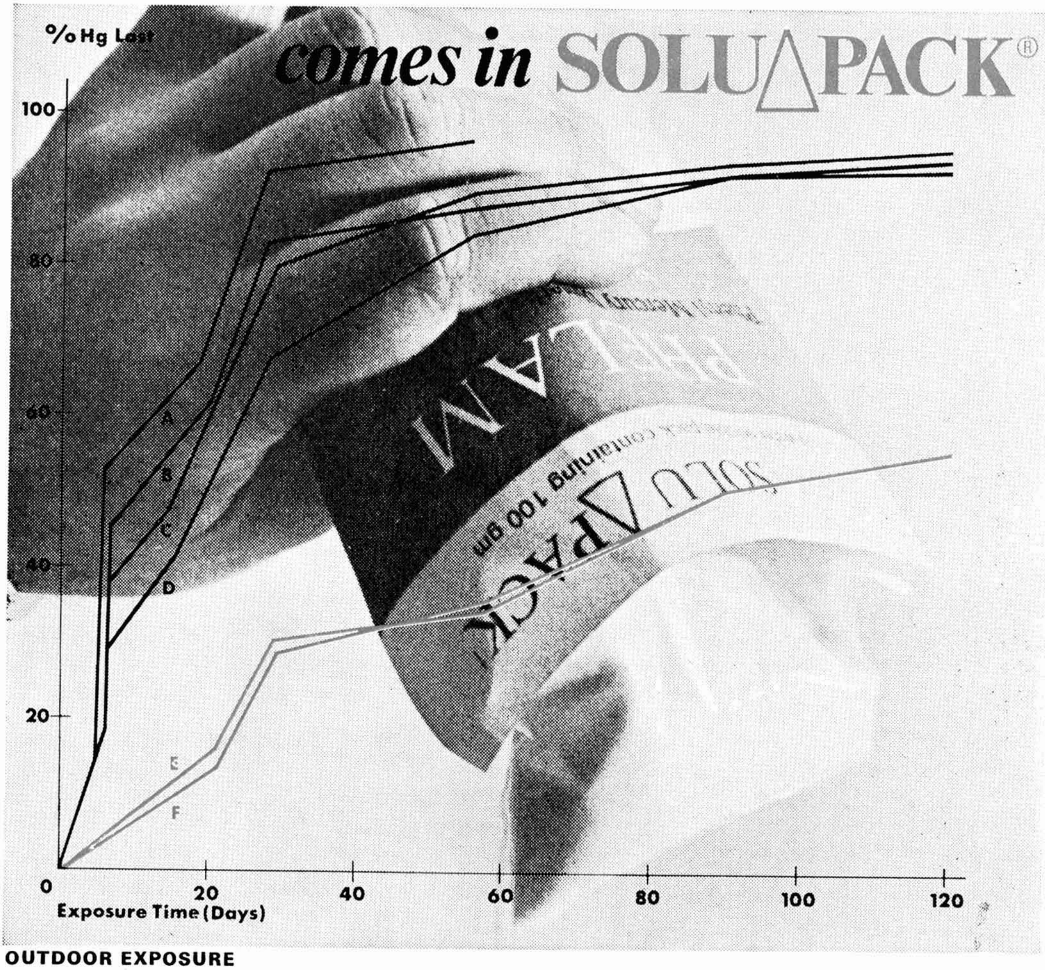
An Introduction to Paint Technology (Second Edition with additional chapter). Pp. 187, illustrated, with index, £1 (including postage).

Paint Technology Manuals

Part 1 : " Non-convertible Coatings " } Second editions will appear
Part 2 : " Solvents, Oils, Resins and Driers" } in November 1968.
Part 3 : " Convertible Coatings," Pp. 318, 35s.
Part 4 : " The Application of Surface Coatings," Pp. 345, 35s.
Part 5 : " The Testing of Paints," Pp. 196, 35s.
Part 6 : " Pigments, Dyestuffs and Lakes," Pp. 340, 35s.

Director & Secretary : R. H. Hamblin, M.A., F.C.I.S., F.C.C.S., Wax Chandlers' Hall, Gresham Street, London, E.C.2.

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Classified Advertisements are charged at the rate of 9s. per line. Advertisements for Situations Wanted are charged at 2s. 6d. per line. A box number is charged at 1s. 0d. They should be sent to the Director & Secretary, Oil & Colour Chemists' Association, Wax Chandlers' Hall, Gresham Street, London, E.C.2. Telephone: Monarch 1439

THE GLIDDEN-DURKEE DIVISION OF SCM CORPORATION has vacancies for chemists and technologists at the new Dwight P. Joyce Research Center of its Coatings and Resins Group. This building of 132,000 square feet will house 250 people and is situated south of Cleveland, Ohio. It is far enough from the City to provide easy daily travel from a wide selection of surrounding communities, yet close enough (by adjacent highway) to enjoy its amenities. The vacancies are:

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SENIOR CHEMISTS

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Thermoset Section—experience is required in development of vehicles for stoving finishes (especially water soluble).

Emulsion Polymerization Section—must be experienced in the fundamentals of emulsion polymerization and capable of designing and directing R and D programs.

CHEMISTS

Emulsion Polymerization Section—experience required in formulating and preparation of emulsion polymers for decorative and industrial coatings.

Plastics Section—experience required in the synthesis and development of unsaturated polyesters.

COATINGS RESEARCH DEPARTMENT

COATINGS CHEMISTS

Qualified chemists or technologists are required who will not be limited by any preconceived ideas or "traditional" methods of formulation. This department is engaged in longer term coatings research where new ideas and materials are developed for use by other R and D departments.

FUNDAMENTAL RESEARCH DEPARTMENT

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A PhD is preferred, but will consider the equivalent in an experienced applicant with a proven research capability. Required is a demonstrated ability to apply and develop fundamental concepts which enhance the understanding of the physical chemistry of coatings and polymer systems and which augment the more rapid development of new products. Responsibilities include developing practical research programs in one or more of the areas of rheology, molecular weight characterization, and physical and mechanical properties, and selling these programs to management. Will initially supervise a chemist and a technician. Publications encouraged.

INDUSTRIAL COATINGS R AND D DEPARTMENT

COATINGS CHEMISTS

Electrocoat Section—must possess a good understanding of both the theory and practice of electrodeposition of organic coatings and their formulation.

Can Coating Section—experience is required in the formulation and evaluation of coatings for interior of metal containers.

Applicants should possess chemistry and/or technology degrees, together with appropriate industrial experience. If you have these qualifications and believe you are capable of working in an environment where the development of your own ideas is given first consideration, then you are invited to write to:

MANAGER, POLYMER AND PLASTICS R AND D,
Glidden-Durkee Division of SCM Corp.,
12430 Elmwood Avenue,
Cleveland, Ohio, 44111

Transport to the USA will be paid by the Company for successful applicants and their families.

SITUATION VACANT

ALCAN

COLOUR CHEMIST

Alcan Aluminium of South Africa Limited has established this new post with responsibility for the formulation, standardisation and preparation of inks and lacquers for aluminium foil coating, for development work on foil finishing and for control of the foil coating laboratory.

Candidates preferably between 25 and 40 should have a degree in Chemistry, or CGLI. Full Technological certificate, or equivalent qualification. Experience should include production or application of paints, inks or organic coatings. Knowledge of printing operations and foil technology would be advantageous.

From its very modern plant in Pietermaritzburg, Natal, the Company supplies the major portion of South Africa's aluminium sheet, extrusion and foil products.

Starting salary will be determined by qualifications and experience. The Company offers contributory pension, life assurance and medical aid benefits.

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One of the world's largest producers of marine paints is to appoint a suitably qualified technologist for senior duties related to research development and production in their European Headquarters. Candidates for this appointment must have a sound academic background in a related field of technology such as chemistry or physics and have extensive experience of this highly specialised field of paint technology.

The man appointed, who will probably be in the 35-45 year age range, must be able to work at a senior management level and be prepared to reside on the Continent of Europe. The salary will be negotiated according to qualifications and experience, but will certainly not be less than £5,000 per annum, a substantially higher salary being available for a man of outstanding experience and ability.

Applications, giving brief details of qualifications and experience, should be sent in confidence to:—

Appointments Secretary, Ref. 436/2,
Industrial Administration Ltd.,
Management Consultants and Consulting Engineers,
194 Old Brompton Road,
London, S.W.5.

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For the Canada Printing Ink Company Limited (Division of Reichhold Chemicals Canada).

Qualifications:

1. GCE (General Certificate of Education)
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3. Five years' experience after obtaining City & Guilds Certificate

Experience in:

1. Lithographic Inks
2. Letterpress Inks
3. Flexo and Gravure
4. Ability to Service Accounts

Salary—$7,500.00 to $10,000.00; plus assistance with passage to successful candidate.

Please reply back to G. C. Wright, Technical Director, The Canada Printing Ink Co. Ltd., Toronto, Ontario, Canada.

SITUATION VACANT

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An opening exists for a good Honours degree Chemist, or GRIC, to work in a stimulating set-up on interesting R & D aspects of synthetic resin systems.

A sound knowledge of the chemistry of these materials is required, preferably in their application to surface coatings.

Excellent working conditions are offered in rural Hampshire. Applications in confidence are invited with brief details of qualification and experience:

The Administrator,
Passfield Research Laboratories,
Metal Containers Limited,
Passfield,
Nr. Liphook, Hampshire.

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COATINGS TECHNOLOGIST with more than ten years' experience in paint and raw materials Research and Development, Technical Service and Plant and Production management, wishes to return to UK towards the end of the year and seeks employment in any of the above areas. For further information write to Box No. 293.

"..........and finally we filled the vacancy through a classified advertisement in J.O.C.C.A."

The *Journal* is read by technical personnel throughout the surface-coatings industries, and Situations Vacant may be advertised at the rates of 9s. per line, and 2s. 6d. per line for Situations Wanted.

OCCA BIENNIAL CONFERENCE

17-21 June 1969 at the
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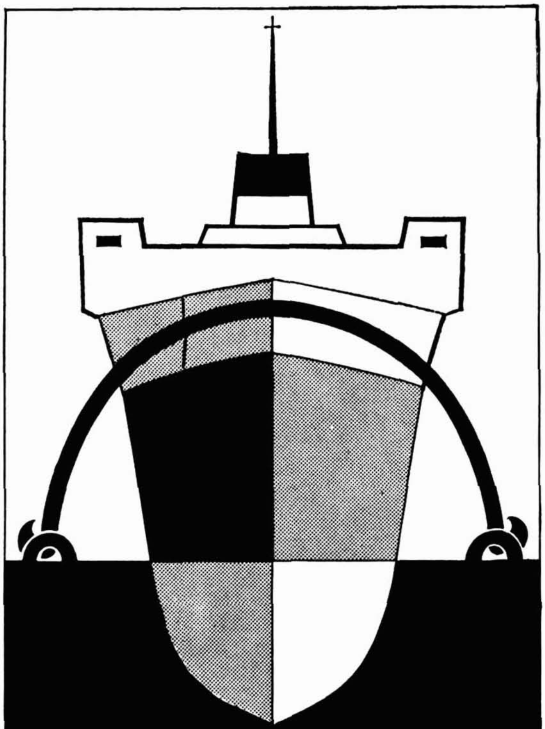

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Corrosion of a ship's hull, under or above water, can lead to expensive trouble. This trouble can be avoided. Epoxy/coal tar coatings are superior to conventional hull paints not only in adhesion and mechanical resistance to damage but their superior resistance to seawater ensures effective protection against corrosion. Many epoxy/coal tar paint formulations avoid trouble by using only U.C.C. Special Pitches and Tars.

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