

J  
O  
C  
C  
A



## OCCA-32 EXHIBITION

Review Issue  
See page 298

The photograph shows some of the stands in the New Hall

# JOURNAL OF THE IL & COLOUR CHEMISTS' ASSOCIATION

Solubility parameter values of hydroxy polymers through its components and chemical group contribution technique

*H. Ahmad*

An overhanging beam method for measuring internal stress in coatings

*S. G. Croll*

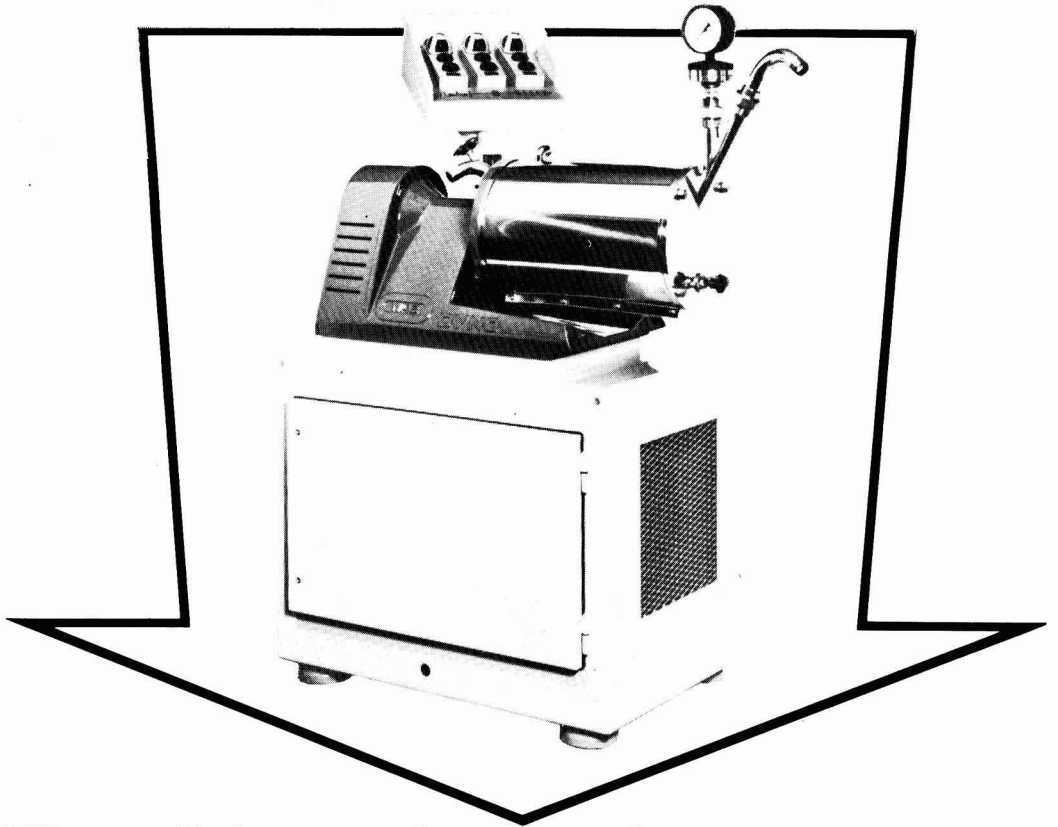
A comparative investigation of stains for wood

*S. Dombey and B. Stangroom*

Hazards of static electricity in workclothing

*R. Verschave and R. Firmin*

# DYNO-MILL®



## The mill that revolutionised paint technology

The legendary DYNO-MILL® is a superb product of Swiss engineering and is now firmly established in hundreds of factories throughout the world. It is the mill you can depend on to produce paints and inks with total reliability, from 2 to 2000 litres/hour, in small batches or in continuous production.

Features include colour change within 20 minutes; self-cleaning dynamic separator; simplicity of design for ease of service.

There are also fully automated models to work without supervision.

For full information on the Dyno-Mill, a demonstration or advice please contact:-

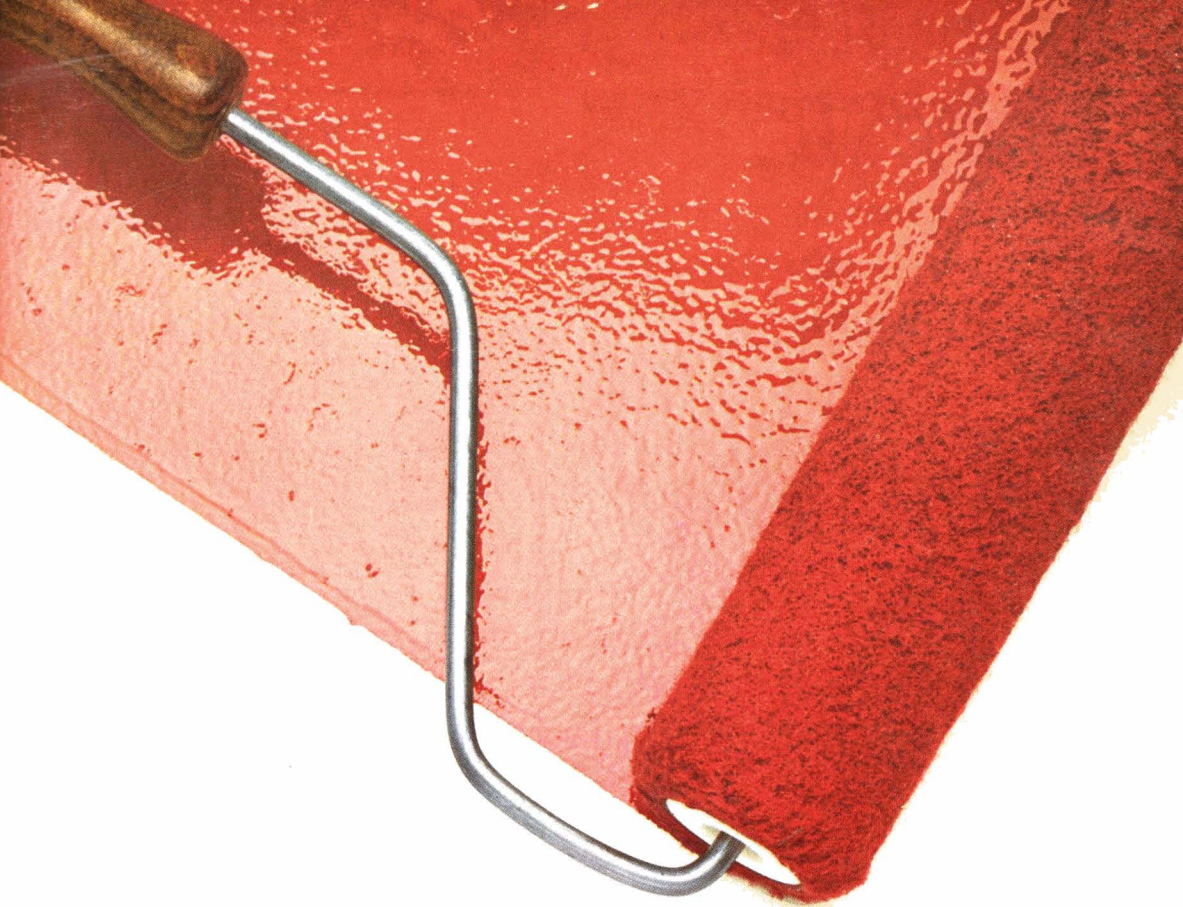
 **Glen Creston**  
Machinery Limited

16 Carlisle Road, London NW9 0HL, England.  
Telephone 01-200 1666. Telex 925791.  
Telegrams Glencrest London NW9.

Inquiries outside the UK and Eire please address direct to the Manufacturers.

 **WILLY A. BACHOFEN AG**

Mfg. Engineers, Dept. of Application Technology, CH 4000,  
Basle 5, Switzerland. Telephone 061-33 55 55. Telex 62564.



# Control the surface characteristics of your paint with Celite<sup>®</sup> extenders and flattening agents from Johns-Manville.

With Celite extenders you have complete control, from flat to gloss, depending on how much you add. They're pure, inert and non-reactive diatomaceous silica. Their high flattening efficiency results in uniform gloss and sheen reduction, from a silky semigloss to dead flat.

Celite extenders are available in several grades for both solvent and

water-thinned paints. These grades give you the flexibility you need depending on your formulations, desired degree of gloss and sheen reduction, type of dispersion equipment and the desired degree of final film smoothness (up to 5 Hegman fineness).

Johns-Manville Technology has been at work in the paint industry for over 30 years. Let us help you.

Contact Johns-Manville Great Britain Ltd., Parkbridge House, The Little Green, Richmond, Surrey, TW9 1QU, Great Britain, Telex: 928635.



**Johns-Manville**

**You'll find  
Hardmans Varnishes  
in some of the  
World's best paints**



There's a world of experience in **HARDMANS OLEO-RESINOUS VARNISHES** — no wonder they are specified by leading U.K. and overseas paint manufacturers.

Modern plant, technical knowledge and long experience ensures close compliance with the most stringent specification.

Contact us for Oleo-Resinous Varnishes manufactured to your own confidential specifications or to our own formulations.

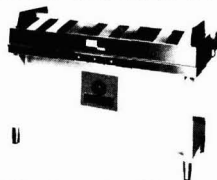
Remember Hardmans — the independent varnish specialists.

**HARDMANS  
VARNISHES**

*Specialist Varnish makers to the paint and printing ink industries.*

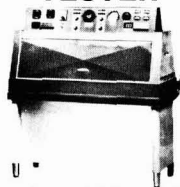
E. Hardman, Son & Co. Ltd.,  
Bedford Street, Hull HU8 8AX, England.  
Tel: 0482 - 23901

## CONDENSATION TESTER



The **QCT** Condensation Tester tests finishes for resistance to moisture in the form of rain and dew. The QCT's unique condensation system gives faster, more realistic tests than conventional humidity, while maintaining foolproof control of water purity, oxygen saturation, and test temperature. Initial cost is quite low, and maintenance is almost nil. Ordinary tap water may be used, because the QCT distills the water in the process of transporting it to the test surface. Test severity can be varied widely by regulating the temperature.

## ACCELERATED WEATHERING TESTER



The **QUV** Accelerated Weathering Tester has replaced conventional methods of durability testing in hundreds of labs throughout the world. The QUV simulates rain and dew by the same mechanism as our QCT Condensation Tester. The effects of sunlight are simulated by an array of 8 special fluorescent lamps. Light emission is concentrated in the critical UV wavelengths, providing closer control and faster testing. Users report excellent correlation with outdoors.

Initial cost and operating costs are surprisingly low compared to carbon arc or xenon arc machines. Electrical consumption is just 700 watts. Operation is completely automatic, with a wide variety of temperatures and cycles easily programmed. Scheduled maintenance is just 15 minutes once a month.

## TEST PANELS

The **Q Panel Co.** is the world's largest manufacturer of steel and aluminium panels for paint testing. Millions of Q Panels are used every year because of their consistently high surface quality and remarkably low price. Q Panels are available in a variety of sizes and finishes.

## THE Q-PANEL CO.

15610 Industrial Pkwy. • Cleveland, Ohio 44135 U.S.A.  
Phone (216) 267-9200



# JOURNAL of the OIL AND COLOUR CHEMISTS' ASSOCIATION

Hon. Editor: D. S. Newton, AMCT,  
CGIA, FICorrT, FIMF, FTSC

*Publications Committee:*

J. Ambury  
T. A. Banfield, PhD, DIC, ARCS,  
FInst.CorrT, FTSC  
H. I. Bosman, BComm, FTSC  
J. Bourne, FTSC  
T. Entwistle, CChem, FRIC, FTSC  
A. W. Fell, BSc, AMCT, ATSC  
C. N. Finlay, ATSC  
P. A. J. Gate, BSc, ARIC, FTSC  
H. R. Hamburg, PhD, FTSC  
T. Harbottle  
T. J. S. Henning  
A. MacDonald, ATSC  
W. MacDonald  
D. V. Maltman  
P. McCrudden  
D. J. Morris  
B. E. Myatt  
A. J. Newbould, BSc, MRIC  
D. Pountain  
F. D. Robinson, BSc, ATSC  
T. W. Slinn, BSc, FTSC  
D. F. Smith  
F. M. Smith, BSc, PhD, CChem, FRIC,  
CCol, FSDC, MIOP, FTSC  
J. R. Taylor, BSc, CChem, FRIC, FTSC  
F. B. Windsor, ATSC

Editorial correspondence should be  
addressed to the Hon. Editor, *JOCCA*,  
Oil and Colour Chemists' Association  
at the address below.

General correspondence should be  
addressed to:

R. H. Hamblin, MA, FCIS,  
Director and Secretary,  
Oil and Colour Chemists' Association  
at the address below.

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

Assistant Editor: D. N. Buddes, BSc

Annual subscription to non-members:  
£40.00 (\$100), post free by surface mail,  
payable in advance.

Single copies £4.00 (\$10), post free by  
surface mail, payable in advance.

© Copyright 1980

**Contents**

**Vol. 63 No. 7**

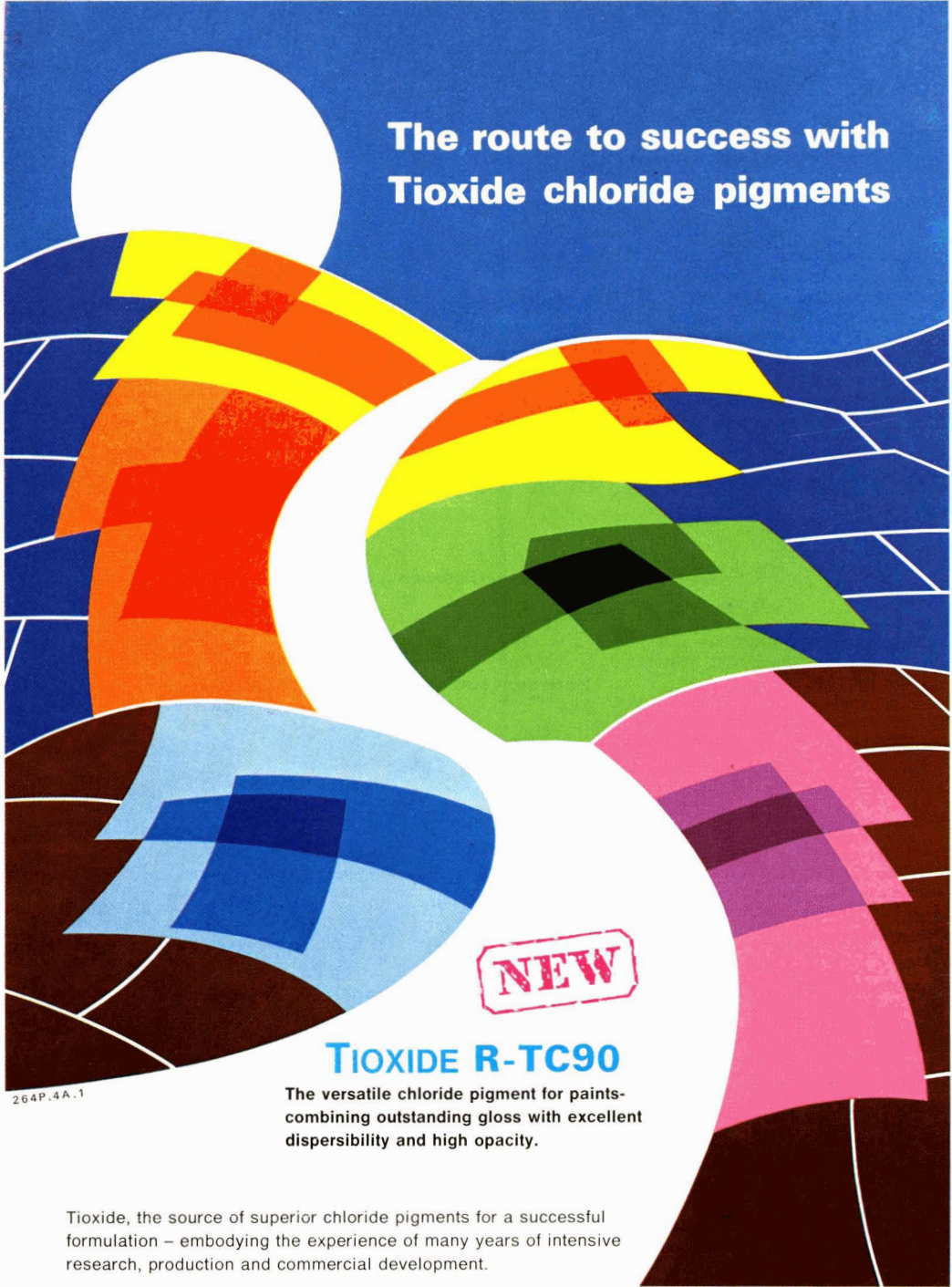
**July 1980**

*Transactions and Communications*

<b>Solubility parameter values of hydroxy polymers through its components and chemical group contribution technique</b> . . . . .	263
<i>H. Ahmad</i>	
<b>An overhanging beam method for measuring internal stress in coatings</b> . . . . .	271
<i>S. G. Croll</i>	
<b>A comparative investigation of stains for wood</b> . . . . .	276
<i>S. Dombey and B. Stangroom</i>	
<b>Hazards of static electricity in workclothing</b> . . . . .	287
<i>R. Verschave and R. Firmin</i>	
<i>Reviews</i> . . . . .	290
<i>OCCA Meetings</i> . . . . .	290
<i>News</i> . . . . .	291
<i>OCCA News</i> . . . . .	294
<i>New members</i> . . . . .	297
<b>OCCA - 32 Exhibition Review</b> . . . . .	298

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

*The Honorary Editor, the Council and the Oil and Colour Chemists' Association do not accept responsibility for opinions expressed by correspondents or contributors to this Journal. The contents of the Journal are copyright and permission to reproduce Transactions and Communications, in full or in part, must first be obtained from the Honorary Editor*



## The route to success with Tioxide chloride pigments

**NEW**

### TIOXIDE R-TC90

The versatile chloride pigment for paints—combining outstanding gloss with excellent dispersibility and high opacity.

Tioxide, the source of superior chloride pigments for a successful formulation – embodying the experience of many years of intensive research, production and commercial development.

**Tioxide**  
TITANIUM PIGMENTS

U.K. SALES: **BTP TIOXIDE LIMITED** · BILLINGHAM · CLEVELAND TS23 1PS · ENGLAND · Tel: 0642 561144  
INTERNATIONAL SALES: **TIOXIDE INTERNATIONAL LTD** · 10 STRATTON ST. LONDON W1A 4XP · ENGLAND · Tel: 01-499 6070

# Solubility parameter values of hydroxy polymers through its components and chemical group contribution technique

By H. Ahmad

Material Science & Technology Centre, Polymer Science & Materials, Indian Institute of Technology, Delhi, New Delhi 110029, India.

## Summary

A chemical group contribution technique based on the principle of the additivity of molar polarisibility, molar refraction and  $E_h$  constants of any group present in a molecule has been used to determine the dispersion, polar and hydrogen bonding solubility parameter values, i.e.,  $\delta_d$ ,  $\delta_p$  and  $\delta_h$ . The overall solubility parameter values were obtained by taking the square root of the sum of the squares of the above components [ $\delta = (\delta_d^2 + \delta_p^2 +$

$\delta_h^2)^{1/2}$ ]. The  $\delta$  values are generally found to decrease with the increase in molar volume. The cohesive packing around central carbon atoms lowers its cohesive energy and is responsible for the low values of  $\delta$ . It has been observed that  $\delta_{Br} > \delta_{Cl}$ , this is because the electro-negativity of the halogens lies in the order  $Cl > Br > I$ . Results show that the calculated  $\delta$  values are fairly comparable with those practically determined.

## Keywords

Miscellaneous terms

internal cohesive energy

Properties, characteristics and conditions primarily associated with

materials in general

solubility parameter

## La détermination des valeurs des paramètres de solubilité de polymères hydroxylés, au moyens de la technique de la contribution de ses constituants et des groupements chimiques

### Résumé

Afin de déterminer les valeurs des paramètres de solubilité de dispersion, de liaison polaire ou d'hydrogène, c'est-à-dire,  $\delta_d$ ,  $\delta_p$  et  $\delta_h$ , on a utilisé une technique de contribution du groupement chimique, basée sur le principe de l'additivité de la polarisibilité molaire, de la refraction molaire et des constantes  $E_h$  de chaque groupement qui est présent dans le molécule. On a obtenu les valeurs globales des paramètres de solubilité à l'aide de la racine carrée de la somme des carrés des constituants mentionnés

dessus, [ $\delta = (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2}$ ]. On a trouvé qu'en général, les valeurs se diminuent en fonction de l'accroissement du volume molaire. Le tassement centripète autour des atomes de carbone diminue l'énergie cohésive et provoque la faible valeur de  $\delta$ . On a noté que  $\delta_{Br} > \delta_{Cl}$ , ce qui est dû à l'électronégativité des halogènes. Celle-ci les range dans l'ordre  $Cl > Br > I$ . Les résultats montrent que les valeurs calculées sont assez comparables avec celles que l'on déterminées a dans la pratique.

## Die Bestimmung der Löslichkeitsparameterwerte von Hydroxypolymeren durch die Beitragstechnik ihrer Bestandteile und chemischen Gruppen

### Zusammenfassung

Man hat eine Technik von chemischem Gruppenbeiträge gebraucht, die auf dem Begriff der Additivität der Molarpolarisierbarkeit, der Molarbrechung, und der  $E_h$  Konstante jener im Molekül anwesenden Gruppe gegründet wird, um die Dispergier-Polar-, und Wasserstoffsbindungs-löslichkeitsparameterwerke zu bestimmen, d.h.,  $\delta_d$ ,  $\delta_p$  und  $\delta_h$ . Die Gesamtwerte der Löslichkeitsparameter werden durch die Quadratwurzel der Summe der Quadrate von den vorliegenden

Bestandteile erhalten [ $\delta = (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2}$ ]. Im allgemeinen, findet man dass die  $\delta$ -Werte sich vermindern je nachdem das Molarvolumen sich vergrößern. Die innerliche Packung ringsum der zentralen Kohlenstoffatome vermindert die Kohäsivenergie, und den schwachen  $\delta$ -Wert verursacht. Es wurde betrachtet dass  $\delta_{Br} > \delta_{Cl}$ , denn die Elektronegativität der Halogen liegt in der Reihe  $Cl > Br > I$ . Die resultate zeigen dass die kalkulierten  $\delta$ -Werte ziemlich vergleichbar mit den praktischen Bestimmten sind.

## Introduction

Refs. 1-7

The concept of solubility parameter based on the theory of regular solution is used quite extensively for assessing the miscibility of polymeric materials in individual solvents and their blends. A knowledge of solubility parameter and other physical characteristics such as hydrogen bonding, polarity, molar volumes wettability etc., of different types of materials saves time and effort in determining their miscibility. Solubility parameter being directly related to basic

and molecular properties of a substance, has been the subject of study by several workers<sup>1-3</sup>. A number of mathematical expressions have been derived for the calculation of solubility parameters for low molecular weight substances<sup>1,2,4</sup>. These expressions are not usable in the case of polymers, as the data on physical constants, i.e. boiling point, molar volume, heat of vaporisation, Van der Waal's and critical constants, compressibility factor, surface tension etc., required for the calculation of solubility parameters are not available.

The process of dissolution of a polymer in a solvent

depends mainly on the heat of mixing which is negligible when the cohesive energy densities of the polymer and solvent are almost equal. The free energy of mixing  $\Delta F_m$  of the polymer solvent system can be expressed as:

$$\Delta F_m = \Delta H_m - T\Delta S_m \dots\dots\dots (1)$$

and  $\Delta H_m = V_m [(E_1/V_1)^{\dagger} - (E_2/V_2)^{\dagger}] \phi_1 \phi_2 \dots (2)$

$$= V_m [\delta_1 - \delta_2] \phi_1 \phi_2 \dots\dots\dots (3)$$

where

- $\Delta H_m$  = the heat of mixing
- $\Delta S_m$  = the entropy of mixing and is always positive
- $V_m$  = total volume of the two components
- $V_1, V_2$  = their molar volumes
- $E_1, E_2$  = their cohesive energy
- $\phi_1, \phi_2$  = their volume fractions
- $\delta_1, \delta_2$  = their solubility parameters

In systems where the long chains of the polymer uncoil in the course of dissolution, it results in high  $\Delta S_m$  values, which in turn favours a negative  $\Delta F_m$  values. If the heat of mixing  $\Delta H_m$  is not greater than  $T\Delta S_m$ , dissolution of polymer in the solvent is possible. In the other case where the heat of mixing is very low ( $\delta_1 \approx \delta_2$ ), the miscibility of two components is assured, but the extent of dissolution is governed by the entropy factor,  $\Delta S_m$ .

This theory has been developed for the mixing of non-polar substances. However, many of the solvents and polymers in common use are polar, i.e. they have dipole moments and/or capabilities for hydrogen bonding. Hence, these factors must be included in the theory.

Pransnitz *et al.*<sup>5,6</sup> separated the energy of vaporisation into dispersion, non-polar and polar parts. They were able to calculate a non-polar solubility parameter and polar solubility parameter. Hansen<sup>7</sup>, divided the polar part into a dipole-dipole contribution and hydrogen bonding contribution, both of which could be determined by solubility experiments.

According to Hansen<sup>7</sup>:

$$\delta^2 = \delta_d^2 + \delta_p^2 + \delta_h^2 \dots\dots\dots (4)$$

- where,  $\delta_d$  = solubility parameter due to dispersion forces
- $\delta_p$  = solubility parameter due to polar forces
- $\delta_h$  = solubility parameter due to hydrogen bonding forces.

These three components are separately related to the refractive index, dipole moment and the energy of hydrogen bonding  $E_h$ .

**Relation between Refractive index,  $n$  and  $\delta_d$**

*Refs. 8, 9*

A relation between the cohesive energy and the index of refraction was first given by Sewell<sup>8</sup>. He showed that the interaction energy between non-polar molecules is dependent on polarisability (London-dispersion forces). The polarisability can, on the other hand, be described by the Lorentz-Lorentz equation:

$$4/3 \pi N/V \alpha = \frac{n^2-1}{n^2+2} \dots\dots\dots (5)$$

where  $N$  = number of molecules in one mole  
 $\alpha$  = is the polarisability/molecule

using the separation of CED into three components, a relationship between  $\delta_d$  and  $n$  would be expected even for polar substances in which the interference of polar and hydrogen bonding forces has vanished. Koenhen and Smolders<sup>9</sup> gave a relationship between  $\delta_d$  and  $n$  applicable for polar substances:

$$\delta_d = 9.55n - 5.55 \dots\dots\dots (6)$$

For non-absorbing media, the additive property correlating optical-refraction with chemical structure is called molar refraction.

According to Lorentz & Lorentz, the molar refraction,  $R_{LL}$  is given as:

$$R_{LL} = \frac{n^2 - 1}{n^2 + 2} \frac{M}{d} = \frac{n^2-1}{n^2+2} V_m \dots\dots\dots (7)$$

and

$$n = \left( \frac{1+2R_{LL}/V_m}{1-R_{LL}/V_m} \right)^{\dagger} \dots\dots\dots (8)$$

**Relationship between dipole moment  $\mu$  and  $\delta_p$**

*Refs. 9-12*

Bearbower<sup>10</sup> proposed a very simple and empirical relationship for the determination of  $\delta_p$ :

$$\delta_p = A \frac{\mu}{V_m^{\dagger}} \dots\dots\dots (9)$$

where,  $\mu$  = dipole moment  
 $A$  = a constant and is equal to 9.5, as proposed by Koenhen & Smolder<sup>9</sup>

hence,  $\delta_p = 9.5 \frac{\mu}{V_m^{\dagger}} \dots\dots\dots (10)$

It is possible to evaluate dipole moments from the Debye equation<sup>11,12</sup>

$$P_{LL} - R_{LL} = \left( \frac{\epsilon-1}{\epsilon+2} - \frac{n^2-1}{n^2+2} \right) V_m = 4/9 \pi N \frac{\mu^2}{KT} = 20.6 \mu^2 \dots\dots\dots (11)$$

$$\text{or } \mu = \left( \frac{P_{LL} - R_{LL}}{20.6} \right)^{\dagger} \dots\dots\dots (12)$$

where

- $K$  = Boltzman's constant
- $T$  = Absolute temperature
- $\epsilon$  = Dielectric constant
- $N$  = Avogadro's number
- $P_{LL} = \frac{\epsilon-1}{\epsilon+2} V_m$  is called the molar polarisability.

The values of group contribution for  $P_{LL}$  and  $R_{LL}$  are available in the literature<sup>12</sup>.



**Relationship between  $E_h$  and  $\delta_h$**

Ref. 9

Different hydrogen bonded compounds possess different and constant values of  $E_h$ . The following relationship was used to evaluate  $\delta_h$ :

$$\delta_h = (E_h/V_m)^{1/2} \dots \dots \dots (13)$$

The values of  $E_h$  due to different groups are available in the literature<sup>9</sup>.

The aim of this paper is to evaluate  $\delta$  values for polyhydroxy alkyl acrylate and methacrylates, poly hydroxy alkyl acrylamide and methacrylamides, as well as polyols and polyhydroxy ethers as determined by its components and the group contribution technique. These polymers impart improved solidity and water impermeability to the soil. The other applications include polymers useful in photography and printing processes, cement additives, synthetic latex foams and rocket fuel propellant binders.

**Materials**

Refs. 12-14

The formulae of the monomers, taken from the book *Functional Monomers*<sup>13</sup>, were rewritten in the form of polymer repeating units of the corresponding polymers for calculating their solubility parameter values.

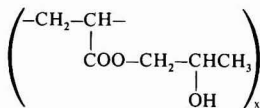
**Procedure**

Refs. 12, 14

The values of refractive index  $n$  and dipole moment  $\mu$  were calculated from the molar refraction  $R_{LL}$  and molar polarisability  $P_{LL}$  their values for the individual chemical groups are reported in the literature<sup>12</sup>. The molar volume<sup>14</sup> of the polymer was calculated by adding the contributions of atoms and bonds present in a single polymer repeating unit. The following three examples illustrate the method of calculation of  $V, n, \mu, \delta_d, \delta_p$  and  $\delta_h$ .

**Example 1**

Poly 2-hydroxypropyl acrylate



The molar volume  $V_m$  of this polymer at 25°C is calculated as follows<sup>14</sup>:

Atoms and Bonds	Molar Volume
6(C)	11.10
10(H)	65.90
3(O)	23.10
1(=)	8.94
(Polymer Repeating Unit, PRU)	2.97
	112.01

The evaluation of  $R_{LL}, n, P_{LL}$  and  $\mu$  are given below:

Groups	$R_{LL}$	$n = \left( \frac{1+2R_{LL}/V_m}{1-R_{LL}/V_m} \right)^{1/2}$	$P_{LL}$	$\mu = \left( \frac{P_{LL}-R_{LL}}{20.6} \right)^{1/2}$
1(CH <sub>3</sub> -)	5.64		5.64	
2(-CH <sub>2</sub> -)	9.30		9.30	
2(-CH <sub>2</sub> <sup>2</sup> -)	7.24	1.700	7.24	0.880
1(OH-)Sec.	2.47		6.00	
1(-COO-)	6.21		15.00	
	27.24		43.18	

Using equation (6), (10) and (13), the following values were obtained:

$$\delta_d = 9.55n - 5.55 = 9.55 \times 1.700 - 5.55 = 10.68 \text{ (Cal/cc)}^{1/2}$$

$$\delta_p = \frac{9.5\mu}{\sqrt{V_m}} = \frac{9.5 \times 0.880}{10.58} = 0.79 \text{ (Cal/cc)}^{1/2}$$

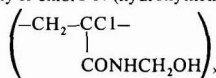
$$\delta_h = \left( \frac{E_{\text{COO}} + E_{\text{OH}}}{V_m} \right)^{1/2} = \left( \frac{1250 + 5000}{112.01} \right)^{1/2} = 7.47 \text{ (Cal/cc)}^{1/2}$$

The total value of  $\delta$  is:

$$\delta = \left( \delta_d^2 + \delta_p^2 + \delta_h^2 \right) = 13.07 \text{ (Cal/cc)}^{1/2}$$

**Example 2**

Poly  $\alpha$ -chloro-N-(hydroxymethyl) acrylamide)



The molar volume  $V_m$  of the above polymer at 25°C is:

Atoms and Bonds	Molar Volume
4(C)	7.40
6(H)	39.54
2(O)	15.40
1(=)	8.94
1(Cl)	20.92
1(N)	4.82
PRU	2.97
	99.99

The values of  $R_{LL}, n, P_{LL}$  and  $\mu$  are:

Groups	$R_{LL}$	$n = \left( \frac{1+2R_{LL}/V_m}{1-R_{LL}/V_m} \right)^{1/2}$	$P_{LL}$	$\mu = \left( \frac{P_{LL}-R_{LL}}{20.6} \right)^{1/2}$
2(-CH <sub>2</sub> -)	9.30		9.30	
1(-C-)	2.58		2.58	
1(-CONH-)	7.23	1.855	30.00	1.203
1(OH-)Primary	2.55		6.00	
1(Cl-)	5.93		9.50	
	27.59		57.38	

Using equations (6), (9) and (13):

$$\delta_d = 9.55n - 5.55 \\ = 12.17$$

$$\delta_p = \frac{9.5\mu}{\sqrt{V_m}} \\ = 1.14$$

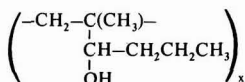
$$\delta_h = \frac{\sqrt{E_{OH} + E_{CONH} + E_{Cl}}}{V_m} \\ = 9.49$$

The total  $\delta$  value of this polymer is:

$$\delta = (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2} \\ = 15.48$$

### Example 3

Poly 2-methyl-1-hexene-3-ol.



The  $V_m$ ,  $R_{LL}$ ,  $n$ ,  $P_{LL}$ ,  $\mu$ ,  $\delta_d$ ,  $\delta_p$ ,  $\delta_h$  and  $\delta$  of this polymer are given below:

Atoms and Bonds		Molar volume	
7(C)		12.95	
14(H)		92.26	
1(O)		7.70	
PRU		2.97	
		115.88	
Groups	$R_{LL}$	$n = \left( \frac{1+2R_{LL}/V_m}{1-R_{LL}/V_m} \right)^{1/2}$	$P_{LL} \mu = \left( \frac{P_{LL}-R_{LL}}{20.6} \right)^{1/2}$
2(CH <sub>2</sub> -)	11.28		11.28
3(-CH <sub>2</sub> -)	13.95		13.95
1(-CH-)	3.62	1.951	3.62
1(-C-)	2.58		3.58
1(OH) Sec.	2.46		6.00

$$\delta_d = 13.08$$

$$\delta_p = 0.37$$

$$\delta_h = 6.57$$

$$\delta = (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2} = 14.64$$

### Results

The  $-\text{CON} \leftarrow$  group is common to a few of the polyacrylamides and methacrylamides, but the value of its molar polarisability  $P_{LL}$  has not been reported in the literature. Hence, the value of the  $P_{LL}$  constant due to the  $-\text{CON} \leftarrow$  group was calculated in order that the contributions due to other groups reported in the literature could be used for determining the total value of  $P_{LL}$  for polyacrylamides and methacrylamides.

Therefore, the following relationship:

$$P_{LL} - \text{CON} \leftarrow = \frac{\epsilon - 1}{\epsilon + 2} V_m - \sum^{x-1} P_{LL} \dots \dots \dots (14)$$

has been used for calculating the contribution due to  $P_{LL} - \text{CON} \leftarrow$ . Here  $\sum^{x-1} P_{LL}$  is the total contributions (reported in the literature) due to all groups present in the molecule except the  $-\text{CON} \leftarrow$  group. The dielectric constants for a large number of polymers were calculated by Maxwells relationship (i.e.  $\epsilon = n^2$ ) and the total molar polarisability by the following equation

$$P_{LL} = \frac{\epsilon - 1}{\epsilon + 2} V_m \dots \dots \dots (15)$$

The values of the  $P_{LL} - \text{CON} \leftarrow$  constant for individual polymers were calculated by substituting the values of  $\sum^{x-1} P_{LL}$  and  $\frac{\epsilon - 1}{\epsilon + 2} V_m$  in equation (14). The mean average value of contributions due to the  $P_{LL} - \text{CON} \leftarrow$  calculated is 26.57 and this has been used for calculating dipole moments and  $\delta_p$ .

### Discussion

Refs. 12, 14-16

For the purpose of establishing the applicability of the additive group contribution technique for the determination of refractive index, dipole moment and ultimately the dispersion, polar and hydrogen bonding solubility parameters, as well as the square root of the sum of the squares of these components  $[(\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2} = \delta]$ , i.e. the total solubility parameter values evaluated and compared with the practically determined ones. The results listed in Table 1 (columns 8 and 9), indicate that the difference between the calculated and experimentally determined solubility parameter values for a polymer is fairly small in most of the cases. However, the  $\delta$  values obtained from such calculations depend greatly on the accuracy of the value of the contribution of the individual groups, atoms and bonds reported in the literature<sup>12,14</sup>. Not many practical methods are available for the determination of solubility parameter values for polymers and the methods proposed by Small<sup>15</sup> and others<sup>3,12</sup> are not applicable to strongly hydrogen bonded compounds. Hence, it was thought worthwhile to evaluate the components of  $\delta$  by the group contribution technique. Earlier, a slightly different technique had been used for calculating solubility parameter values of low and high molecular weight compounds<sup>16</sup>.

In Tables 2-4, polymers are listed according to the increasing size of the constituent groups in them, hence they become arranged in the increasing order of their molar volumes. A scrutiny of the data reveals that a decrease in  $\delta$  values is observed with an increase in molar volume. As the size of the polymer repeating unit increases the values of both  $V_m$  and cohesive energy also increase. But the decrease in  $\delta$  values indicates that the increase in  $V_m$  and cohesive energy are not in exact proportion.

The  $\delta$  values of poly 2-hydroxyethyl methacrylate is higher than that of the poly 2-hydroxyethyl acrylate. The introduction of methyl groups into the first compound raises its  $\delta_d$  value and reduces  $\delta_p$  and  $\delta_h$  values (Table 2). The increase of  $\delta_d$  is such that it predominates over the other two components i.e.  $\delta_p$  and  $\delta_h$ . Hence the total value is higher in the case of methacrylate than in the case of acrylates. A similar phenomenon is also noticed in

Table 1  
Solubility parameters of polymers and their comparison with experimental values reported in the literature (Cal/cc)<sup>h</sup>

Name of the polymer	Molar volume $V_m$	Refractive index $n$	Dipole moment $\mu$	Components of solubility parameter			Solubility parameter $\delta = (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2}$	$\delta$ —Reported in the literature <sup>17</sup>
				$\delta_d$	$\delta_p$	$\delta_h$		
1 Poly vinyl acetate	74.25	1.454	0.653	8.34	0.72	4.10	9.32	9.40(C)
2 Poly methyl acrylate	74.25	1.454	0.653	8.34	0.72	4.10	9.32	10.1(C) 10.1(V)
3 Poly ethyl acrylate	89.28	1.460	0.664	8.39	0.67	3.74	9.21	9.40(C) 9.40(V)
4 Poly butyl acrylate	119.34	1.409	0.642	7.90	0.56	3.24	8.56	8.76(C) 8.80(V)
5 Poly methyl methacrylate	89.28	1.466	0.653	8.45	0.66	3.74	9.26	9.10(C) 9.50(C) 9.10(V) 9.40(V)
6 Poly ethyl methacrylate	104.31	1.476	0.653	8.55	0.61	3.46	9.24	8.95(C)
7 Poly butyl methacrylate	134.37	1.488	0.653	8.66	0.61	3.05	9.20	8.75(C)
8 Poly ethylene	33.03	1.466	—	8.45	—	—	8.45	7.90(C)
9 Poly styrene	99.66	1.593	—	9.66	—	—	9.66	8.60(V) 9.10(V) 9.10(C)

Note: (C) = experimentally determined from the maximum swelling of crystalline or crosslinked polymer  
(V) = experimentally determined from the maximum intrinsic viscosity.

Table 2  
Solubility parameters of poly hydroxyalkyl acrylates and poly hydroxyalkyl methacrylates (Cal/cc)<sup>h</sup>

Name of the polymer (1)	Molar volume $V_m$ (2)	Refractive index $n$ (3)	Dipole moment $\mu$ (4)	Components of Solubility parameter			Solubility Parameter $\delta = (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2}$ (8)
				$\delta_d$ (5)	$\delta_p$ (6)	$\delta_h$ (7)	
1 Poly 2-hydroxy ethyl acrylate	96.98	1.845	0.776	12.07	0.74	8.03	14.52
2 Poly 2-hydroxy-1-methyl ethyl acrylate	112.02	1.862	0.782	12.22	0.69	7.47	14.34
3 Poly 2-hydroxy propyl acrylate	112.01	1.700	0.892	10.68	0.79	7.47	13.07
4 Poly 3-hydroxy propyl acrylate	112.01	1.850	0.782	12.12	0.69	7.47	14.25
5 Poly 4-hydroxy butyl acrylate	127.04	1.882	0.782	12.42	0.65	7.01	14.28
6 Poly 2-hydroxy butyl acrylate	127.04	1.877	0.752	12.38	0.63	7.01	14.24
7 Poly 5-hydroxy pentyl acrylate	142.07	1.861	0.843	12.22	0.66	6.63	13.92
8 Poly 6-hydroxy hexyl acrylate	157.10	1.910	0.782	12.68	0.58	6.30	14.18
9 Poly 7-hydroxy heptyl acrylate	172.13	1.927	0.843	12.85	0.60	6.03	14.21
10 Poly 2,3-dihydroxy propyl acrylate	119.71	1.829	0.888	11.92	0.76	9.69	14.75
11 Poly 3-chloro-2-hydroxy propyl acrylate	126.24	1.904	0.888	12.63	0.74	7.58	14.75
12 Poly diethylene glycol acrylate	137.74	1.861	0.888	12.22	0.72	7.10	14.15
13 Poly 2-hydroxyethyl methacrylate	112.01	1.861	0.782	12.69	0.69	7.44	14.73
14 Poly 3-hydroxypropyl methacrylate	127.04	1.861	0.782	12.69	0.65	7.01	14.51
15 Poly 2-hydroxy propyl methacrylate	127.04	1.877	0.784	12.38	0.65	7.01	14.24
16 Poly 4-hydroxy butyl methacrylate	142.04	1.899	0.782	12.59	0.62	6.63	14.24
17 Poly 2-hydroxy butyl methacrylate	142.04						
18 Poly 5-hydroxy pentyl methacrylate	157.10	1.910	0.782	12.69	0.58	6.31	14.18
19 Poly 6-hydroxy hexyl methacrylate	172.13	1.921	0.782	12.80	0.56	6.03	14.16
20 Poly 7-hydroxy heptyl methacrylate	187.16	1.933	0.784	12.91	0.54	5.78	14.16
21 Poly 2,3-dihydroxy propyl methacrylate	134.74	1.850	0.789	12.12	0.72	9.14	15.19
22 Poly 3,4-dihydroxy butyl methacrylate	149.77	1.675	0.888	10.45	0.68	8.67	13.60
23 Poly 4,5-dihydroxy pentyl methacrylate	157.10	1.910	0.782	12.69	0.58	6.31	14.18
24 Poly 5,6-dihydroxy hexyl methacrylate	179.83	1.899	0.886	12.59	0.62	7.91	14.86
25 Poly 1,3-dimethyl-3-hydroxy butyl methacrylate	172.13	1.916	0.785	12.75	0.56	6.03	14.12
26 Poly 3-chloro-2-hydroxy propyl methacrylate	141.37	1.819	0.888	11.82	0.70	6.70	13.61

methacrylamides and acrylamide compounds (Table 3).

In some cases, it has been observed that the values of solubility parameters are equal to each other for polymers

having equal molar volumes, but belonging to different types (Table 3, polymers: 5 and 6; 24 and 25; Table 4: polymers 9 and 10, 11 and 12, 13 and 14; 16, 17, 18; 38 and 39 etc.). There are also cases where the polymers have

Table 3  
Solubility parameters of poly hydroxy alkyl acrylamides and polyhydroxy methacrylamides (Cal/cc)<sup>h</sup>

Name of the polymer (1)	Molar volume $V_m$ (2)	Refractive index $n$ (3)	Dipole moment $\mu$ (4)	Components of Solubility parameter			Solubility Parameter $= (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2}$ (8)
				$\delta_d$ (5)	$\delta_p$ (6)	$\delta_h$ (7)	
1 Poly N-hydroxy methyl acrylamide	85.96	1.799	1.128	11.63	1.16	10.18	15.50
2 Poly N-(2-hydroxy ethyl) acrylamide	100.69	1.834	1.128	11.96	1.07	9.40	15.04
3 Poly N-(1-hydroxy ethyl) acrylamide	100.69	1.789	1.130	11.53	1.07	9.40	14.92
4 Poly N-methyl-N-(2-hydroxyethyl) acrylamide	115.65	1.916	1.049	12.75	0.93	8.77	15.50
5 Poly N-(1-ethyl-2-hydroxyethyl) acrylamide	130.75	1.882	1.128	12.42	0.94	8.25	14.91
6 Poly N-(1,1-dimethyl-2-hydroxyethyl) acrylamide	130.75	1.877	1.128	12.38	0.94	8.25	14.91
7 Poly N-propyl-N-(2-hydroxyethyl)acrylamide	145.78	1.939	1.049	12.97	0.83	7.81	15.16
8 Poly N-(1,1-dimethyl-3-hydroxybutyl) acrylamide	160.81	1.904	1.130	12.63	0.85	7.44	14.68
9 Poly N-(1-hexyl-2-hydroxy-1-methylethyl) acrylamide	205.90	1.939	1.128	12.97	0.75	6.57	14.57
10 Poly N-cyclohexyl-N-(2-hydroxypropyl) acrylamide	195.07	2.000	1.369	13.55	0.93	6.75	15.17
11 Poly N-(hydroxyethyl)-N-(hydroxymethyl) acrylamide	123.35	1.882	1.126	12.42	0.96	10.62	16.37
12 Poly N-(2,3-dihydroxypropyl)acrylamide	123.35	1.834	1.202	11.96	1.03	10.62	15.83
13 Poly N-[1,1-bis(hydroxymethyl)ethyl] acrylamide	130.75	1.945	1.200	13.02	0.98	10.31	16.64
14 Poly N,N-bis(hydroxyethyl)acrylamide	138.75	1.899	1.126	12.59	0.91	10.02	16.12
15 Poly N-[2-hydroxy-1,1-bis(hydroxymethyl)] acrylamide	130.75	2.018	1.268	13.72	1.05	12.02	18.27
16 Poly $\alpha$ -chloro-N-(hydroxymethyl) acrylamide	99.99	1.855	1.203	12.17	1.14	9.49	15.48
17 Poly N-(2,2,2-trichloro-1-hydroxyethyl) acrylamide	143.68	1.850	1.275	12.12	1.01	8.00	14.56
18 Poly $\alpha$ -bromo-N-(hydroxymethyl) acrylamide	105.26	1.945	0.984	13.03	0.91	9.19	15.97
19 Poly diacetone acrylamide	157.57	1.804	1.171	11.68	0.87	—	11.72
20 Poly N-(hydroxymethyl) methacrylamide	100.69	1.834	1.128	11.96	1.07	9.40	15.25
21 Poly N-(2-hydroxyethyl) methacrylamide	115.65	1.861	1.128	12.22	0.97	8.77	15.07
22 Poly N-(2-hydroxy-2-methyl ethyl) methacrylamide	130.75	1.963	1.128	13.20	0.94	8.25	16.32
23 Poly N-methyl-N-(2-hydroxyethyl) methacrylamide	130.75	1.927	1.047	12.85	0.87	8.25	15.30
24 Poly N-(1-ethyl-2-hydroxyethyl) methacrylamide	145.78	1.893	1.128	12.53	0.89	7.81	15.03
25 Poly N-(1,1-dimethyl-2-hydroxyethyl) methacrylamide	145.78	1.893	1.128	12.53	0.89	7.81	15.03
26 Poly N-(1,1-dimethyl-3-hydroxypropyl) methacrylamide	160.81	1.904	1.128	12.63	0.85	7.44	14.68
27 Poly N-[1-(hydroxy methyl) cyclohexyl] methacrylamide	180.04	1.993	1.428	12.91	1.01	7.03	14.73
28 Poly N-(1,1-dimethyl-3-hydroxybutyl) methacrylamide	182.04	1.855	1.130	12.17	0.80	6.98	14.05
29 Poly N-(2-hydroxyethyl)-N- (hydroxymethyl) methacrylamide	138.45	1.899	1.126	12.59	0.91	10.02	16.12
30 Poly N-(2,3-dihydroxypropyl) methacrylamide	138.45	1.850	1.202	12.12	0.97	10.02	15.76
31 Poly N-[1,1-bis(hydroxymethyl)ethyl] methacrylamide	152.48	1.882	1.198	12.42	0.92	9.55	16.50
32 Poly N,N-bis(hydroxyethyl) methacrylamide	152.48	1.921	1.126	12.80	0.87	9.55	15.99
33 Poly N-[2-hydroxy-1,1-bis(hydroxymethyl) ethyl] methacrylamide	161.18	1.850	1.268	12.12	0.95	10.83	14.25
34 Poly N-(3-hydroxyphenyl) methacrylamide	152.22	2.126	1.379	14.75	1.06	7.69	16.67
35 Poly N-benzyl-N-(2-hydroxyethyl) methacrylamide	170.56	2.520	1.126	18.55	0.82	7.26	19.94
36 Poly N-phenyl-N-(2-hydroxyethyl) methacrylamide	221.89	1.779	1.042	11.44	0.66	6.39	13.12
37 Poly N-(2,2,2-trichloro-1-hydroxyethyl) methacrylamide	158.71	1.871	1.275	12.32	0.96	7.61	14.51
38 Poly N-cyclohexyl-N-(2-hydroxyethyl) methacrylamide	194.07	2.012	1.367	13.66	0.93	6.77	15.27



Table 4  
Solubility parameters of poly ols and poly hydroxy ethers (Cal/cc)

Names of the polymers (1)	Molar volume $V_m$ (2)	Refractive index $n$ (3)	Dipole moment $\mu$ (4)	Components of Solubility parameter			Solubility Parameter $= (\delta_d^2 + \delta_p^2 + \delta_h^2)^{1/2}$ (8)
				$\delta_d$ (5)	$\delta_p$ (6)	$\delta_h$ (7)	
1 Poly allyl alcohols	55.79	1.866	0.409	12.27	0.52	9.47	15.51
2 Poly 1-butene-4-ol	70.79	1.927	0.409	12.85	0.46	8.40	15.36
3 Poly 1-pentene-3-ol	85.82	1.819	0.415	11.82	0.43	7.63	14.08
4 Poly 1-pentene-4-ol	85.82	1.921	0.415	12.80	0.43	7.63	14.91
5 Poly 1-pentene-5-ol	85.82	1.905	0.409	12.64	0.42	7.63	14.77
6 Poly 1-hexene-3-ol	100.85	1.939	0.415	12.97	0.39	7.04	14.76
7 Poly 1-octene-3-ol	130.91	1.963	0.415	13.20	0.34	6.18	14.58
8 Poly 2-methyl-2-propene-1-ol	70.79	1.899	0.409	12.59	0.46	8.40	15.14
9 Poly 2-ethyl-1-propene-3-ol	85.82	1.927	0.409	12.85	0.42	7.63	14.95
10 Poly 2-methyl-1-butene-4-ol	85.82	1.927	0.409	12.85	0.42	7.63	14.95
11 Poly 3-methyl-1-butene-3-ol	85.82	1.916	0.417	12.75	0.43	7.63	14.86
12 Poly 2-methyl-1-butene-3-ol	85.82	1.916	0.415	12.75	0.43	7.63	14.86
13 Poly 3-methyl-1-pentene-3-ol	100.85	1.933	0.415	13.48	0.39	7.04	14.71
14 Poly 2-methyl-1-pentene-4-ol	100.85	1.933	0.415	12.91	0.39	7.04	14.71
15 Poly 3-methyl-1-pentene-4-ol	100.85	1.939	0.415	12.85	0.39	7.04	14.70
16 Poly 2-ethyl-1-pentene-3-ol	115.85	1.951	0.415	13.08	0.37	6.59	14.64
17 Poly 2-methyl-1-hexene-3-ol	115.88	1.951	0.415	13.08	0.37	6.57	14.64
18 Poly 4-methyl-1-hexene-4-ol	115.88	1.951	0.415	13.08	0.37	6.57	14.64
19 Poly 1-nonyl-2-pentene-1-ol	191.03	1.993	0.415	13.48	0.29	5.12	14.42
20 Poly 2,3-dimethyl-1-pentene-3-ol	115.85	1.945	0.415	13.02	0.37	6.57	14.59
21 Poly 3,5-dimethyl-1-hexene-3-ol	124.32	2.051	0.415	14.04	0.35	6.34	15.41
22 Poly 3,4-dimethyl-1-hexene-4-ol	130.91	1.963	0.415	13.20	0.35	6.18	14.58
23 Poly 2,4-dimethyl-1-hexene-4-ol	130.91	1.850	0.415	12.12	0.35	6.18	13.61
24 Poly 2-chloroallyl alcohol	70.09	1.939	0.584	12.97	0.66	8.53	15.54
25 Poly 2-bromoallyl alcohol	75.36	2.071	0.297	14.23	0.33	8.15	16.40
26 Poly 1-chloro-3-butene-1-ol	85.12	1.963	0.583	13.20	0.60	7.74	15.31
27 Poly 2-chloro-3-butene-1-ol	85.12	1.957	0.416	13.14	0.43	7.74	15.26
28 Poly 1-phenyl-2-propene-1-ol	122.39	2.112	0.415	14.62	0.36	6.39	15.96
29 Poly 2-hydroxyethyl vinyl ether	78.49	1.866	0.583	12.27	0.63	8.40	14.88
30 Poly allyl-2-hydroxy ether	93.52	1.893	0.583	12.53	0.57	7.70	14.72
31 Poly 4-hydroxy butyl vinyl ether	108.55	1.916	0.583	12.75	0.53	7.15	14.63
32 Poly 3-hydroxybutyl vinyl ether	108.55	1.904	0.583	12.63	0.54	7.15	14.52
33 Poly allyl-2-hydroxy propyl ether	108.55	1.695	0.587	10.64	0.54	7.15	12.83
34 Poly allyl-1-methyl-2-hydroxy ethyl ether	108.55	1.910	0.583	12.69	0.53	7.15	14.58
35 Poly allyl-1-hydroxy methyl-2-hydroxy ethyl ether	116.25	1.882	0.713	12.42	0.63	9.53	15.67
36 Poly allyl-2,3-dehydroxy propyl ether	116.25	1.877	0.716	12.38	0.63	9.53	15.64
37 Poly 3-chloro-2-hydroxy propyl ether	122.88	1.945	0.720	13.02	0.62	6.78	14.69
38 Poly allyl-2-hydroxy-1-phenylethyl ether	160.15	2.112	0.583	14.62	0.44	5.94	15.79
39 Poly allyl-2-hydroxy-2-phenyl ethyl ether	160.15	2.112	0.586	14.62	0.44	5.94	15.79

equal molar volumes, but their  $\delta$  values are not the same (Table 2: polymers: 2, 3 and 4; 5 and 6; 14 and 15; Table 3: polymers: 2 and 3; 11 and 12; 13 and 14; 22 and 23; 29 and 30; 31, 32 and 34; Table 4: polymers: 3, 4 and 5; 22 and 23; 26 and 27; 31, 32, 33 and 34; 35 and 36 etc.). The reason for having the same values of solubility parameters for polymers which have equal molar volumes is that the groups in their polymer repeating units are identical, and the total contributions of the groups to any one of the constants, i.e.  $n$ ,  $\mu$  and  $E_s$  is also the same. Consequently, the  $\delta$  values for such polymers calculated from these constants will be equal to each other. The polymers which have equal molar volumes but different  $\delta$  values, have the same number of atoms and bonds in their repeating unit. Therefore, their molar volumes are equal but the nature of groups present in these units are different, hence the values for individual polymers differ from each other.

The solubility parameter  $\delta$  of  $\alpha$ -bromo-N-(hydroxymethyl)acrylamide is greater than the  $\delta$  value of  $\alpha$ -chloro-N-(hydroxymethyl)acrylamide. (Table 3 compounds 16, 18.) This is because the electronegativity of these com-

pounds is in the following order: Cl > Br > I. The more electro negative the substituent halide group, the less is the value of  $\delta$ . The solubility parameter  $\delta$  of the poly N-(2,2,2-trichloro-1-hydroxyethyl)acrylamide is lower than that of the poly  $\alpha$ -chloro-N-(hydroxymethyl)acrylamide. This is because the chlorine present in the first compound is in triplicate whilst in the latter case it is present as a single atom, hence it causes lowering in  $\delta_d$ ,  $\delta_p$ ,  $\delta_h$  and ultimately the overall  $\delta$  value.

The solubility parameters  $\delta$  of Bis-polymers (Table 2, polymers: 13, 14 and 15; 31, 32 and 33) lie in the range 15-18 which are slightly higher than the  $\delta$  values of the common polyacrylamides and polymethacrylamides. This may be because the bis-hydroxy polymers contain additional double OH groups and the presence of these bulky groups in the repeating units of the polymer is responsible for the increased steric hindrance, and hence  $\delta$  values of such polymers are higher.

The accumulation of groups around the central carbon atom lowers the  $\delta$  value of these polymers (Table 2,

polymers: 3 and 4; 5 and 6; Table 3, polymers: 2 and 3; Table 4, polymers: 3 and 4; 10 and 12; 31 and 32 etc.). This is because packing round a carbon atom lowers its cohesive energy<sup>15</sup> and is responsible for the low value of  $\delta$ .

[Received 26 March 1980

### References

1. Hildebrand, J. H. and Scott, R. L., "The solubility of Non-Electrolytes", *Reinhold Publishing Corpn.*, 1949, New York.
2. Burrell, H., *Official Digest*, 1955, **27**, 726.
3. Hoy, K. L., *J. Paint Technol.*, 1970, **42**, 76.
4. Ahmad, H. and Yaseen, M., *J. Colour Soc.*, 1974, **13**, 7.
5. Blanks, R. F. and Pransnitz, J. M., *Ind. Eng. Chem. Fundam.*, 1964, **3**, 1.
6. Weiner, R. F. and Pransnitz, J. M., *Hydrocarbon Process Petrol Refiner*, 1965, **44**, 237.
7. Hansen, C. M. and Skaarup, K., *J. Paint Technol.*, 1967, **39**, 511.
8. Sewell, J. H., *R.A.E. Technical Report* No. 66185, June 1966.
9. Koenhen, D. M. and Smolders, C. A., *J. Appl. Polym. Sci.*, 1975, **19**, 1163.
10. Beerbower, A. and Dicky, J. R., *A.S.L.E. Trans.* 1969, **12**, 1.
11. Debye, P., *Phys. Z.* 1912, **13**, 97.
12. Van Krevelen, D. W. and Hoftyzer, P. J., "Properties of Polymers Correlation with Chemical structures", *Elsevier Publishing Company*, 1972, Amsterdam.
13. Nyquist, E. B., "Functional Monomers", Vol. 1, *Ed. Yocum and Nyquist, Marcel Dekker*, 1973, New York.
14. Sewell, J. H., *J. Appl. Polym. Sci.* 1973, **17**, 1741.
15. Small, P. A., *J. Appl. Chem.* 1953, **3**, 71.
16. Ahmad, H. and Yaseen, M., *JOCCA*, 1977, **60**, 99, *ibid.* 1977, **60**, 488.  
*Paint Manuf.* 1978, **28**.  
"Polymer Engineering and Science", 1979, **19**, 858.  
*J. Coatings Tech.* 1978, **50**, 86.
17. Gardon, J. L., *J. Paint Technol.* 1966, **38**, 43.

# An overhanging beam method for measuring internal stress in coatings

By S. G. Croll\*

National Research Council of Canada, Division of Building Research, Ottawa K1A 0R6, Canada

## Summary

The internal stress in polystyrene and polyisobutyl methacrylate lacquers was measured by coating a thin steel substrate on one side and measuring its bending as the coating dried. The substrate was supported simply at two points, so calculated that the deflection at the centre of its span was independent of weight changes in the coating, where the bending displacement was due only to stress in the coating. Internal stress proved to be large

and independent of dried coating thickness and initial solution concentration and the results obtained agreed well with internal strain data obtained previously. The simply supported overhanging beam configuration used here seems to be more accurate than a cantilever arrangement, where the constraints imposed by the end clamp result in values for internal stress that are too low.

## Keywords

*Equipment primarily associated with analysis, measurement or testing*

overhanging beam balance

*Miscellaneous terms*

stress

*Properties, characteristics and conditions primarily associated with*

dried or cured films

shrinkage

*Types and classes of coatings and allied products*

clear coating  
lacquer

*Raw materials for coatings binders (resins etc)*

methacrylate resin  
polystyrene resin

*solvents*

toluene

## Une méthode utilisant une lame en portique pour mesurer la tension au sein des revêtements

### Résumé

On a déterminé la tension au sein des vernis à base de polystyrène ou de méthacrylate de polyisobutyle en les appliquant à une face de minces supports en acier et en mesurant la déformation du support lors du séchage du revêtement. Le support était soutenu simplement à deux endroits, dont l'emplacement avait été calculé de façon que la flèche au centre de la portée était indépendante des changements de poids du revêtement, et où la déflexion était due seulement aux con-

traintes au sein du revêtement. La tension se montrait importante et indépendante de l'épaisseur du revêtement sec et aussi de la concentration initiale de la solution. Les résultats étaient en accord avec les données sur la tension que l'on a obtenues antérieurement. Le système d'une lame en portique simplement soutenue, que l'on a utilisé au cours de cette étude paraît plus précis qu'une configuration en cantilever, où les contraintes imposées par la crampon au bout rendent les trop faibles valeurs de la tension.

## Eine Oberbalkensmethode zur Bestimmung der Innenspannung in Beschichtungen

### Zusammenfassung

Bei der Ausbiegungsmessung eines dünnen Stahlsubstrats während des Trockens einer Beschichtung, wurde die Innenspannung von Polysyrol und Polyisobutylmethakrylatlacken bestimmt. Das Substrat war an zwei Stellen unterstützt, damit die Ausbiegung an dem mittelpunkt der Spannweite unabhängig von der Gewichtsänderungen der Beschichtung war, und der Ausbiegungsgrad kam ausschliesslich von der Beanspruchung her. Die Innenspannung zeigte sich wichtig und unabhängig von

der Dicke der trockenen Beschichtungen und von der Anfangskonzentration. Die erhaltenen Ergebnisse standen in guten Übereinstimmung mit den Innenspannungsdaten, die früher erhalten sein worden. Das einfach unterstützte Oberbalkensgebilde, das man hier benutzte, scheint genager zu sein, als eine freitragende Einrichtung, wo die von einer Endklammer geschafften Zwänge, Innenspannungswerte zur Folge haben, die zu schwach sind.

### Introduction

Refs. 1-7

Internal stress, or strain, has been measured for a variety of coatings and, in many cases, has proven to be large<sup>1,2</sup>. High stresses or strains can reduce the adhesion of a coating considerably and even promote spontaneous peeling or flaking<sup>3</sup>. In some instances the coatings may crack under the influence of internal stress<sup>4</sup>. Thus, it is

desirable to determine the presence, magnitude and origin of such stresses.

Measurement of internal stress is usually made by observing the bending of a thin metallic plate coated on one side only. As the film dries and tries to shrink, it bends the plate. The plate can be either clamped at one end, like a cantilever, or supported on knife edges. Use of the knife-edge support method has one intrinsic advantage over the cantilever clamping arrangement<sup>4</sup>. Clamping is thought to

\*Present address 53 Turpins Way, Baldock, Herts. SG7 6LW

influence the way in which the cantilever bends. One end of the substrate plate is kept flat, whereas the coating attempts to shrink in all directions and should bend the substrate plate both ways, across and along its length. Supporting the plate on knife-edges does not impose any constraint on the bending.

In addition, most films are applied either from solution or suspension; in both cases there is considerable weight loss during drying. If the substrate plate is oriented so that its plane is horizontal, the loss in weight will produce a deflection due to the action of gravity, which cannot be separated continuously from the deflection due to the increasing internal stress. One can allow for it by weighing the coating wet and dry and making appropriate corrections. An alternative is to use the cantilever arrangement with the plane of the plate and coating vertical. The wet coating would be prone to sagging however, and produce an uneven thickness which renders analysis of the data very difficult. This paper presents a configuration of the knife-edge support method that is completely insensitive to weight changes in the coating so that deflection of the plate is entirely due to the bending produced by the internal stress in the coating. Thus, analysis of the data is simpler and it is not necessary to weigh the film to determine solvent loss.

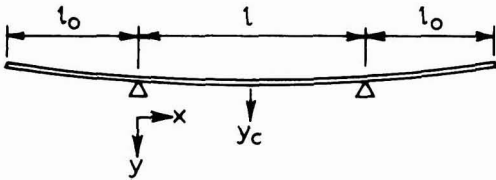


Figure 1. Diagram for overhanging beam analysis

**Theory**

The principle behind the configuration suggested here (Figure 1) is that the weight loss from the overhanging parts of the beam should provide a moment that opposes the upward deflection of the beam in the centre span due to weight loss there. Lengths  $l$  and  $l_0$  can be chosen so that the deflection in the centre of the span, due to weight loss, is zero.

**Weight change on a simply supported overhanging beam**

The coating on top of the plate is responsible for a downward force/length, corresponding to its weight, constant along the length of the beam ( $2l_0 + l$ ). If that force is  $\omega$  ( $\text{Nm}^{-1}$ ) then the bending moment,  $M$ , at the supports as given by Morley<sup>5</sup> is:

$$M = \frac{\omega l_0^2}{2} \dots \dots \dots (1)$$

For a simply supported beam, e.g., on knife-edges, with a uniformly distributed load:

$$\omega = EI \frac{d^4y}{dx^4} \dots \dots \dots (2)$$

where  $E$  = modulus of elasticity of the beam material  
 $I$  = moment of inertia of the area of the cross-section of the beam about its neutral axis.

$y, x$  = Cartesian co-ordinates, as in Figure 1 (the origin lies at the left-hand support).

In practical situations the coating is much thinner than the substrate and its modulus is about two orders of magnitude less. Its effect on the bending of the composite beam, therefore, is assumed negligible for this calculation. The deflection,  $y$ , of the beam can be found by integrating Equation (2):

$$EI \frac{d^2y}{dx^2} = \frac{\omega x^2}{2} + Ax + B \dots \dots \dots (3)$$

$A$  and  $B$  are constants of integration which can be determined at this stage by applying the boundary conditions<sup>5</sup>. When  $x = 0$  and  $l$ :

$$EI \frac{d^2y}{dx^2} = M = \left( \frac{\omega l_0^2}{2} \right) \dots \dots \dots (4)$$

Thus  $B = M$  and  $A = -\frac{\omega l}{2}$ .

Integrating Equation (3) further, the expression for the deflection is given by:

$$EIy = \frac{\omega x^4}{24} - \frac{\omega l}{2} \cdot \frac{x^3}{6} + \frac{Mx^2}{2} + Cx + D \dots \dots (5)$$

Now the integration constants  $C$  and  $D$  must be determined. At  $x = 0$  the deflection  $y = 0$ , as at  $x = l$ .

Thus  $D = 0$  and

$$C = \frac{\omega l^3}{24} - \frac{Ml}{2} \dots \dots \dots (6)$$

The deflection at the centre of the span,  $y_c$ , can now be written out substituting Equations (6) and (1) in (5), i.e., at  $x = l/2$ :

$$EIy_c = \frac{\omega l^2}{16} \left( \frac{5l^2}{24} - l_0^2 \right) \dots \dots \dots (7)$$

If this deflection is to be insensitive to changes in weight, i.e.,  $dy_c/d\omega = 0$ , then it follows from Equation (7) that:

$$l_0^2 = \frac{5l^2}{24} \dots \dots \dots (8a)$$

or

$$l_0 = 0.4564l \dots \dots \dots (8b)$$

Therefore, if the ratio of the overhanging length,  $l_0$ , to the span,  $l$ , is chosen according to Equation (8b), the deflection of the beam at the middle of the span caused by internal stress will not change if the weight changes. A similar arrangement has been used before<sup>6</sup> but the appropriate overhang,  $l_0$ , was assumed to be half the span length and not 45.6 per cent as indicated by the full analysis presented here.

**Calculation of internal stress**

The displacement of the substrate,  $d$ , as it bends allows the equivalent bending radius,  $r$ , to be calculated:



$$r = \frac{l^2}{8y_c} \dots\dots\dots (9)$$

where  $l$  = length of the span, as in Figure 1  
 $y_c$  = deflection measured at the centre of the span.  
 Internal stress,  $\sigma$ , can then be calculated<sup>7</sup> using:

$$\sigma = \frac{Et^3}{6t_c r(t+t_c)(1-\nu)} \dots\dots\dots (10)$$

where  $E$  = Young's Modulus of the substrate.  
 $t$  = thickness of the substrate.  
 $t_c$  = coating thickness.  
 $\nu$  = Poisson's ratio for the substrate.

The expression for  $\sigma$  does not require knowledge of the mechanical properties of the coating. A full analysis of this experiment shows that there should be additional terms to Equation (10) involving the properties of the coating. In general, the extra terms are negligible<sup>7</sup> under normal conditions where  $t \gg t_c$  and the modulus of the coating is two or more orders of magnitude less than that of the substrate (usually steel). The bending of the substrate is caused by the stress in the coating but the response of the beam is dominated by the metallic substrate.

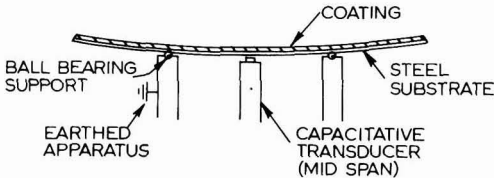


Figure 2. Schematic of the apparatus for measuring internal stress

**Experimental**

Refs. 3, 5

All the experiments were conducted in a room maintained at 23°C (±1°C) and 50 per cent RH (±2 per cent). The coatings investigated were polystyrene, PS (Dow Styron 685), and polyisobutyl methacrylate, PIBM (Elvacite 2045), cast from solutions in reagent grade toluene. Results were obtained using a variety of coating solution concentrations.

**Internal stress**

The apparatus used to measure the internal stress is drawn schematically in Figure 2. A non-contacting capacitive transducer system (Wayne Kerr Dimeq TE200, fsd 200 μm, accuracy 0.5 per cent) was used to measure the displacement at the centre of the span. These transducers are very sensitive and permit the use of comparatively thick substrates that do not bend much and are easier to handle. The substrate (steel feeler gauge stock, 12.7 mm wide) was earthed (to form the other electrode of the capacitor) through the 1/16 in. ball bearings used as supports. Three ball bearings were used, two at one end of the span, in a tripod support system.

The central span length used was 50 mm; the total length of the substrate was 95.64 mm (overhang calculated by Equation 8). Use of a continuously recording strip chart to record the output from the transducers

proved necessary because deflection caused by internal stress began almost immediately.

Coating thickness was measured using an Elcometer Minitecator FN.

**Substrate Properties**

Substrate thickness was measured by micrometer. The modulus of the steel substrates varied enough to warrant measuring for each one used. If one end of the strip is clamped in place and a weight,  $F$ , is attached to the other end then the deflection,  $y$ , along the cantilever is given by Morley<sup>5</sup>:

$$y = \frac{12F}{Et^3b} \left( \frac{Lx^2}{2} - \frac{x^3}{6} \right) \dots\dots\dots (11)$$

$b$  = width of the cantilever  
 $t$  = thickness of the cantilever  
 $L$  = length of the cantilever  
 $x$  = position co-ordinate along the cantilever, zero at the clamp,  $x = L$  at the end with the weight.

All the quantities in Equation (11) can be measured, permitting  $E$  to be determined. The value of  $E$  was typically 1.9 GPa. Poisson's ratio,  $\nu$ , of the steel was taken to be 0.29.

**Results**

The final, equilibrium, value of internal stress is plotted as a function of dried coating thickness in Figure 3(a) for the PIBM coatings and 3(b) for the PS coatings. There is no discernible trend with coating thickness for either coating, over the range of thicknesses employed.

Mean value of residual stress in PIBM = 5.6 MPa  
 standard deviation = 0.3 MPa  
 Mean value of residual stress in PS = 17.28 MPa  
 standard deviation = 0.67 MPa

PS coatings thicker than 18 μm spontaneously detached<sup>3</sup> from the substrate and so could not be used to measure internal stress. Thinner coatings of PS adhered, but frequently crazed under stress, a well-known phenomenon.

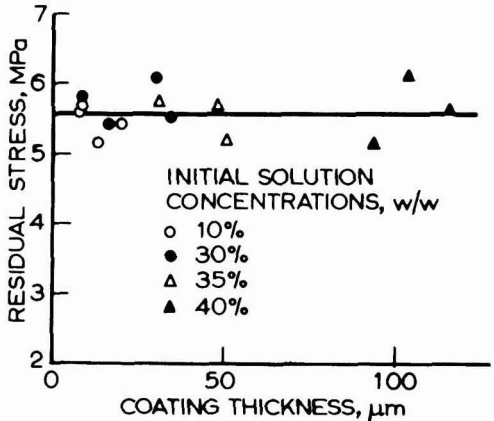


Figure 3(a). Dependence of residual internal stress on coating thickness and solution concentration in PIBM coatings

Before a coating is completely dried, the solvent content will vary with depth and thus internal stress will also vary through the coating. Consequently, deflection of the beam at intermediate times gives a value of internal stress averaged through the thickness of the coating; examples are given in Figures 4(a) and 4(b).

**Discussion**

*Refs. 3, 8*

In both lacquers the residual stress is independent of dried coating thickness and initial solution concentration over the ranges tested. The same features were present in residual strain measurements published previously<sup>8</sup>.

Additionally, the magnitudes of the residual strain ( $\epsilon$ ) and stress can be compared. Stress-strain curves obtained for both PIBM and PS coating films were used in a previous study<sup>3</sup> and are reproduced here as Figures 5(a) and 5(b). Values obtained for the residual strains<sup>8</sup> are:

$$\begin{aligned} \text{PIBM, } \epsilon &= 5.8 \times 10^{-3} (\pm 4.4 \times 10^{-4}) \\ \text{PS, } \epsilon &= 1.75 \times 10^{-2} (\pm 1 \times 10^{-3}) \end{aligned}$$

Using Figures 5(a) and 5(b), these correspond to stresses ( $\sigma'$ ) of:

$$\begin{aligned} \text{PIBM, } \sigma' &= 3.4 \text{ MPa} \\ \text{PS, } \sigma' &= 10.9 \text{ MPa} \end{aligned}$$

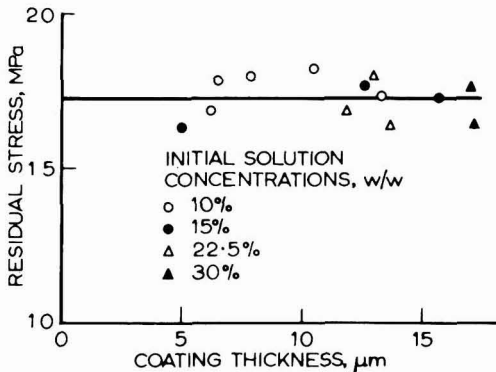


Figure 3(b). Dependence of residual internal stress on coating thickness and solution concentration in PS coatings

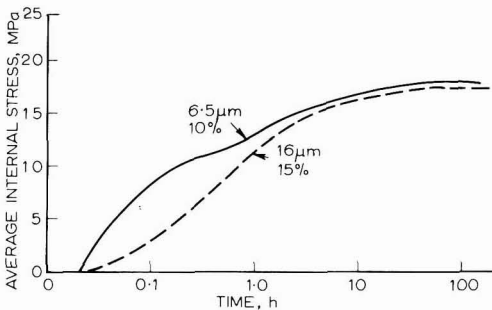


Figure 4(a). Development of internal stress in PIBM lacquers, showing initial solution concentration (% w/w) and dried coating thickness ( $\mu\text{m}$ )

Now the shrinkage in the coating is isotropic, so the film has two equal stresses or strains at right angles in the plane of the coating. In this plane stress situation

$$\sigma = \frac{E(\epsilon) \cdot \epsilon}{1-\nu} \dots\dots\dots(12a)$$

or

$$\sigma = \frac{\sigma'}{1-\nu} \dots\dots\dots(12b)$$

This adjustment is necessary because the residual strain and stress-strain curves are measured uniaxially whereas the bending plate determination of residual stress measures the combined effect of the stresses in the plane of the coating.

Poisson's ratio for the coatings has been given before<sup>8</sup> as 0.4 for PIBM and 0.39 for PS. Equation 12(b) predicts that the residual stress measured should be 5.67MPa for the PIBM and 17.9 MPa for PS. The agreement is very good between values predicted from the residual strain and the values for residual internal stress measured. Cracking in PS does not influence the agreement between experiments.

Previously, the residual stress was measured for the same two lacquers using a cantilever substrate<sup>8</sup>. Values obtained then were 4.5 MPa for PIBM and 14.3 MPa for PS, about 20 per cent low in both cases. The discrepancy is probably due to the clamping of one end of the substrate, which restricts its bending. Presumably it restricts the bending arising from the component of stress across the width of the beam.

Internal stress can be followed better as it increases with time in this type of experiment where changes in coating weight have no effect on the beam deflection. However, the experiment gives only the average value of internal stress because the coating dries at a rate that varies according to depth. This particular method seems to be more accurate and rather simpler than other, similar, methods. The coating can be horizontal, keeping its thickness even, and there is no need to weigh it to determine the deflection caused by weight change.

As in investigations carried out previously on solvent cast coatings, the residual internal stresses or strains have been shown to be considerable. For PS coatings the internal stress causes adhesive loss even in very thin coatings and is close to the maximum stress the films can bear (Figure 5), and which, in fact, often craze. Although the

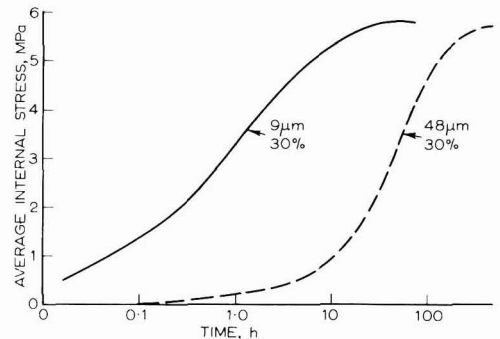


Figure 4(b). Development of internal stress in PS lacquers, showing initial solution concentration (% w/w) and dried coating thickness ( $\mu\text{m}$ )

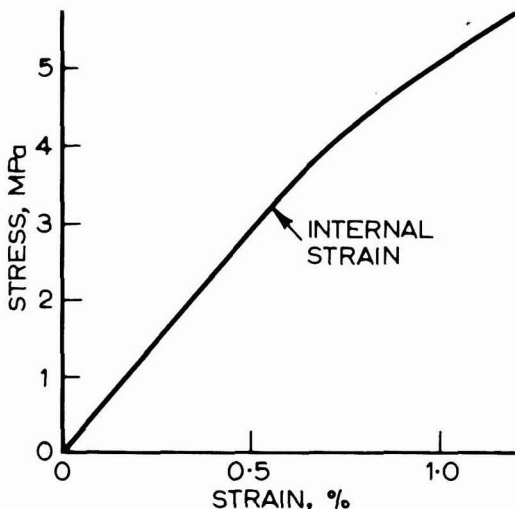


Figure 5(a). Uniaxial, relaxed stress-strain relationship for PIBM films

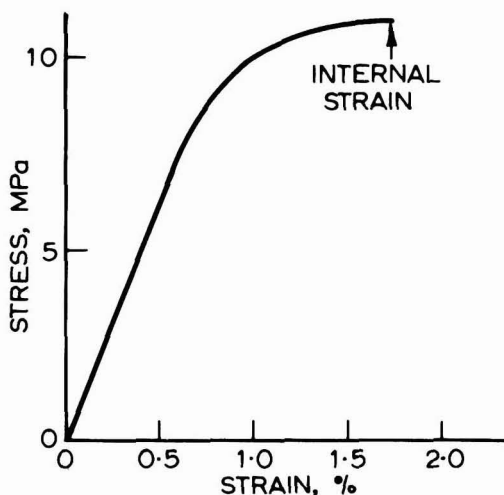


Figure 5(b). Uniaxial, relaxed stress-strain relationship for PS films

adhesion of PIBM coatings is good, and the stress much lower than for PS, the residual stress is still a significant fraction of the maximum stress the films can withstand.

### Conclusions

The overhanging beam configuration adopted here proved to be a simple and accurate apparatus for measuring internal stress in coatings. The length of the centre span and overhang can be adjusted so that there is no deflection at the centre of the span due to weight loss from the coating. Displacement of the beam substrate at that position is due solely to internal stress in the coating. The change of average internal stress with time can be monitored well because the changing weight of the coating has no influence on the measurement.

As in the case of internal strain measurements, the residual stress proved to be independent of dried coating thickness and initial solution concentration. The magnitude of the residual stress predicted from the residual strain data was in close agreement with the value obtained from the overhanging beam configuration. The two measures of the same phenomenon proved to be consistent.

Employing the substrate as a cantilever yields values for internal stress that seem about 20 per cent lower. Clamp-

ing one end probably restricts the bending deflection produced by a given stress in the coating, and hence the cantilever arrangement should be used with caution.

It can be seen, particularly with the PS lacquer, that residual stress poses a considerable threat to the cohesive and adhesive properties of such coatings.

### Acknowledgment

The author is grateful to Mr R. Myers for performing much of the experimental work described here. This paper is a contribution from the Division of Building Research, National Research Council of Canada, and is published with the approval of the Director of the Division.

[Received 30 January 1980]

### References

1. Prosser, J. L., *Mod. Paint and Coatings*, 1977, **67**(7), 47.
2. Croll, S. G., *JOCCA*, **63**(6), 230.
3. Croll, S. G., Adhesion loss due to internal strain. To be published.
4. Perera, D. Y., Private communication.
5. Morley, A., "Strength of Materials", 11th ed., Longmans, Green and Co. Ltd, 1954, London.
6. Aronson, P. D., *JOCCA*, 1974, **57**(2), 66.
7. Corcoran, E. M., *J. Paint Tech.*, 1969, **41**(538), 635.
8. Croll, S. G., *J. Coatings Tech.* 1979, **51**(648), 64.

# A comparative investigation of stains for wood

By S. Dombey and B. Stangroom

Furniture Industry Research Association, Maxwell Road, Stevenage, Herts. SG1 2EW

## Summary

An experimental investigation has been made into the comparative technical merits of a representative selection of commercially available staining agents for wood for use in the manufacture of furniture.

The selection included the traditional solvent-based type as well as some more recently developed pigments and dyestuffs for application in aqueous systems. Some of the stains were acquired from commercial suppliers in the ready-for-use form, others were obtained as sets of four primary colours (yellow, red, blue and black) from which appropriate blends could be made by mixing as required.

## Keywords

*Types and classes of coatings and allied products*

*wood stain*

*Types and classes of structures or surfaces to be coated*

*furniture  
wood  
veneer*

The properties to be evaluated comparatively included light-fastness, stability towards acidic and "oxidative" wood finishes, adsorption to and retention by, a substrate and their overall aesthetic appeal when applied to wooden surfaces in the normal manner and covered by a conventional finish.

Possible aids to penetration of wooden substrates, applied as pre-treatment to veneered panels, were likewise investigated and so were some simple, practical ways to produce special effects in plain veneers so as to render them more decorative in appearance, such as contrast, tinting, multitone effects and end-grain staining.

*Properties, characteristics and conditions primarily associated with*

*dried or cured films*

*ultra violet resistance*

*structures or surfaces being coated*

*porosity  
wood grain  
sap wood  
heartwood  
edge grain  
roughness*

## Une étude comparative sur des colorants pour bois

### Résumé

On a fait une étude expérimentale sur les avantages comparatives sur le plan technique d'une sélection représentative de colorants pour bois qui sont disponibles sur le marché et qui sont utilisés dans la fabrication de meubles.

La sélection renfermait des types traditionnels, solubles dans des solvants organiques, et d'ailleurs des pigments et des colorants tout récemment mis au point pour application en systèmes aqueux. Certains des colorants ont été acquis sous forme prêt à l'usage chez des fournisseurs, des autres ont été obtenus en jeux de quatre couleurs primaires (jaune, rouge, bleu et noir) et à partir desquels on pourrait obtenir les mélanges appropriés aux besoins.

## Eine vergleichende Untersuchung der Holzbeizmittel

### Zusammenfassung

Eine experimentale Untersuchung wurde der vergleichenden technischen Werte von einer typischen Auswahl der zu geschäftlicher Verfügung stehenden Holzbeizmittel gemacht, die bei der Möbelfabrikation gebraucht werden. Die Auswahl umfasst die traditionellen Materialien, die löslich in organischen Lösungsmitteln sind, sowie die neuhergestellten Pigmente und Farbstoffe, die für wässrige Systemen bestimmt werden. Einige der Holzbeizmittel wurden in streichfertigen Formen von Lieferanten erhalten. Andere wurden als eine Reihe der vier Primärfarben (gelb, rot, blau, und schwarz) erhalten, worauf, man die erforderlichen passenden Gemische schaffen könnte.

Die Eigenschaften zur Bestimmung umfassten Licht-

Parmi les caractéristiques à être évaluées comparativement étaient la solidité à la lumière, la stabilité aux finitions pour bois, soit acide ou oxydative, l'aptitude à être absorbé et retenu par le substrat, l'ensemble de leur attrait esthétique, lorsqu'on les applique d'une façon normale aux surfaces en bois et l'on les couvre d'une couche de finition.

On a étudié d'une même façon les adjuvants pour aider la pénétration dans les supports en bois, en les appliquant aux panneaux de contreplaqué affiné. On a étudié également certains moyens pratiques et faciles pour produire des effets spéciaux sur des placages simples, afin de les accorder un aspect plus décoratif au point de vue de contraste, de pouvoir colorant, des effets multicolores et de coloration du bois de bout.

Beständigkeit, Stabilität gegen saure und "oxydative" Holzlacke, Fähigkeit von dem Substrat zu absorbieren und festgehalten werden, und ausserdem der ganze ästhetische Reiz wenn das Holzbeizmittel auf hölzerne Substrate normalerweise aufgetragen, und danach mit einer konventionellen Oberschicht gedeckt wird.

Eventuelle Hilfsmittel zur Imprägnierung von hölzernen Substraten werden als eine Vorbehandlung auf furnierten Sperrholz untersucht. Einige leichten und praktischen Methoden zum Schaffen der speziellen Effekten wurden auch untersucht, um ihnen einen reizenderen Anschein hinsichtlich des Kontrasts, der Färbung, der Vielfachtoneffekten, und des Hirnholzbeizens zu geben.

## Introduction

The staining of wooden furniture to enhance its

appearance by applying a colouring matter or a suitable chemical that can cause a colour change in situ has long been an established practice in the cabinet making crafts.



It is still enjoying considerable popularity today particularly in the manufacture of numerous "period" styles that, owing to the high esteem in which British-made period furniture is held overseas, have in recent years been among the important export-earning commodities.

A conventional stain or staining agent may, typically, be applied directly to the prepared surface of wood or, also quite commonly, it may be blended with a compatible lacquer. In either case the application of a colouring matter is an integral part of the finishing process and is normally considered as such. Whilst there is a vast abundance of technical literature available to the cabinet maker and polisher on wood-finishing materials and processes, in general, stains and staining techniques as distinct stages in the finishing process seem to have received insufficient treatment or even exclusion in standard manuals on finishing, in spite of their long adoption by the furniture industry.

This fact and the rapid advances made, in recent years, with water-borne dyes and pigments, as a result of the ever-growing interest in water-based finish systems, has initiated this practical study and survey on the principal types of stain currently available to the trade.

This study was confined to representative products of commercial materials, selected to include the well-known conventional types as well as some newer varieties.

The object of the investigation was to evaluate comparatively their technical and aesthetic merits according to a limited set of selected criteria described fully below. The criteria adopted involved properties that have often led to faults and other problems both in service and in production, the most common of which were the following: (a) non-uniformity (blotchiness), muddyness (grainyness), (b) volatility and migration (causing contact staining of neighbouring materials), (c) solubility in lacquers subsequently applied, (d) poor compatibility with some finishes, (e) poor light-fastness (leading to fading), (f) rejection by veneering glue sometimes through the pores in the laying of veneers under pressure, (g) more intense staining of the end-grains.

### Classification of stains and staining agents

Before a description of the materials used in this study is given, a brief reference to classification should be made.

It is inevitable that products having such a diversity of features as synthetic dyes, pigments and other chemical agents capable of changing the colour of wood may be classified in many different ways, depending on the special features or characteristics that are of particular interest to the user, supplier or manufacturer.

Some of the common features adopted as the basis for classification may be listed as follows:

(A) *In accordance with the method used to produce the final colouration of a wooden substrate, for example:*

(1) In-situ pigmentation by applying appropriate oxidising agents that convert the colourless polyphenols present in most woods into coloured derivatives.

(2) Metal complex formation involving polyhydroxy aromatic compounds, such as: tannins present in many types of wood and a suitable heavy metal salt, typically iron compounds.

(3) Chemical reaction of phenolic compounds present in the wood with other reagents, e.g. the nitrosation with nitrous acid.

(4) Contact staining by direct application of a coloured substance, i.e. dyestuff or pigment, which are normally synthetic materials. These are the most common and the most important.

(B) *Classification according to the broad chemical types of synthetic pigment or dye used, for example:*

(1) Cationic, mainly for application in solution in organic solvents.

(2) Anionic, typically sodium salts of sulphonated compounds to render them soluble in water.

(3) Metal chelates, e.g. the phthalocyanin pigments and other complexes.

(4) Interaction products of cationic and anionic dyes (salt formation).

(C) *According to polarity of solvent vehicle (medium), for example:*

(1) Non-polar; naphtha, white spirit, xylene, etc.

(2) Moderately polar; alcohols (e.g. IMS), lower esters (e.g. ethyl acetate) all of medium polarity.

(3) Highly polar; water-soluble dyes and water-dispersing pigments (polar medium).

(D) *Classification according to the phase in which the colourant is present, for example:*

(1) True solutions, normally clear to light.

(2) Colloidal solution or extremely fine dispersion (partial solution).

(3) True pigment dispersions – two distinct phases.

(E) *Classification according to the functional groups present in the colourant molecule, for example:*

(1) azo

(2) nitroso

(3) xanthene

(4) anthraquinone

(5) phthaleins

There may be other methods of classification, arbitrary or natural, to meet special needs or situations.

### Materials used for the investigation

All the materials included in this survey were standard commercial products, some of which were ready-to-use stains, commonly blends of two or more components, and a representative selection of primary colours for experimental blends to be prepared as required.

These materials will be identified by reference to the coding adopted as shown below.

Table 1  
List of types of stains used

Code	Type
1.	Insoluble pigments, comprising yellow, red, blue and black primaries for aqueous dispersions.
2.	Normal salts of anionic dyes, comprising yellow, red, blue and black primaries for aqueous solutions.
3.	Slightly soluble organic pigments, comprising yellow, red, green and black primaries for application from a limited range of organic solvents.
4.	Ready-to-apply commercial soluble aqueous stains.
5.	Ready-to-apply commercial spirit stains in industrial methylated spirits.
6.	Ready-to-apply aqueous solutions of commercial stains.
7.	Conventional naphtha stains to a "mahogany" colour.

The substrate upon which the selected properties, other than lightfastness, were studied consisted normally of conventional veneer laid on plyboard and bonded with a urea-formaldehyde glue. The resistance to fading by light was investigated on a chemically inert white filter paper, Whatman No. 1.

The veneers comprised European beech (*Fagus sylvatica*), European elm (*Ulmus procera*) and Sapele (*Entandrophragma cylindricum*) and a coat of conventional polyurethane lacquer, except when the resistance to chemically active finishes was assessed, which was normally applied following staining.

A thin layer chromatographic laminar material, Gelman Chromedia SA, was used for the investigation of the relative adsorptivities of the stains to a substrate, a neutral solvent mixture and an acidified blend of lacquer solvents were used for elution of the chromatograms.

#### Assessment of primaries for resistance to ultraviolet light

The primaries were prepared by dissolving or dispersing

commercially available dyestuffs and pigments in the concentrations recommended by the suppliers. The proportions of solids to liquids of the first three types of stain listed in Section 3 were the following:

- Fully soluble anionic dyestuffs comprising a yellow, a red, a blue and a black primary, 2 grammes of each per 100 ml of water.
- Water-dispersible pigments, comprising a yellow, a red, a blue and a black primary, 4 grammes of the yellow, 5 grammes of each of the others per 100 ml of water.
- Solvent-dispersible pigments, comprising a yellow, a red, a green and a black primary, 5 grammes of the yellow, 6 grammes of each of the others per 100 ml of butyl acetate.

The above primaries were applied individually to Whatman No. 1 filter paper by dipping in duplicates, they were then left to dry at room temperature. Half of the duplicates were mounted on 6 cm-wide strips of plywood and the test pieces so prepared were subjected to irradiation by ultraviolet light from a xenon source in a Fadeometer, at a distance of 23 cm from the source. Exposure was maintained for a continuous period of 100 hours, after which a 48-hour period of dwell-time in the shade was allowed before the changes were assessed by spectroscopic measurements. These were carried out with an abridged reflectance spectrophotometer, using the blue, green, yellow and red light filters, the peak transmission bands which correspond to the wave lengths 470nm, 520nm, 580nm and 700nm respectively.

The individual reflectance values of 60 mm diameter areas before and after the exposure and the resultant percentage changes are presented in Table 2.

The reflectance changes recorded in the vertical columns marked "d" in Table 2 are also shown in bar charts constructed for each group or primaries and are presented in Figs 1, 2 and 3.

Table 2  
Surface reflectance values of stained filter paper before and after exposure, with reference to unstained paper (reflectance = 100%)

Primary	blue filter			green filter			yellow filter			red filter		
	b	a	d	b	a	d	b	a	d	b	a	d
blank paper	100	99	-1	100	99	-1	100	99	-1	100	100	0
an Y	23	28	+22	76	76	0	99	99	0	98	100	+2
an R	10.5	22.5	+114	9.5	18	+89	21.5	34	+58	100	92.5	-7.5
an Blu	56.5	46	-19	38.5	35.5	-8	7.6	8.5	+13.5	16.5	15	-9
an Bla	8	8	0	6.5	6.5	0	5.5	6	+9	6.5	7.5	-15
aq p Y	42	41	-2.4	100	97	-3	102	100	-2	99	102	+3
aq p R	13.5	13.5	0	11	10.5	-4.5	26	25.5	-1.9	100	102	+2
aq p Blu	44	43.5	-1	22	21.5	-2.3	8	7	-12.5	11.5	11.5	0
aq p Bla	9	9	0	8.5	8	-6	8.5	8.5	0	9.5	9.5	0
bu Y	12.5	12.5	0	17	16	-6	95	92	-3	101	100	-1
bu R	9.5	9.5	0	10	9.5	-5	13.5	13.5	0	96	94.5	-1.6
bu G	22	22	0	27	26.5	-1.8	8	8.5	+6	9	9	0
bu Bla	7	7.5	+7	7	6.5	-7	7	7	0	8	8	0

Key to the symbols in the preceding table -

- b - before exposure to light in Fadeometer
- a - after exposure to light in Fadeometer
- d - percentage change in reflectance
- an - anionic dyestuffs, giving true solutions in water
- aqp - insoluble pigments, giving fine dispersions in water

- bu - butyl acetate dispersing pigment dyes
- Y - yellow dye or pigment
- R - red dye or pigment
- Blu - blue dye or pigment
- Bla - black dye or pigment
- G - green pigment

### The effect of liquid stains on the surface quality of veneer

All the products listed in Table 1 have been evaluated for their effect on the surface quality of wood in the veneer form, especially in regard to the extent to which grain-raising or fibre swelling is liable to be caused by the solvent present.

The "ready-to-apply" commercial preparations of stain were used without any modification and the other groups comprising the primaries were made up into mixtures to give conventional "mahogany" shades, the overall solid contents being kept to the levels recommended by the suppliers.

All the stains were applied by swabbing liberally on to veneered panels with a sponge, any excess being wiped off with a rag. The test panels were allowed to dry at room temperature and the roughness of the surfaces was measured indirectly with the Bendtsen porosity meter for hardboards and other porous panels. This method is based on the freedom of air flow between a polished smooth metallic surface and a porous or rough wooden or hardboard surface, the magnitude of which is shown on a flow meter. The increase in surface roughness due to the raised grain is proportional to air speed, which is shown in  $\text{cm}^3$  per minute.

Owing to the inevitable random variation in surface quality within any area of a panel, a large number of

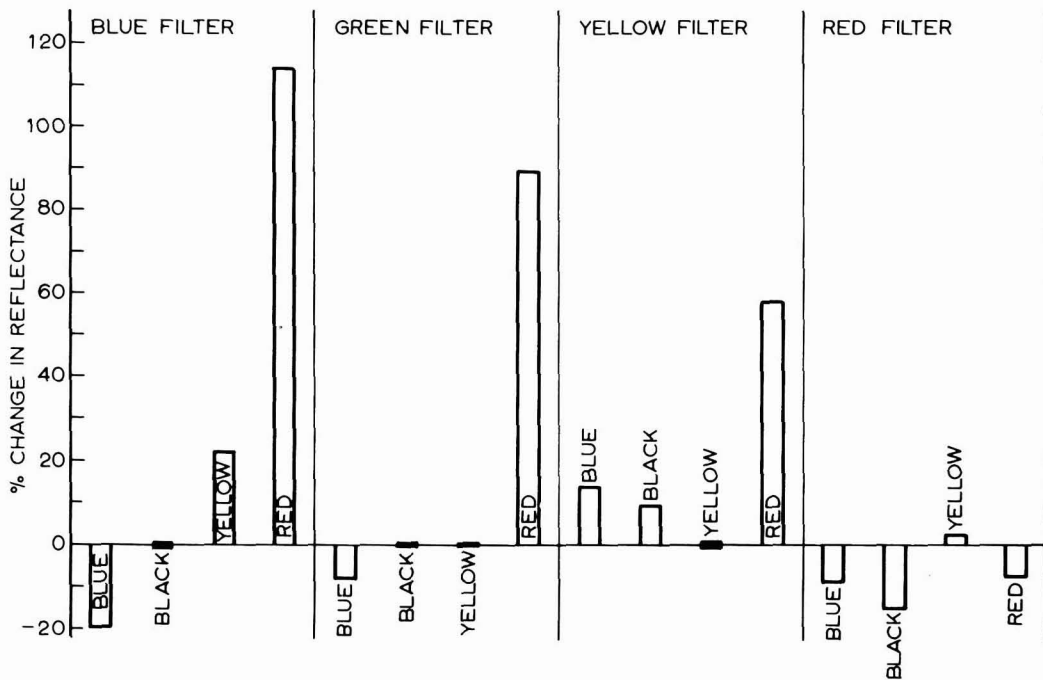


Figure 1. Primaries of water-soluble anionic dyes. Changes in reflectance of stains on filter paper following exposure to xenon light

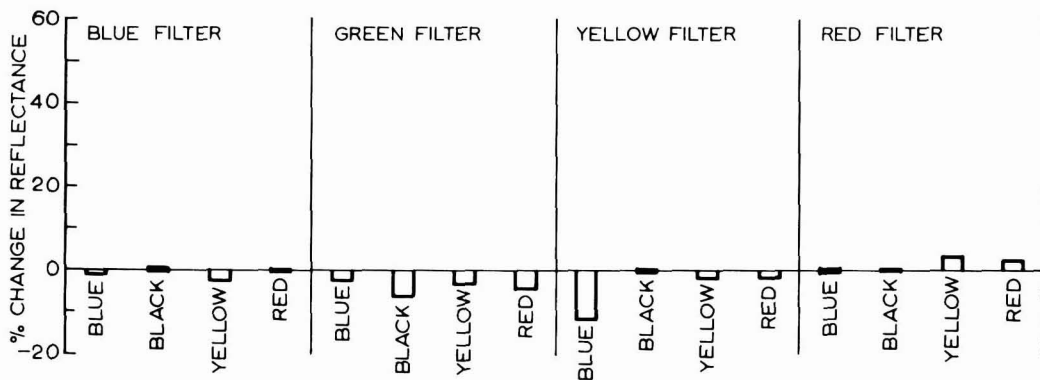


Figure 2. Primaries of water-dispersible pigments. Changes in reflectance of stains on filter paper following exposure to xenon light

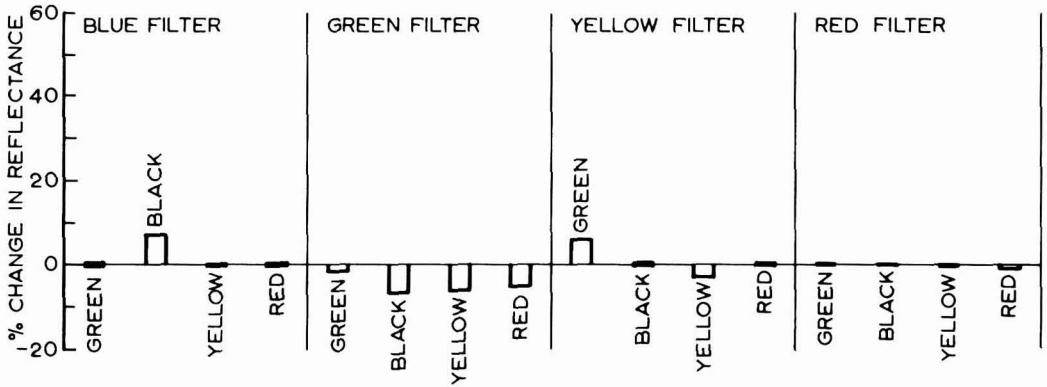


Figure 3. Primaries of butyl acetate dispersible pigments. Changes in reflectance of stains on filter paper following exposure to xenon light

Table 3  
Surface porosities of stained beech veneer, as a function of air speed in the porosity meter

Stain No.	Description	Average airflow cm <sup>2</sup> /min
—	bare wood sanded with 120 grit (used for all tests)	15
6.	commercial aqueous solution of dyes	180
5.	commercial spirit stain in industrial methylated spirits	45
1.	blend of pigments in aqueous dispersion	30
7.	commercial naphtha stain	15
3.	blend of pigment dyes dispersed in butyl acetate	10

individual readings of each test piece had to be taken to minimise statistical errors. The mean values obtained with the stains used on beech-veneered panels previously sanded with 120 grit are presented in Table 3 and are also shown by bar chart in Figure 4.

It was apparent from the above results that the most severe condition of surface roughness due to fibre raising occurred with the straight aqueous solution and the least was caused by the butyl acetate dispersion. It was noteworthy that the aqueous pigment dispersion (stain No 1) resulted in considerably less apparent grain raising than the true solution (stain No 6). This anomaly may be attributed to the insoluble pigment particles becoming deposited within the "lows" in the surface and thus partly offsetting the fibre-swelling action of water. Similar explanations would apply to the apparent reduction of surface roughness with the butyl acetate dispersed pigments (stain No 3) the solvent having no swelling action upon the fibre at all.

It was also noted with interest that moderate swelling action was caused by the industrial methylated spirits of the stain No 5.

Additional studies on grain-raising, and its practical implications on finishing of panels, are described later on in connection with the investigation of certain possible penetration promoters.

**The effect of chemically reactive lacquers on stains applied to wood**

The primary colours of the three systems (a) anionic

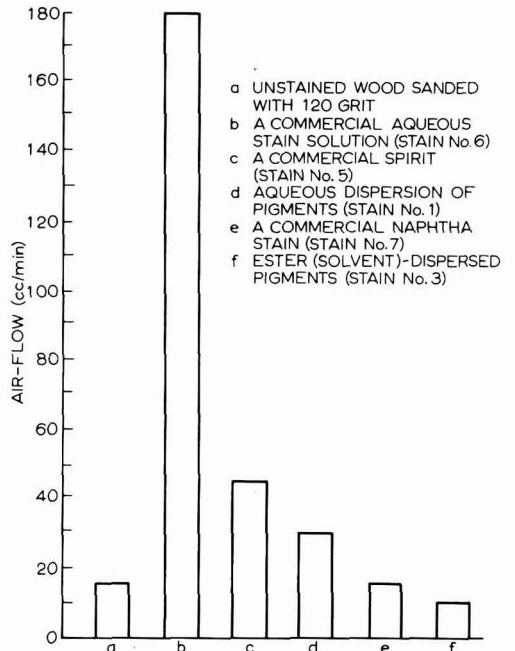


Figure 4. Changes in the surface porosity of beech veneer following application of liquid stains

Table 4  
Percentage changes of surface reflectances of lacquered beechwood,  
following staining

Primary	Blue (2)		Light filters				Red (9)	
	Acid catalysed	Nitro-catalysed	Acid catalysed	Nitro-catalysed	Acid catalysed	Nitro-catalysed	Acid catalysed	Nitro-catalysed
anY	0	+3.5	+1.3	-8.5	+2.0	-3.0	+0.7	-1.3
anR	0	+17.5	0	-5.5	-10.5	-6.5	+2.5	-1.8
an Blu	-2.0	+4.0	-4.0	-9.0	0	-6.0	0	+6.5
an Bla	+5.5	-6.0	+6.0	-14.0	+6.0	-6.5	+9.0	-5.5
aqp Y	-6.5	-2.0	-2.2	-8.5	-2.5	-9.0	-1.8	-7.0
aqp R	-3.8	-8.0	0	-4.5	0	+2.3	+2.4	-3.8
aqp Blu	0	+8.0	-3.2	+3.0	0	+6.3	+4.2	+8.0
aqp Bla	-6.0	0	-6.3	-6.3	0	+5.5	0	0
bu Y	0	+4.0	+6.0	+11.5	+4.5	-2.9	+1.2	-6.3
bu R	0	-8.5	-5.0	-10.5	0	-4.2	+2.3	-3.7
bu Blu	0	+11.6	0	+11.6	+5.5	+2.3	+5.3	+2.5
bu Bla	0	+6.0	0	0	0	+6.7	+6.0	+12.0

The descriptions are in accordance with the key given under Table 2.

water-soluble dyes, (b) water-dispersible pigments and (c) solvent-dispersible pigment were dissolved or dispersed, as appropriate, in liquids specified by the suppliers and in the concentrations suggested by them. The resultant liquids were applied to beech-veneered boards by sponges and, after being dried in the usual way, they were finished with two kinds of lacquer; a conventional nitrocellulose and a two-pack acid-catalysed urea-formaldehyde lacquer. The test panels were dried at room temperature and as soon as this was complete, i.e. before any chemical interaction with the stains was likely to occur, spectrophotometric measurements with the abridged spectrophotometer were made. The colour filters used were a blue, a green, a yellow and a red.

The test pieces were left to stand for three days at room temperature, the test panels were then subjected to heating in an oven at 90°C for two hours to hasten possible chemical reactions, then, following a 48 hour dwell time, the reflectance measurements of the surfaces were repeated.

Changes in the hues of the primaries were indicated by differences between the two sets of reflectance values and they were expressed as a percentage increase or decrease in the reflectance through each of the four filters. The results are summarised in Table 4.

The implications of the above results, shown also by bar chart (Figure 5) are discussed under Conclusions.

#### Comparative assessment of stains on wood for overall subjective appearance

The stains selected for studying the overall visual (aesthetic) quality imparted to wood were from the seven representative systems in Table 1, each being used as ready-to-apply blends to three kinds of veneered panels as shown in Table 5. The liquids were swabbed on in the usual way and all panels lacquered with a two-pack clear polyurethane lacquer. The surface qualities investigated both visually and with a low-power reflectance microscope included features such as uniformity, freedom from blotchiness, clarity and adherence to the glue in the veneer. The assessment of these effects have, owing to practical difficulties in quantifying them instrumentally, been based

purely on subjective observation and are hence necessarily descriptive, as shown in Tables 5 and 6.

The stained test panels could be ranked in descending order of quality with reference to selected features assessed subjectively as follows, the numbering of stains being the same as in Table 1.

Beech:	Stain No's
Clarity of colour:	2 > 1 > 5 > 6 > 3 > 4 = 7
Evenness of stain:	2 > 3 > 6 > 4 > 1 > 5 = 7
Contrast:	2 > 3 > 1 > 6 > 5 = 7 = 4
Overall:	2 > 3 = 4 > 1 = 6 > 5 > 7
Elm:	
Clarity of colour:	3 > 2 > 7 > 5 > 6 > 1 > 4
Evenness of stain:	3 > 2 > 1 > 4 > 6 > 7 > 5
Contrast:	3 > 2 > 7 > 6 = 4 > 5 > 1
Overall:	3 > 2 > 5 = 1 > 7 > 6 > 4
Sapele:	
Clarity of colour:	3 > 5 > 2 = 7 > 6 > 1 > 4
Evenness of stain:	2 = 3 = 1 = 6 > 7 > 5 > 4
Contrast:	3 > 7 > 5 > 2 = 6 > 1 = 4
Overall:	2 = 3 = 5 = 7 > 6 > 1 > 4

It was found by visual observation that, in general, Sapele responded to most classes of stain more readily than did the other types of wood. This relative ease of staining may be due in part to the overall uniformity of texture of this wood, its relative softness and the presence of large uniform pores that allow colouring to an aesthetically higher standard than that which could be achieved with the other types.

#### The comparative evaluation of stains for adsorbitivity to, or retention by, an adsorbent substrate

The purpose of this study was to gain information about the relative ease of migration of stains in an inert substrate. This property is directly related to the liability of the stain or its individual components to diffuse (bleed) into a wet lacquer film applied to the stained wood.



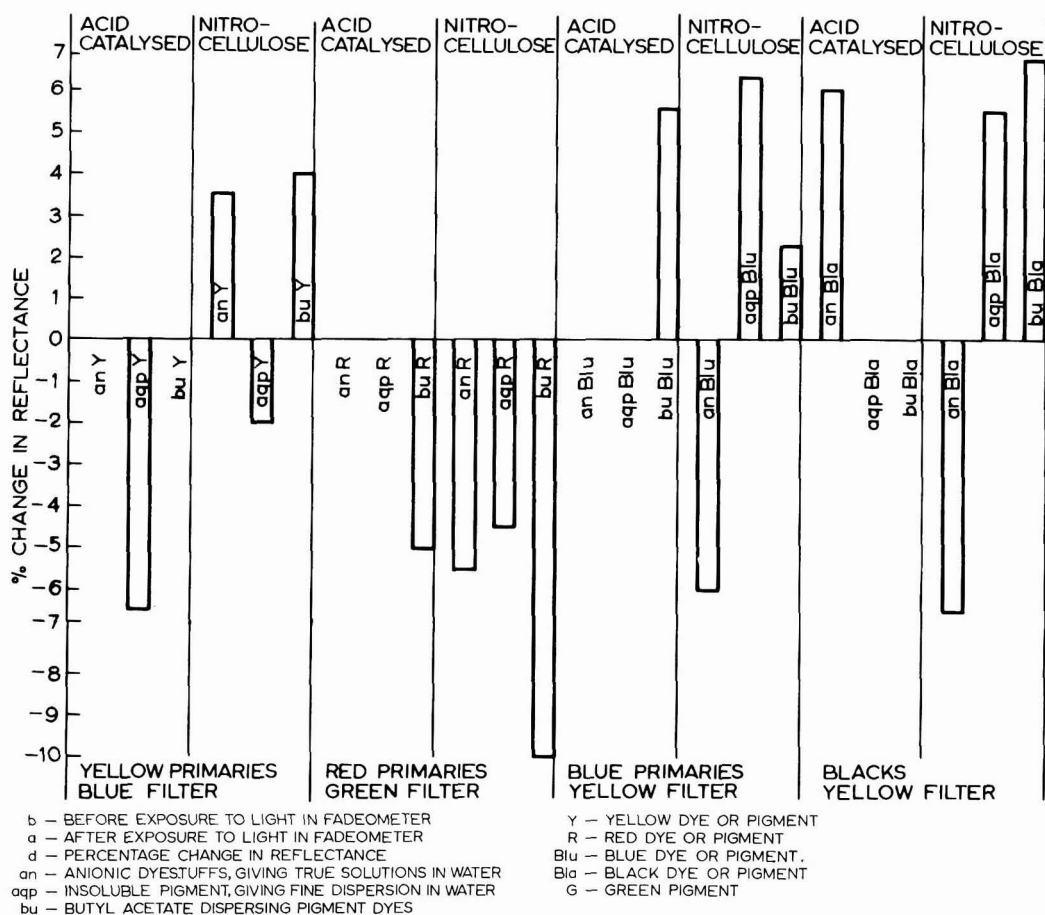


Figure 5. The effect of chemically active lacquers on stains (primaries)

Table 5

Description of colours produced with the stains as applied to veneers

Stain No.	Beech	Elm	Sapele
1.	purple brown	purple brown	purple brown
2.	red brown	red brown	red brown
3.	fawn	pink brown	fawn
4.	red	red	red
5.	medium brown	medium brown	medium brown
6.	grey brown	purple brown	grey brown
7.	grey fawn	light brown	fawn

The relative migration rates of the stains when applied to thin layer chromatographic plates (Gelman Chromedia SA) and eluted with artificial solvent blends, were thus determined by direct measurement and the results transformed into the commonly adopted Rf values. These are shown in Tables 7 and 8. The Rf value is the ratio of the distance moved along a straight line by the substance to that moved by the eluting solvent. The higher the Rf value the faster the migration and conversely the lower the retentivity or adsorbance.

The eluting mixtures were as follows:

- toluene, butyl alcohol, concentrated hydrochloric acid in the ratio 50:45:5, by volume respectively, to simulate an acid catalysed lacquer and
- toluene, butanone in the ratio 50:50, by volume to simulate a neutral e.g. nitrocellulose lacquer.

The reconstruction of the chromatograms, showing the separation of the stains into their primaries, where applicable, is presented in Figure 6.

Table 6  
Overall characteristics of stained surfaces of  
three kinds of veneer under PU lacquer

Stain No.	Beech veneer
1.	medium grained; annual rings and rays in good contrast
2.	very fine grained; clear; annual rings and rays in good contrast
3.	coarse grained; good contrast in growth rings
4.	fine grained; severe mottling; rays in contrast
5.	very fine grained; slightly blotchy; contrast poor
6.	medium grained; mottled; dull look
7.	medium grained; muddy; mottled; dull look

Stain No.	Elm veneer
1.	medium grained; staining even but dull
2.	very fine grained; good even stain
3.	large grains in pores; good even stain; wets glue in pores
4.	medium grained; does not wet glue in cavities
5.	very fine grained; staining uneven and blotchy
6.	fine grained; slightly blotchy; glue wetting poor
7.	hazy, diffuse; staining uneven and blotchy

Stain No.	Sapele veneer
1.	fine grained; even and uniform, though dull look
2.	very fine grained; even and uniform; rich colour
3.	very fine grained; even and clear; rays contrast well
4.	fine grained; severe mottling; poor contrast
5.	very fine grained; clear colour; good contrast
6.	medium grained; even and uniform colour, though poor contrast
7.	medium grained; clear and uniform; good contrast

Table 7  
The Rf values and description of stain components, separated in acid medium

1		2		3		4		5		6		7	
Rf Value	Colour	Rf Value	Colour	Rf Value	Colour	Rf Value	Colour	Rf Value	Colour	Rf Value	Colour	Rf Value	Colour
1.00	yellow	0.75	yellow	0.00	brown	0.78	red	0.95	blue	0.84	yellow	1.00	blue
0.00	brown	0.68	red			0.74	yellow	0.90	yellow	0.81	brown	0.95	yellow
		0.00	blue			0.00	blue	0.87	red	0.00	brown	0.90	brown
								0.00	brown			0.00	brown

Table 8:  
The Rf values and description of stain components, separated in neutral medium

1		3		3		4		5		6		7	
Rf Value	Colour	Rf Value	Colour	Rf Value	Colour	Rf Value	Colour	Rf Value	Colour	Rf Value	Colour	Rf Value	Colour
1.00	yellow	0.00	brown	0.00	brown	0.00	brown	0.34	blue	0.13	yellow	0.93	black
0.18	red							0.29	yellow	0.05	mauve	0.89	red
0.00	brown							0.06	mauve	0.00	brown	0.00	black

It was evident from these results that, with the exception of Stain No. 3, retention by adsorptive substrates, including wood fibre, was much lower under acid conditions than in a neutral medium. The full implications of this are also discussed in the Conclusion.

#### Chemical pre-treatment of veneered panels to enhance depth of staining

Because of their polyfunctionality and solubilising effect

for a wide range of materials, formamide, dimethylformamide and cellosolve (2 ethoxy-ethanol) have briefly been investigated for any possible enhancing action on the penetration of fibre by liquid stains and thus improvement of the aesthetic appearance of stained boards.

The liquids, mixed with water, were applied by brush to veneered boards which had been sanded with 120 grit. The excess liquid was mopped up by absorbent paper and the surface allowed to dry adequately, to a damp but not

glossy appearance, for the stains to be applied in the usual way. As it was expected from past experience with such chemicals that some loss of surface smoothness, owing to the grain-raising action of these liquids, was likely to result from their application, the panel surface quality was monitored instrumentally, this time with the FIRA Roughness Gauge.

The test panels had two coats of a pre-catalysed lacquer (total solids approx. 30 per cent) applied with a 150 $\mu$  K-Bar and the surface roughness measured before lacquering as well as following each consecutive application of the lacquer.

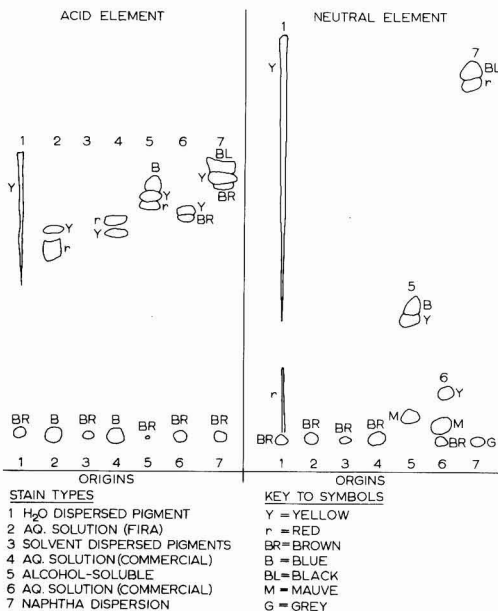


Figure 6. Relative retentions of various stains on silical gel film

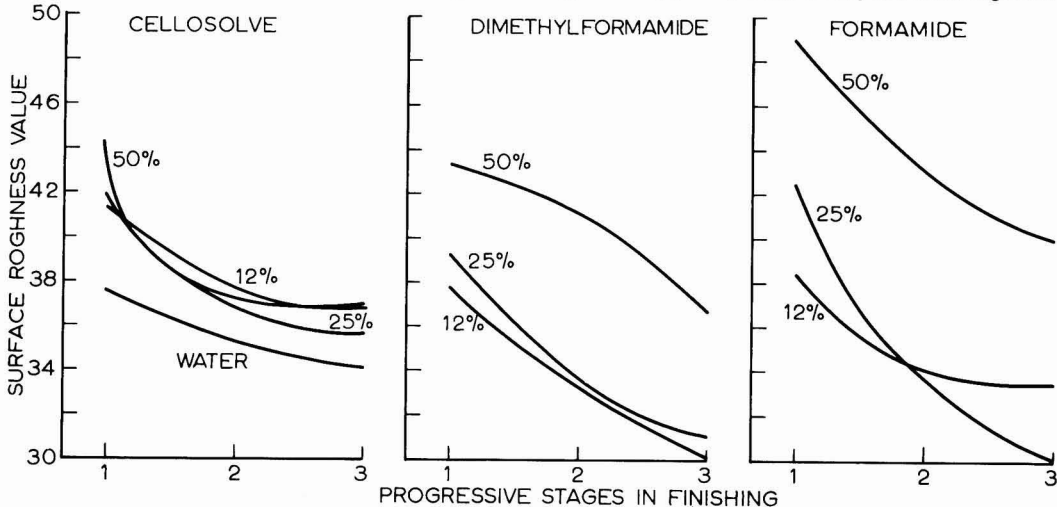


Figure 7. Changes in the surface quality of elm-veneered panel with progressive application of lacquer following treatments with various liquids to increase penetration of surface

The variation in the coarseness of elm veneered panels with progressive steps of finishing is presented graphically in Figure 7, the numerical indication of the stages being:

- 1 - after pre-treatment but before lacquering
- 2 - after the first coat of lacquer and
- 3 - after the second coat of lacquer

When compared with the grain-raising action of water alone (Figure 7) it was clear that all three liquids, in the concentrations used, caused additional swelling of fibre, and the effect was much greater at 50 per cent than at the other concentrations. Formamide was by far the most effective and it also allowed deeper and richer staining with all classes of stain than did the other two liquids. Indeed both cellosolve and dimethylformamide, even at 50 per cent concentrations, gave only a barely perceptible improvement in depth of colour, as could be assessed both subjectively (visually) and by spectroscopic measurements. It seemed that the slight improvement could not be justified by the disproportionate increase in the grain-raising of the panel surface. Similar considerations might apply to formamide at the lower concentrations. With 50 per cent mixtures with water, pre-treatment with the last-named solvent can give extra benefits that might, however, be considered adequate to compensate for the additional increase in the raising of the grain which, after two applications of a high build lacquer, might still allow an acceptable smoothness of surface finish to be produced.

**Special effects**

Possibilities of producing certain special effects have been studied briefly and the particular features of the greatest interest are summarised in this section.

**Differential, or contrast staining**

This is a condition that is usually possible in species whose timber includes hard and soft tissues as a regular feature, e.g. (a) prominent surface markings due to natural tissues such as, rays and soft tissues that contrast distinctly with the harder fibrous tissue, (b) prominent annual rings (growth rings) clearly differentiating into alternating zones

of dense tissue with small pores and more open tissue with wider vessels. Wood of species possessing these and similar features is likely to absorb stains unevenly, the lighter and softer tissues assuming richer and deeper colours generally than the more firmly packed, less porous dense tissue. The resultant condition has been considered to be of aesthetic value and the principle is often exploited by mixing different species of wood for veneer inlays of various geometric designs.

The degree of contrast with any stain was found to depend to some extent on the species used and tissue features. The response of the three species listed in Table 6 has already been noted in the same table and it can be inferred from those results that, in general, water-borne stains are likely to prove more effective for such applications than the solvent dispersible kind.

#### Multitone effect

The plain appearance of some timber, such as birch, beech and sycamore, may be enhanced by applying consecutively several stains of different hue to simulate an artificial figure or to produce a geometric pattern of greater aesthetic appeal. Experiments using panels veneered with wood from the above species have shown that clear solutions of stains that can be applied conveniently by spraying would be particularly suitable for such use. When veneered panels had been pre-treated with an effective penetration promoter, such as formamide, and subsequently sprayed with several shades of anionic stain, the overall effect was indistinguishable from naturally occurring pigments in wood. The use of stains for producing such artificial effects may, however, require special skills which, with adequate training and practice, most furniture polishers should be able to acquire.

#### Tinting water-borne lacquers

In common with conventional types, water-borne lacquers are normally colourless, although they may sometimes assume a milky appearance in the pot, owing to the incomplete solubility in water of some of the polymers used in their manufacture. In brief empirical experiments, the compatibility was tested of a chemically neutral or slightly alkaline cross-linking type with a commercially available water-soluble stain. Only small quantities of solutions were blended, before the cross-linking agent was added, to impart a light brown hue to the veneer, to which the lacquer/stain blend was applied with a 150 $\mu$  K-bar. Close scrutiny of the finished test panels following the drying of the lacquer revealed that the resultant tinted finish was of a high standard and no practical problems were visualised in applying this technique in large scale production.

These remarks apply only to true solutions of stains and relatively neutral aqueous lacquers; the compatibility of acid catalysed water-borne lacquers with stains, in a mixture, on the one hand, and the suitability of pigment dispersions for blending with any lacquer, on the other, remain to be investigated.

#### Staining the end-grain of sawn timber

A production problem that occurs quite frequently has been the objectionably darker staining acquired by the end-grain of solids relative to the longitudinal surfaces of rails, frames, lippings and similar components owing to the open-grained surface of the transverse section which

absorb liquid stains more rapidly and to a greater depth. In experiments aimed at overcoming this problem a variety of potentially suitable fillers, stoppers etc, were applied to transverse sections of 40 mm wide rails of European beech to fill the end-grain and so prevent disproportionate absorption of stain. Some materials, among them urea-formaldehyde and melamine-formaldehyde resins, have been found to reject stains completely, a characteristic that made them entirely unsuitable for this purpose. The best results were achieved with a polyvinyl acetate woodworking glue, consisting of a 25 per cent emulsion of polymer in water. This preparation could be wiped on to the end-grain with a rag. When rails of beech treated in this way were subsequently swabbed with both organic solvent-based and water-borne stains, the colour or hue acquired by the end-grain was an extremely good match for that assumed by the longitudinal surface.

#### Conclusions

The implications of the various facets of this investigation may be summed up as follows.

##### Light fastness

The water-soluble anionic primaries, especially the red, were found to fade more readily than the pigments; changes following exposure to ultraviolet light in the latter materials were extremely small. With one or two exceptions in both the solvent-dispersible and water-dispersible types, the measurable changes consisted of a slight reduction in overall reflectance, suggesting overall darkening rather than bleaching on exposure. The net effects on colours, however, were so minute that these types of pigment stain could reasonably be regarded as possessing almost complete light fastness.

##### Resistance to chemically reactive lacquers

The response to both types of lacquer used (acid catalysed, A/C and nitrocellulose, N/C) varied from primary to primary in all groups, but the best overall resistance under both acid and oxidative (N/C) conditions was shown by the water-dispersible pigments. The fading of colour under the cellulose nitrate lacquer was generally greater than under the A/C, which might suggest some adverse effect on the C-NO<sub>3</sub> group on the one hand, and on the other possible stabilising action of the acidity on all classes of primaries as a whole.

##### Effect on surface quality of veneer

Without doubt, grain-raising was most severe with water-soluble anionic dyestuffs, and least severe with solvent-dispersible pigments; a somewhat intermediate effect was found to be associated with the methylated spirit-type stain and the water-dispersible pigments. Owing to non-diffusion of the insoluble pigment particles in solvent dispersions, their application may result in an even smoother surface than that of the bare wood.

Formamide was found to be the most effective of the potentially useful penetration promoters evaluated when applied to veneered panels in a mixture with an equal volume of water, as a form of pre-treatment before staining. Just how significant, as a possible problem, the additional grain-raising produced by this pre-treatment is likely to be, may depend on (a) the type of wood used (species); (b) the solid content and film thickness of the

*Table 9*  
*The relative merits and disadvantages of aqueous and non-aqueous stains for wood*

Advantages	
Aqueous Stains	Organic Solvent Stains
non-flammability and non-toxicity of solvent (water); adsorptivity to and penetration of fibre is of a high order; non-bleeding into organic solvent-borne lacquers, hence suitable for mixed systems; good resistance to chemicals; good light-fastness; cheap solvent; equipment can be washed clean with water.	non-grain-raising; quick-drying at low temperatures makes application cost-effective; non-corrosive towards metal components of equipment; non-bleeding into water-borne lacquers – suitable for mixed systems; adsorption to glue in veneer, due to percolation, generally better; the solid fraction is cheap.
Disadvantages	
Aqueous Stains	Organic Solvent Stains
slow drying, may require costly heating; grain-raising of solutions on some woods can be severe; metallic components of application equipment liable to corrode in presence of moisture; the solid fractions of the stain is generally expensive.	solvents generally flammable and often toxic; solvents tend to be expensive; environmental (atmospheric) pollution can be a problem; resistance to light and chemicals of soluble stains often low; shallow penetration of wood; adsorption to fibre often poor; differential volatility and liability to bleed into solvent lacquer are frequent problems.

lacquer applied; and (c) the standard of quality set by the cabinet maker and other possible factors.

#### Subjective comparison of stains on test panels

Actual performance appeared to be dependent to some extent on the type of wood (species), and on the special characteristics of the stained surface under evaluation: water-soluble stains yielded, in general, clearer, richer and more even colours than did the other types. Glue-wetting, on the other hand, was much better with pigment stains, especially with the solvent-dispersed kinds.

#### Adsorption and performance

With the exception of the naphtha and the methylated spirit types of stain, overall retention by the substrate when flooded with neutral solvent was quite good but, with the exception of the butyl acetate dispersible pigments, all classes displayed a strong tendency to bleed into acidified

solvent mixtures. Of even greater significance was the variability of this tendency shown by primaries (components) making up the blends. This variability highlighted possible pitfalls in formulating stain mixes from primary colours possessing different physico-chemical properties.

#### Preferential uses of different kinds of stain

Although the relative aesthetic merits of the different classes of stain have been noted in the preceding paragraphs, the choice or preference for a particular application might be influenced by other considerations, amongst which could be cost, health hazard, fire risk, drying rate of liquids and other factors. When stains are divided into water-borne and organic solvent-borne types, the relative advantages and disadvantages of each group can be summarised as in the comparative table (Table 9).

[Received 1 February 1980]



# Hazards of static electricity in workclothing

By: R. Verschave and R. Firmin

George's Road, Stockport, Cheshire SK4 1DP

## Summary

Operatives working in explosive or inflammable environments are exposed to potential hazards through static electricity. Their clothing, if untreated, may be highly static prone and thus become extremely dangerous, not only to the person wearing it but to an entire plant. Even a low static discharge has the ability to detonate an atmosphere loaded with certain chemicals, dust, or gas and air mixtures. In factories concerned with the making of paint or other surface coatings, conditions may arise which give a distinct possibility of fires or explosions through electrostatic discharge.

## Les risques créés par l'électricité statique en vêtements de travail

### Résumé

Le personnel qui travail dans des environnements explosifs ou inflammables est exposé aux risques éventuels à cause de l'électricité statique. Leurs vêtements, dans le cas où ils n'ont pas été traités, pourraient être très susceptibles au développement d'une charge statique et ainsi de devenir extrêmement dangereux, non seulement aux porteurs de ces vêtements, mais aussi à l'ensemble de l'installation. Même une faible décharge d'électricité statique peut faire détoner une atmosphère chargée de certaines substances chimiques, de poussière, ou des mélanges de gaz avec de l'air. Aux usines qui s'occupent de la

There is, furthermore, the possibility of involuntary reflexes by persons exposed to an electrostatic shock which may result in uncontrolled movements leading to a chain reaction of unforeseeable consequences.

It must also be remembered that electrostatic charges can easily lead to the malfunction of electronic instruments or disarrange computers.

fabrication de peintures et d'autres revêtements, des conditions peuvent se produire une possibilité distincte des incendies ou des explosions à cause d'une décharge électrostatique.

Il y a d'ailleurs la possibilité des réflexes involontaires par les personnes frappées par un choc électrostatique, qui peuvent provoquer des gestes irresponsables aboutant à une réaction en chaîne dont on ne saurait pas prévoir les conséquences. En outre on doit rappeler que des charges électrostatiques peuvent susciter avec facilité la malfunction du matériel électronique et le dérangement des ordinateurs.

## Die Gefahren von statischer Elektrizität in Arbeitszügen

### Zusammenfassung

Arbeitnehmer, die in explosion oder feurgefährlichen Umgebungen arbeiten, sich durch statische Elektrizität zur eventuellen Gefahren setzen aus. Wenn ihre Kleidung unvorbehandelt ist, lässt sich hoch statik sein, und deswegen ausserst gefährlich nicht dem Träger allein, sondern der ganzen Anlage werden. Sogar eine geringe statische Entladung kann eine Atmosphäre detonieren lassen, die mit gewissen Chemikalien, Staub, oder Gasluftgemischen aufgeladen sind. In Fabriken, die sich mit der Herstellung von Lacken und anderen Beschichtungsmitteln beschäftigen, mögen Bedingungen entstehen, die durch

statische Entladung eine bestimmte Feur- oder Explosionsmöglichkeit schaffen.

Es gibt ausserdem die Möglichkeit unwillkürlicher Reflexe von ein elektrostatische Schlag ausgesetzten Menschen, die in unbeherrschte Bewegungen geraten können, und die einer Kettenreaktion unvorausehender Konsequenzen zuführen können. Man muss sich auch daran erinnern, dass electrostatische Ladungen die Missfunktion elektronischer Geräte, oder die Unordnung der Elektronenrecher leicht dazu bringen können.

## The nature of electrostatic effects in workclothing

Static electricity is generated simply by the rubbing of the outer garment with the underwear, also it can be generated

by removing the outer garment. The potential can reach 7000 volts (see Table 1). As soon as a conductor is touched, a sudden discharge takes place and a spark may be produced.

Table 1  
Potentials reached by various fabrics (tested at 25 per cent RH 20°C)

Material tested	Underwear	Antistatic treated	Body voltage (in volts)
Wool gaberdine	Pes/cotton shirt	none	6500
Wool gaberdine	65/35	1 per cent Bekinox	750
Wool gaberdine		2 per cent Bekinox	350
Cotton drill	Synthetic labcoat	none	3500
Cotton drill	Synthetic labcoat	1 per cent Bekinox	280
Pes/cotton 65/35		none	3700
Pes/cotton 65/35		1 per cent Bekinox	370
Nomex labcoat	65/35 shirt	none	4000
Nomex labcoat		1 per cent Bekinox	120

Bekinox ® trade mark

*Table 2*  
*Energies and corresponding potentials*  
*on an individual necessary for ignition*

	Ignition energy (in milli-joules)	Corresponding potential necessary for ignition (in volts)
Methane	0.5	2 150
Gasoline	0.8	2 650
Ether (diethyl)	0.2	1 350
Cyclopropane	0.2	1 350
Benzene	0.5	2 150
Acetone	0.6	2 350
Leao Azide	0.04	650

Source: National Information Service – US Department of Commerce – October 1973.

To show that the indicated garments may already endanger the person wearing them, some ignition data of chemicals frequently used are given in Table 2.

**Parameters influencing the generation of static electricity**

**Relative humidity**

Clothing will generate very little static when the relative humidity is 65 per cent or more. With decreasing humidity there is an increasing risk of static charge.

It was found that at 38 per cent RH there is 20 times more static on textiles than at 65 per cent; and at 20 per cent RH up to 300 times more. Cotton and wool are often considered to be antistatic in nature but this is only due to the high moisture retention of these fibres, which is greater than for synthetic materials; once the moisture is lost, they become as static prone as synthetics (see Table 1).

**The human body**

The amount of charge accumulated on a person depends on the body capacitance, which in turn is determined by body size, mass and skin surface properties.

**The fabric itself**

There are a number of parameters which will define how far clothing will generate static such as:

- Nature of fibres
- Position in the tribo-electrical series (Table 3) of the

*Table 3*

Tribo-electric ranking of materials
Wool
Nylon
Viscose
Cotton
Silk
Acetate
Polyvinylchloride
Polyester
Acryl
Modacryl
Polyethylene
Teflon

Ref. Hersch, S.P. and Montgomery, D. J., *Tex. Res. J.*, 1955, 25.

outer garment composing fibres, versus the underwear composition. The further from each other they are listed, the more static will be generated (figures mentioned in Table 1 will be different with other underwear).

**Construction of the fabric**

Treatment and finishes, some finishes isolate completely the fabric and become more static prone, e.g. a polyurethane coated fabric will be far more static prone than a non-treated one.

**Antistatic treatments**

**Chemical treatment**

Although they appear cheap, they have many disadvantages:

1. They are not permanent
2. Not always effective at low relative humidity
3. Retreatment is necessary each time the clothing is washed

**Bekinox stainless steel fibres**

These are: permanent

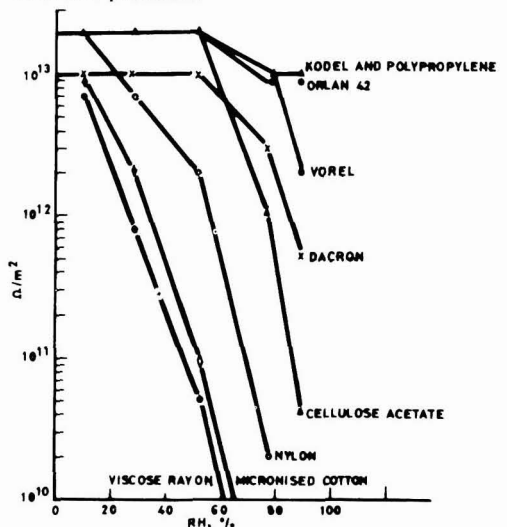


Figure 1. The behaviour of various fibres in relation to the relative humidity

Table 4  
The effect of adding percentages of stainless steel fibres  
to the yarns of fabrics (results recorded at 25 per cent RH 21°C)

Material	Weight/m <sup>2</sup>	Percentage Bekinox	Surface resistivity (2) Ω cm <sup>2</sup>	Transverse resistivity (2) Ω cm	Decay test FTMS 101B Method 4046 (3)
Cotton	166	neutral	> 10 <sup>12</sup>	> 10 <sup>12</sup>	60 sec.
Cotton	166	1.20	4.80 × 10 <sup>7</sup>	4.1 × 10 <sup>5</sup>	0 sec.
Cotton	166	1.20	4.40 × 10 <sup>7</sup>	3.6 × 10 <sup>5</sup>	0 sec.
50/50 polyester/cotton	242	neutral	> 10 <sup>12</sup>	> 10 <sup>12</sup>	60 sec.
50/50 polyester/cotton	242	0.85	5.14 × 10 <sup>8</sup>	1.74 × 10 <sup>4</sup>	0 sec.
67/33 polyester/cotton	250	1.25	8.99 × 10 <sup>7</sup>	2.16 × 10 <sup>5</sup>	0 sec.
polyester	144	1.60	3.37 × 10 <sup>6</sup>	0.94 × 10 <sup>4</sup>	0 sec.
Nomex	250	neutral	> 10 <sup>12</sup>	> 10 <sup>12</sup>	60 sec.
Nomex	250	0.70	1.88 × 10 <sup>8</sup>	0.36 × 10 <sup>4</sup>	0 sec.
Nomex	230	1.25	1.17 × 10 <sup>5</sup>	6.57 × 10 <sup>4</sup>	0 sec.
Nomex	230	1.50	2.59 × 10 <sup>5</sup>	1.81 × 10 <sup>4</sup>	0 sec.
Wool	240	neutral	> 10 <sup>12</sup>	> 10 <sup>12</sup>	
Wool	240	1	8.43 × 10 <sup>4</sup>	24 × 10 <sup>4</sup>	0 sec.

(1) after 50 washings

(2) electrodesystem as specified by Shirley Institute Manchester

(3) a charge of 5,000 volt is induced on the fabric. The decay time to 500 volt is measured. Federal Standard Testing Method USA.

very effective  
easy to control

The static eliminating character is based on two effects:

1. In an electrostatic field the very high voltage gradient created around the metal fibres present causes an ionisation of the air. The ionised air molecules neutralise the static charges generated. This is the so called "brush discharge effect".
2. When the metal fibre content in the clothing is sufficiently high (1 per cent) the metal fibres make contact with each other. As a consequence a spreading or levelling down effect of the charge is obtained in a large body conductor.

### Norms

Surface resistivity of the fabric is the most widely accepted

criterion for judging antistatic properties. The generally accepted degrees of "safety" associated with resistivity values (Ohms per cm<sup>2</sup>) measured at 30 per cent RH and 21°C are:

less than 10<sup>9</sup>Ωcm<sup>2</sup>: safer than cotton  
10<sup>9</sup>Ωcm<sup>2</sup> to 10<sup>11</sup>Ωcm<sup>2</sup>: practical safe level and as safe as cotton  
10<sup>11</sup>Ωcm<sup>2</sup> to 10<sup>12</sup>Ωcm<sup>2</sup>: marginal for safety  
greater than 10<sup>12</sup>Ωcm<sup>2</sup>: progressively unsafe

How unsafe garments made with untreated fibres are, may be shown in Figure 1. This diagram lists fabrics with various fibres in relation to their behaviour in relative humidities from 20 to 90 per cent.

It is obvious that antistatic work-clothing increases the safety of human beings and will reduce the hazards which may lead to losses due to fires and explosions.

[Received 30 January 1980

## Next month's issue

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

**Copolymers of polystyrene glycol and glycerol phthalate resins in surface coatings** by S. Chandra and S. Pasari

**Deposition efficiency of powders in the electrostatic powder coating process** by J. A. Cross, Sampuran-Singh and Abu Bakar Ahmed

**Solving air pollution problems in the manufacture and use of surface coatings** by N. A. R. Falla

**New metal complex pigments** by A. M. Naser, A. A. Salman, I. M. Abd-Ellah, M. A. Abd El Ghafa and A. N. Khouzondar

**American study on mortality rates in the coatings industry, preliminary details published** (Short Communication) CEPE, 49 Square Marie-Louise, 1040 Brussels

# reviews

## The Printing Ink Manual

Edited by D. E. Bisset, C. Goodacre, H. A. Idle, Dr R. H. Leach, C. H. Williams, Northwood Publications 1979

Pp 488. Price: £20.00

Readers of *JOCCA* recently became aware of the difficulty of revision of its Paint Technology Manuals particularly when most parts were out of print. The Printing Ink Manual has also been out of print and in need of revision so that the emergence of the Third Edition "completely revised and up-dated in response to a world-wide demand" must be welcomed, not only for its contents and importance to the many members of the Association concerned with the components and end products of printing and packaging, but appreciated also as a manifestation of an ideal demanding dedicated work by editors and authors and inspired, as were the Paint Manuals, by the Association's Technical Education Committee set up nearly forty years ago.

This reviewer, discussing the second edition, pleaded for a division into two volumes because of the breadth of the

Further information on any of the publications reviewed may be obtained by circling the appropriate *Reader Enquiry Service* number on the form at the back of the *Journal*. Enquiries will be forwarded to the publisher.

subject. This suggestion has, in effect, been followed in the third edition partly by adoption of a new publisher and partly by the inclusion of a comprehensive bibliography covering most of the Part 1 of the earlier editions. The new edition deals with raw materials (in a chapter occupying nearly a quarter of the book), inks for each printing process, theoretical bases for colour reproduction, chemical and physical aspects of film conversion and rheological considerations for the application of inks. Each chapter is written with the clarity and authority of an expert.

The fundamental principles characterising each process and related ink formulation is discussed without excessive use of formulation examples. One chapter, lithographic ink, dispenses with ink formulation altogether and thus fully achieves the ideal laid down as the guiding philosophy when the original manual was conceived and where the principles underlying formulation were to be dominant features rather than a catalogue of recipes.

The third edition as a whole is much closer to this ideal and makes the manual less likely to become out of date in a short time – a matter for concern to authors in a volume which inevitably takes a long time to prepare and publish.

It is difficult to fault this book in anyway. There are few statements which could be considered arguable and this reflects great credit on the authors and editors.

*Reader Enquiry Service No. 21*

J.A.L.H.

# occa meetings

## Manchester

### Transportation and Labelling of Hazardous Materials (Part One)

This lecture was presented on 8 February 1980 at the Manchester Polytechnic, All Saints, to 33 members and guests by Messrs J. Fleming and G. Hicks of Esso Chemicals Ltd.

The lecture was divided into two sections and Glyn Hicks who is a Technical Associate gave the first part entitled Labelling. Defining the title as a general method of imparting information, the associated general principles were listed thus: (1) Compliance with regulations. (2) Label products not covered by regulations. (3) Label all lesser hazard products. (4) Legible markings – longevity. (5) Multi-language labels. (6) Consistency of wording. (7) Consistency of wording with literature. (8) User labels – EEC directives.

Future sub-divisions described were as follows:

### User

For non-experts  
Long/short term effects  
Preventive advice

### Transport

For experts  
Immediate problems  
Emergency action

User Label – Solvesso Toluene, Hazchem Label 3YE for Tankers 1294, Specialist advice: Fawley (0703) 891558

Methods of Labelling: Adhesive or mechanical, Printed or stencilled, Placards and embossed plates, How many labels?

Summary – Compliance with regulations/exceed compliance level/consider user.

### (Part Two)

This lecture outlined the many international regulations that existed to control the transportation of hazardous materials. These regulations can be summarised as follows: (1) IMCO – 4 code books – International Maintenance Consultancy Organisation. (2) DOT – Blue book – 5 volumes – Department of Trade. (3) IATA – established 23 years – International Air Transport Association. (4) ICAO – To replace IATA – International Civil Aviation Organisation. (5) ADR – Road, RID – Rail, and ADN – Rhine Navigation. Also British Rail Regulations.

Further planned regulations quoted in detail were the United Nations Recommendations in relation to: (1) Dangerous Goods list; (2) Classification; (3) Packaging; (4) Hazard Information System.

The UN recommendations also contained 9 separate classes of materials with various sub-divisions.

The lecturers answered several questions which covered subjects varying from Hazchem labels on empty road tankers, hazardous wastes and a long established controversial point on whether combustible materials should be described as flammable or inflammable.

Ray Stott delivered a Vote of Thanks with judicial praise for the Esso Safety Policy that includes a principle that existing safety legislation can be exceeded where appropriate in the interests of safety.

### Physical Testing of Paints and Coatings

This Student Lecture was presented to 23 members and guests by Mr R. Harris of MQAD, MOD on 20 February 1980 at the Manchester Polytechnic, All Saints, Manchester.

Commencing his lecture by listing his present duties as Chemist I/C Paints Branch Woolwich, Chairman BSI Committee, PVC 10 - BS 3900 and a Working Group Leader ISO, he then described the three basic aims of paint testing as follows: (1) Is paint suitable for new use? (2) To evaluate new material for existing use; (3) Determination of quality from batch to batch.

His appraisal of the three aims were given in reverse order, i.e. (3) Straight forward; (2) Difficult - Empirical tests, the "scratch/bang/scrape brigade".

Mr Morris then continued by describing various tests performed at Woolwich and the correlation of results with both alternative test methods and testing laboratories. The tests described can be summarised thus:

- (1) Pendulum damping - Perzoz -  $12^\circ - 4^\circ$  - measure time.
- (2) Koenig - similar in principle - work at Woolwich has included testing in relation to light exposure and darkness storage.

Further information on any items mentioned below may be obtained by circling the appropriate Reader Enquiry Service number on the form at the back of the Journal. Enquiries will be forwarded to the organisation concerned.

### PRI award

The Plastics and Rubber Institute Award for outstanding service has been given to Jack Mitchell Buist, FInstP, FPRI, the immediate past president of the Institute.

Reader Enquiry Service No. 31

### BSI

The British Standards Institution has published BS 3900 "Methods of test for paints" Part H1 "Designation of quantity and size of common types of defect - general principles and pictorial scales for blistering and rusting". It defines the general principles of a system for assessing defects in paint films and specifies criteria for the assessment of blistering and rusting. Also published is BS 3900 Part D5 "Measurement of specular gloss of non-metallic paint films at  $20^\circ$ ,  $60^\circ$  and  $85^\circ$ ". This new standard is identical with ISO 2813.

Methods are specified for determining specular gloss at three angles;  $60^\circ$  being generally applicable,  $20^\circ$  giving better differentiation in the high gloss range and

$85^\circ$  giving better differentiation in the lower gloss range. The methods specified are not suitable for the measurement of the gloss of metallic paints. The standard sets out the maximum angles and relative dimensions of source image and receptor for all three angles of measurement.

Reader Enquiry Service No. 32

### Business as usual

Alfa Chemicals Ltd suffered the loss of their Staines base when the building in which their offices were situated was destroyed by fire on the night of the 23 June 1980.

The day-to-day running of the company has temporarily been transferred to the Alfa Preston office on the 5th Floor, Unicentre, Lordswalk, Preston PR1 1DH. Telephone (0772) 58960/69. Telex 677545. The company wish to point out that there will be no delay in filling customers' orders or any interruption in the Alfa service.

An extra telephone line is available for callers on (0772) 22716.

# occa meetings

(3) (i) Wallace indenter - load/temperature of film/time, (ii) good correlation between GLC and PRA laboratories, (iii) indentation polymers - function of time/temperature/load/shape of indenter, (iv) temperature dependance of indentation - time under load, (v) effect of ageing on indentation of paints, (vi) indentation depth at constant load.

(4) Adhesion - direct pull-off, Elcometer 1-1 ISO 4624, torque spanner, cross hatch, tape peel, impact, and deformation.

Factors: Method, substrate, substrate preparation, paint application, paint conditioning, adhesive type, temperature, relative humidity, rate of strain and evaluation.

The lecture of approximately 1 hour duration was followed by a 30 minute question/answer period which can be summarised as follows: (a) Polymer properties - initial approach is ND testing followed by testing to destruction, (b) cross hatch/chisel tests were discussed, (c) lap shear tests, (d) influence of RH on pendulum hardness, (e) MQAD favour epoxy adhesives for adhesion testing, (f) Mr Morris was highly critical of Sward Rocker performance.

Geoff Flood proposed a vote of thanks in which the quality of content and excellence of detail of the lecture was acknowledged by unanimous acclaim.

F.B.W.

# news

## new products

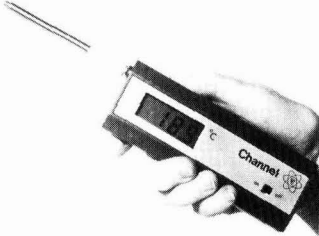
### Brighter metallic flakes

A new range of brighter stainless steel, nickel and bronze flake pigments is to be marketed throughout Europe by MPD Technology Limited.

Called Novamet the decorative flakes give true metallic brightness, have outstanding corrosion resistance (the nickel and stainless steel pigments passed the ASTM 500-hour salt spray test with flying colours) and are stable in both dry powder and water based systems. The flakes are available either in paste form or vacuum dried.

Reader Enquiry Service No. 33

# news



**D150 Digital Thermometer**

## Digital thermometer

The D150 series hand held digital thermometers, from Channel Electronics (Sussex) Limited, have been designed to provide fast and reliable readings of direct and differential temperature. The model D150 accepts a single sensor via a 2.5 mm jack socket mounted at the end of the instrument and indicates direct temperature from  $-50$  to  $150^{\circ}\text{C}$ .

D150D has two jack sockets and will provide with one sensor, readings of direct temperature to the above range or with the use of a second sensor, differential temperature within the range  $-100^{\circ}\text{C}$  to  $+100^{\circ}\text{C}$ . Both models measure to a resolution of  $0.1^{\circ}\text{C}$ .

*Reader Enquiry Service No. 34*

## New dyes

Atlantic Chemical Corporation announces the manufacture of Atlantic Brilliant Paper Red P Liquid (Basic Red 12), which can be used on ground wood pulp, bleached, and unbleached kraft. The dye, bleachable with chlorine, imparts a vibrant fuchsine hue to combination colours and self-shades. It is one of the brightest colours available to the paper industry.

Also introduced is Atlantic Alizarine Brilliant Sky Blue R (Acid Blue 62). The manufacturer recommends this dye for the dyeing of wool/nylon blends.

*Reader Enquiry Service No. 35*

## White can lining

A new white interior can coating can be formulated from special epoxy resins - XB 2957 and XB 3014 - in combination with a curing agent XB 3015. Used successfully on the Continent in the food industry, it is now available for the first time in the UK from Ciba-Geigy.

*Reader Enquiry Service No. 36*

## New decor additives

Degussa has extended its range of decor additives to include three new items.

Antiblock 80 680 is an additive for various Degussa film solutions. Optimum matching of the screen printing oil and the film solution by means of 80 860 greatly improves solidity of the resulting transfer picture sheets, so that an interleaved sheet is not normally needed.

Liquefier 80 604 is supplied as a means of adjusting the viscosity of screen printing pastes for glass, porcelain and enamel colours. Its use is recommended whenever a prepared paste fails to flow sufficiently freely or has become stiff as a result of a moist colour powder having been used.

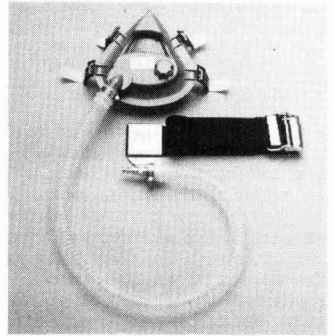
80 650, the third of these new items, is an almost odourless additive for the soak water used to soften transfer pictures. The addition of approx. 6 per cent to the soak water renders the pictures more resilient and elastic, so that they can be transferred more rapidly and without any difficulty by either manual or machine methods.

*Reader Enquiry Service No. 37*

## A novel paint system

A completely novel concept in epoxy surface coatings - Aqueous Powder Suspensions (APS) - has been announced by Ciba-Geigy. This pollution free range of epoxy based paints brings the high quality normally associated with powder coatings to that of water based paints.

*Reader Enquiry Service No. 38*



**Half-mask respirator**

## New air-fed half-mask

Protection against dusts, fumes, vapours, smokes, gases and mists not immediately hazardous to health is given by the 3M W-2922 half-mask airline respirator system from 3M UK Limited.

The new mask is designed to be worn with most goggles and visors, and under most welding shields.

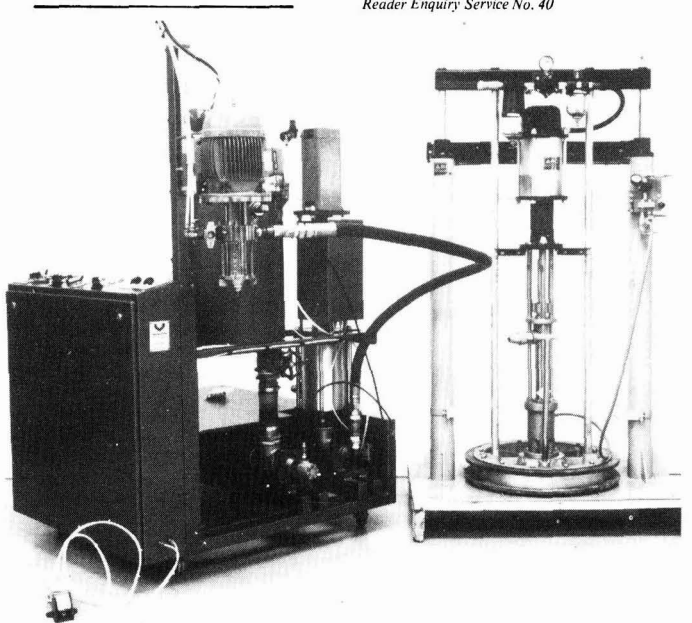
*Reader Enquiry Service No. 39*

## Double glazing sealants

A new metering mixing and dispensing machine designed specifically for the double glazing industry has been introduced by Liquid Control.

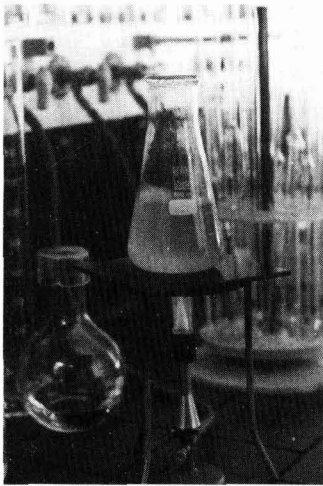
Designated the Twinflow LVRG it is aimed at the low volume user of double glazing sealants such as epoxy polysulphides, where it is essential that the two component parts of the sealant are mixed in exactly the correct proportions in order to obtain optimum performance.

*Reader Enquiry Service No. 40*



**Twinflow LVRE mixing, metering and dispensing machine**





"Ceran" protection plate

### Protection plate

For the distribution and conduction of heat in the application of gas burners, Schott, Mainz, offers an energy-conserving, ecologically harmless and chemically resistant protection plate of "Ceran" glass-ceramics. This plate does not emit noxious substances when being heated and thus can replace asbestos screens.

*Reader Enquiry Service No. 41*

### New mixing valve

A unique thermostatic mixing valve claimed to be the world's most advanced and incorporating an entirely new method of temperature control has just been launched by shower manufacturer Walker Crossweller & Co. Limited.

Walker Crossweller say that the accuracy and reliability of the new valve makes it ideal for any industrial or chemical process that requires a consistent supply of water at a precise temperature within the 30-50°C range.

The valve is so accurate that it will allow only a 1°C change in the blend temperature despite a change of up to 10°C in either inlet temperature.

Process safety is also guaranteed because of the valve's extremely fast response time. In the event of cold water failure, total shut-off can occur in approximately 1.5 seconds.

*Reader Enquiry Service No. 42*

### New stirrer

The new Rapidex Anchor Stirrer is one of the latest mixers to be introduced to the John Godrich Consulting Engineer range of machines. Claimed to be useful for slow stirring, each unit is individually made to fit any existing vessel. It can also be fitted with teflon scrapers to prevent deposits of material on the vessel wall.

*Reader Enquiry Service No. 43*

### New airless spray hose

Graco has introduced a new high-quality airless spray hose that offers excellent resistance to the most highly aggressive solvents.

Called Super Blue Plus, this tough new hose is compatible with a wide range of fluids, including many of the most aggressive materials now used in the paint industry. These include methylene chloride, 1,1,1-trichloroethylene, carbon tetrachloride, tetrachloroethylene, dichloromethane, acetone, methyl-ethylacetone, butanol, ethanol, ethyl acetate, toluene, dimethyl phthalate and dipentene.

*Reader Enquiry Service No. 44*

### Cyanoacrylate adhesive

Industrial Science Limited announce the introduction of three new grades of Cyanolit 301 which is a heat resistant cyanoacrylate adhesive, effective up to 120°C.

*Reader Enquiry Service No. 45*

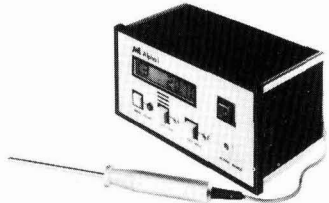
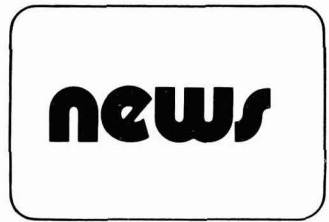
### Pyrene developments

Pyrene Chemical Services Limited has added two new spray processes to its low temperature range energy-saving pre-treatments for the metal finishing industries. Pyroclean 599 a liquid alkaline cleaner which lends itself to automatic dosing control and Bonderite 399 a nitrite-free zinc phosphate process for multi-metal applications.

These two new processes operate at only 25°C to 35°C, thus offering substantial energy cost-savings compared with the conventional pretreatment chemicals at 50°C to 60°C.

Pyrene have also developed an electronically-operated, fully automatic controller called the Autobond ZPE to control the strength of Bonderite zinc phosphating solutions. To do this, it monitors the solution conductivity and maintains the required chemical strength within close limits by making frequent small additions of chemicals.

*Reader Enquiry Service No. 46*



The Alpha 1

### Temperature alarm

A brand new development from AWL Electronics is the Alpha 1 Temperature Alarm.

Indicating temperature in degrees centigrade on an eight digit LCD display the unit uses standard AWL probes which are available for every temperature measurement application and are interchangeable to suit the operator's use. The Alpha 1 can accept up to three probes which are continually and sequentially monitored.

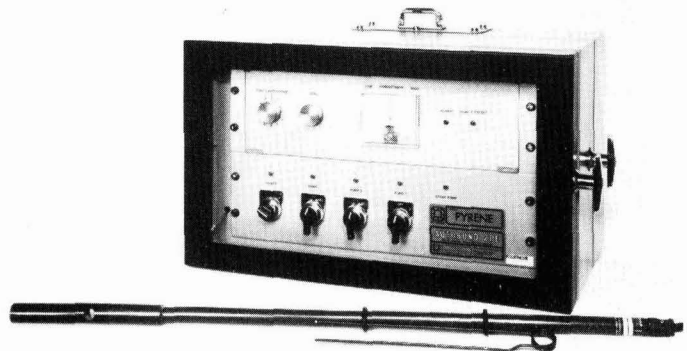
*Reader Enquiry Service No. 47*

### New filter range

A new range of stainless steel compressed air filters is announced by Domnick Hunter Filters Limited. Customer demand from chemical, petro-chemical, offshore drilling, marine and process industries resulted in the new range which can resist most corrosive atmospheres.

The filters fit pipes from 0.75 in. to 2.5 in. and there are three grades of elements to suit specific compressed air requirements.

*Reader Enquiry Service No. 48*



The new Autobond ZPE

# news

## Fail-safe device

Now available from Baird & Tatlock Ltd is a fail-safe device for Buchler Fraction Collectors.

To ensure that valuable samples are not lost in the last stage of a separation process, a patented Liqui-fuse is fitted to the highly successful 200 tube fraction collector.

In the event of any spillage the liqui-fuse shuts down the collector and any ancillary equipment, such as pumps, to avoid loss of sample.

*Reader Enquiry Service No. 49*

## Microfine Bentonite

A unique separation and classification process developed by the American Colloid Company has produced a highly pure, microfine mineral which can replace synthetic additives.

Microfine Benonite is chemically a sodium aluminium hydroxy silicate and is derived from montmorillonite, a mineral deposit. It is a wholly natural product, non-toxic, non-irritating and chemically inert.

Its unique properties of swelling, thixotropy and the ability to mix without chemical reaction with other ingredients make the mineral of interest to any formulator wishing to enhance a suspension, disperse a tablet, bind a material, stabilise

an emulsion or modify the viscosity of a product.

*Reader Enquiry Service No. 50*

## New absorption spectrophotometers

Perkin-Elmer have announced the release of two new atomic absorption spectrophotometers.

The new model 2380 replaces models 380 and 560 and the model 2280 replaces model 280. Both instruments include new microprocessor electronics, offering the user more features and convenience than ever before in low cost atomic absorption instrumentation.

*Reader Enquiry Service No. 51*

# literature

## Alkyd stoving finishes

R.H. Chandler Ltd have published a review called "Alkyd Stoving Finishes". One of the oldest industrial finishes available, the alkyd stoving enamel is still used extensively because of its flexibility and adaptability.

The chapters deal with the alkyd resin and the melamine resin components separately, the storage stability and curing of the alkyd system on a solvent basis, water-thinnable enamels and high solids coatings. About 80 patents are abstracted individually in a final chapter and there are author and patent indexes.

*Reader Enquiry Service No. 52*

## Flame ionisation detectors

Bioscan has a new technical bulletin available describing procedures for cleaning flame ionisation detectors (FID).

Supelco bulletin No. 753 provides useful information on how to isolate a

dirty FID from other problems in the system which have similar symptoms. The bulletin describes step-by-step procedures for light and more thorough cleaning, and offers several products which will simplify either cleaning job.

*Reader Enquiry Service No. 53*

# meetings, etc.

## Protective Paint Coatings

A symposium entitled "Protective Paint Coatings" is to be held at Loughborough University of Technology on 17-19 September 1980.

## Corrosion Symposium

The 21st Corrosion Science Symposium is to be held at the University of Oxford on 16-19 September 1980.

# appointments

**Dirk Betlem** has been named to succeed **Donald P. Sullivan** as managing director of Du Pont de Nemours (Belgium) and director of Finishes, Fabrics and Finishes Department, Europe, effective from 15 April. Mr Sullivan will return to E. I. de Pont de Nemours and Co. in Wilmington, USA, where he has been appointed director, business planning, Corporate Plans Department.

**Mr J. D. Cormie**, Finance Director of Reed International Limited, has been appointed a non-executive director to the board of Laporte Industries (Holdings) Limited.

**Mr H. M. Scopes** has been appointed to the board of directors of ICI Petrochemicals Division - as Raw Materials and Purchasing Director, effective from 1 April.

# occa news

## Obituary

### R. F. G. Holness

It is with regret that Council learned of the death of Mr R. F. G. Holness, a member of the Association since 1925.

Reg, as he was affectionately known to his many associates and colleagues served the printing industry both as a chemist with the ink makers John Kidd Ltd and, subsequently, as chief chemist for many

For information on membership of OCCA, enquiries should be sent to the Association's offices, see front cover for address.

years with the famous printing firm of Waterlows until his retirement. He was highly regarded for his skilled approach to many specialised areas of printing, examples being, pigmentation of litho inks for the hand separated colours requiring twelve or more printings used in artists' poster reproductions and copperplate security inks which led him to be called in by Scotland Yard as a consultant in the detection of forgery.

Reg Holness contributed much to the Association and to other societies with related interests, including seven years as London Section's Honorary Publications Secretary, Chairman from 1953-55, two terms of service on Council and Chairman of Exhibition committee. Service on other bodies included the technical com

mittee of the one time Federation of British Ink makers, Technical Training Board for the Ink Industry including a two year term as chairman, Associate Editor of the Printing Ink Manual (1st and 2nd editions), City and Guilds examiner in Paper and Print, notable contributions to the Institute of Printing, Penrose Annual and OCCA representative on the Colour Group.

Reg will be remembered for his precise analysis and clear exposition of problems which together with his unique experience and observations made it inevitable that his contributions on a wide variety of subjects guaranteed a fruitful discussion at any meeting.

J.A.L.H.

IOCCA

## Bristol Section

### Ladies' night

The Annual Ladies' Night was held on Friday 21 March in the Mayfair Suite, Bristol.

Mrs Eileen Harper, the Acting Chairman thanked everyone for supporting the evening and welcomed the Section's guests, the President Dr F. M. Smith and Mrs Smith, the Past President of the Birmingham PVL Club, Mr D. Heath and Mrs Heath, the Chairman of the Scottish Section, Mr. I. McCallum, the Thames Valley Section, Mr G. Hill and the Manchester Section, Mr A. Jolly and their wives. The top table guests were completed by the Director and Secretary Mr R. H. Hamblin.

Mrs Harper explained why the Section had a lady Chairman for the third year and expressed regret that due to ill-health Mr D. N. Fidler had been forced to resign as Chairman. She was sure everyone would send their best wishes to him in his retirement.

As always the evening provided the opportunity of meeting old friends, some of whom had travelled long distances to attend. A very enjoyable evening was spent by over 180 members and guests and was due in no small way to the hard work of the Social Secretary, Mr T. Lague, to whom we express our sincere thanks.

L.J.B.

## Auckland Section

### Annual General Meeting

On 12 March 1980 the Auckland Section deserted its usual meeting place of an "eagles nest" in the Leagues Club on the cliffs overlooking the railway yards and wharfs for a meeting at sea level in the Tamaki Yacht Club. As members approached the venue along the waterfront they had the fascinating sight of hundreds of joggers practising for the following weekend's "run for fun" in which 50,000 runners turned out for the biggest fun run in the world, 10 km along the harbour frontage. Inside the Commodore Lounge the view was across the harbour to the extinct volcano of Rangitoto and Waiheke Island, with the "yachties" slowly working homewards in the evening sunshine. The Maori name for the harbour, Waitemata, means sparkling water, and it surely is one of the most picturesque and beautiful harbours in the world.

Whether it was the new meeting place, its situation, or the speaker, the result was a turn-out of 61 for the Annual General Meeting of the Section, and competition by eleven members for the seven vacancies on the committee. Altogether OCCA in Auckland is in a healthy condition.

1980(7)

The speaker was Mr John C. Martins of the Sheffield Consulting Group, and his subject, "Experiences as a Consultant in New Zealand". Members' expectations from "the most entertaining speaker" at the previous years Toastmasters' convention were fully realised and his examples ranged from chewable aspirin to two shoe salesmen in Africa ("terrible place, no-one wears shoes" or "marvellous place, no-one wears shoes"), and from the cat in Alice in Wonderland to Henry Ford. With audience participation and interruption by back-chat and laughter he outlined his observations:

High level performers: learn from experience, think positively, recognise and exploit opportunities, identify and dismiss lack of opportunity, assess priorities, build on their strengths, aim for objectives, work effectively, move on, plan and control.

They innovate because they are: continually asking questions, sensitive to opportunity, dissatisfied with the status quo, convinced they can do things better, able to pick winners, planning with faith in the future.

To achieve results, they: delegate authority, act deviously, negotiate alternatives, set tight deadlines, take precautions against failure, are cautious of acting too soon, take risks appropriate to rewards, accept full responsibility for results.

A.M.

## Manchester Section

### Winter Committee meeting

This function, famous in the annals of OCCA legends as the longest meeting with the shortest agenda, was dutifully attended (with an obvious lack of reluctance) by 27 members of the Manchester Section. The 1980 meeting was held on Friday 18 January at the Hark to Bounty Inn, at Slaidburn which is near Clitheroe and approximately 234 miles north of Watford. The Inn, which dates from the 13th century, and until 1875 was known as "The Dog", is also famous as the Ancient Courthouse of the Hodder Valley.

Aperitifs, which varied from real ale to an excellent choice of malt whiskies, were followed by a dinner which included such specialities as game pie, venison, Montrose salmon and local fed lamb. It is the writer's painful duty to report that the liar dice addicts present introduced their heinous habit between and during courses and the deceitful contests continued until 2.30 a.m., when the writer had the pleasure of relieving the President, Francis Smith, of the "pot". Other festivities enjoyed included such mundane games as darts, in which the aptly named Harold Archer excelled, and dominoes. The two female members present joined



in the activities under the watchful eyes of the Revd. D. Taylor and Inspector Stretton respectively.

After breakfast, discussions had a strong technical bias in relation to the effect of excess consumption of aldehydes and congeners on the body, and the validity of a high dosage of ascorbic acid as treatment. In conclusion, it was felt that a successful meeting, typical of the Manchester Section, had been held, organised this year by the Vice-Chairman, Frank Redman.

F.B.W.

## Scottish Section

### AGM/Ladies evening

The Annual General Meeting of the Scottish Section was held in the Albany Hotel, Glasgow on 10 April 1980. This occasion saw the retirement of Mr I. R. McCallum who had been Chairman of the Section for the past two years. A vote of thanks was recorded in respect of the efforts put in by Mr McCallum on behalf of the Section during his period of office.

Mr T. L. M. Humphrey was formally appointed Chairman and we all wish him well in this post.

The Section Secretary for the last few years Mr R. Hill has regretfully had to step down from this post and our sincere thanks must go to him also in recognition of the considerable time and effort put in by him on behalf of the Section. Mrs A. Gibson was appointed as Secretary and we wish her well.

One of the highlights of the AGM this year was the Commendation Award presented to Mr Jack Davidson. Jack joined the Scottish Section of OCCA on 8 November 1934 and since then, besides serving on the committee in various posts has also been past Chairman of the Section and served a term as a member on Council. He is also a member of the Professional Grades Committee. The Immediate Past Chairman Mr Ian McCallum when presenting Mrs Davidson with a gift said "behind every good man is a good woman" (or partner) and she has certainly been behind Jack in his 46 years of service with OCCA, as well as being a great ambassador for Scotland on visits to other section functions.

Following the formal business of the AGM a most successful ladies' evening

295

was held which on this occasion took the form of a "champagne evening". Over 60 people attended and supped champagne during the evening. A most informative talk and film was given on the manufacture of champagne by Mr Innes Ingram of the Wine Development Association. Before the film everyone was informed that there would be a quiz and the answers to the questions were to be contained in the film. The evening was finished off with a buffet and a selection of more Scottish beverages. General comment from those attending was "why not have this once a month?" In the vote of thanks which followed Mr Ingram was praised for a very interesting and enjoyable evening.

#### **Golf tournament**

The Annual Scottish Section Golf Tournament was once again held at Aberdour. Over 30 members and friends enjoyed perfect weather, good food and some most entertaining golf. Last year the need for a trophy for the most improved golfer was highlighted and the first winner of the tankard presented by British Titan Products was Mr T. Kirkwood. The main event, the Whittaker Trophy was won by W. Donaldson with a nett 62.

Other prize winners were - Morris Ashby Quach for the best scratch score - W. Donaldson gross 78, Visitors Shield - P. Nixon - nett 59.

A.M.

## **Midlands Section**

#### **AGM Report**

The Annual General Meeting of the Midlands Section of OCCA was held in the Belfry, Wislaw on 25 April when Mr R. L. Devenish was elected Chairman. The following were elected to serve as Officers: E. C. Wallace Hon. Secretary, A. G. Eades Hon. Treasurer, B. E. Myatt Hon. Publications Secretary, R. K. Chater Student Secretary, D. D. Kimber Student Liaison Officer, with G. Lewis, D. Clement, G. Williams, A. Wallington elected to join D. Penrice and B. A. Fowler as members of the Committee. H. Clarke and H. Griffiths are to serve as Section Auditors. J. A. Burns was presented with his Past Chairman's medal by his successor and he will continue to serve on Committee.

A vote of thanks to the retiring members G. A. Tabbernor and L. P. G. Goodale was given by D. Kimber.

The AGM was preceded by an afternoon golf competition held on the Derby Course of the Belfry Complex, which is the HQ of the PGA and following the formal meeting a very enjoyable Buffet-Disco took place during which the prizes for the golf competition were presented by R. Devenish to the following: Mrs Margaret King, Ladies Prize - Steve King, Best Stableford Score Man - Syd Harris, Second Mens - Graham Carless,

Third Mens - Bert Wingrove, Fourth Mens. The format arranged proved to be a very successful blend of the formal and informal giving a very enjoyable time to those who attended.

B.E.M.

## **London Section**

#### **Annual General Meeting**

The 42nd Annual General Meeting of the London Section was held on Thursday 24 April 1980, at the Rubens Hotel, SW1 under the chairmanship of Dr T. A. Banfield.

The Annual Report was presented to the meeting by the Honorary Secretary, Mr B. F. Gilliam. He commented that the year had been a difficult one for a number of unrelated reasons. The Honorary Programmes Officer, Mr R. N. Faulkner had resigned from his position during the year as a result of a move from the London area; Mr R. G. Handley took over for the remainder of the session. The weekend conference on "Home Decoration" arranged to be held in Hastings in February attracted such a poor response that it had to be cancelled two weeks before the event. Fortunately the costs incurred in cancelling at such short notice were negligible. Much greater consideration would be given by the committee to organising such events in the future. Notification to all members of the Association of the Association Golf Tournament which was organised by the section in 1979, was delayed due to late publication of the relevant copies of the *Journal*. The committee reluctantly cancelled the event in view of the small number of entries received from Association members.

In common with many societies the attendance at evening meetings was generally poor although symposia continued to attract large audiences. Evening meetings at the Princess Alice were popular; however meetings held at the Rubens Hotel rarely resulted in more than twenty members and guests attending and the committee would need to give serious thought to the continuation of meetings at such an expensive venue.

The Ladies' Night was held again at the Selsdon Park Hotel in November and had been a successful evening. Due to a clash of dates with the Manchester Section Ladies' Night being held on the same evening numbers attending were lower than the previous year.

More positively two of the papers presented to the Section during the year had been accepted for publication in the journal. Mr J. J. Froggatt's lecture on "Priming and Putty" was to be published as a review paper and Mr N. A. R. Falla's presentation on "Analysis of surface coatings" as a technical paper.

The Annual Report was adopted unanimously by the meeting.

Mr D. B. Bannington, Honorary

Treasurer, presented the Financial Report. Inflation continued to take its toll with the accounts showing an increased excess of expenditure over income compared with the previous year. This deficit had been made up from the deposit account rather than by seeking a grant from central funds. Day symposia had continued to contribute to the Section's finances. A major element of the increased expenditure had been the high rise in the cost of room hire and refreshments for evening meetings at the Rubens Hotel. Whilst the committee were reluctant to consider changing Central London venues once again, the value to the Section members of meetings at such high cost was questionable.

The Financial Report was accepted unopposed.

The election of the Honorary Officers of the Section was proposed from the chair and adopted.

As required by the rules of the Section during the first year of the Chairman's term of office, the election of Vice-Chairman (Chairman designate) was held. Mr B. F. Gilliam was proposed from the chair and elected unopposed. To aid the smooth handover to his successor, Mr A. Saxby was elected as Honorary Assistant Secretary for the 1980/81 session.

Three nominations only were received for the three vacancies for elected committee members and as a result no ballot was required. Messrs B. A. Canterford, D. P. Lawler and F. D. H. Sharp were elected.

Dr T. A. Banfield's position as Chairman for his second and final year was confirmed by the meeting.

The two retiring committee members, Mr I. W. Hardie and Dr R. C. Denney; Mr E. A. Pachebat who resigned during the year and Mr R. N. Faulkner were thanked for their services in committee and to the Section.

Under "any other business" the high cost of accommodation at the Selsdon Park Hotel was raised and discussion on suitable venues ensued.

In the absence of further business the meeting closed at 7.20 pm.

#### **Drinking and driving**

Following the AGM of the London Section on 24 April 1980, at the Rubens Hotel Dr R. C. Denney of the Thames Polytechnic presented a lecture on the topical subject of "Drinking and Driving". Dr Denney is one of the foremost authorities in the UK on the effects of alcohol particularly in relation to driving ability.

Before the introduction of the law in 1968 which brought breathalysers into use the police were only able to satisfactorily obtain convictions for

drunken driving when blood alcohol level was so high that the driver was incapable of carrying out any precision operations whatsoever. Blood alcohol levels generally in excess of 150 mg/100 ml were necessary for such loss of ability; a driver with this blood alcohol level stood a twenty-five fold chance of having an accident compared with a non-drinker. As a result the powers of the police to control and prevent death or injury as a result of drunken driving were limited.

Extensive investigation and testing in the 1950s and 1960s of drivers involved in accidents both fatal and non-fatal clearly demonstrated the direct relationship between blood alcohol level and the chances of an accident. In the UK over 30 per cent of dead drivers had more than 80 mg/100 ml blood alcohol levels and between 10 p.m. and 4 a.m. over 70 per cent of all drivers involved in accidents had levels above 80 mg/100 ml. The likelihood of a driver having an accident is exponentially related to the blood alcohol level. Taking a base line of 10 mg/100 ml (i.e. a non-drinker) there is a two fold increase at 60 mg/100 ml, a four fold at 80 mg/100 ml, a seven fold at 110 mg/100 ml and a twenty-five fold increase at 150 mg/100 ml.

The majority of the developed countries have subsequently introduced legislation restricting the blood alcohol level in vehicle drivers. The acceptable maximum varies from country to country; the EEC is mainly standardised on 80 mg/100 ml, the communist block at 30 mg/100 ml whilst some American States are as high as 100 mg/100 ml.

The blood alcohol level peaks about 30-45 minutes after drinking has ceased and the alcohol is then slowly

metabolised at a rate of between 10-25 mg/hour. Hardened drinkers metabolise alcohol more rapidly. The urine alcohol level is generally 30 minutes behind the blood alcohol level. One effect of the slow rate of alcohol metabolism is that the driver can "top-up" a lunchtime drink with an evening drink and, whilst each can produce less than 80 mg/100 ml alcohol, put the driver above the legal limit. If the metabolism rate is slow enough drivers can still fail the breath test during the day following an evening drinking.

The toxic level of alcohol is about 400-450 mg/100 ml and can be achieved by drinking about two-thirds of a bottle of spirits in 30 minutes. The "world record" for blood alcohol level was 1350 mg/100 ml and equated to about 30 per cent alcohol in the fluid in the veins.

Dr Denney then went on to describe the various devices used to test the alcohol level of drivers suspected of being above the legal limit. The method used in the UK employed a relatively inaccurate method (in the way in which it was used) at the road side, which was then followed by more sophisticated blood or urine analysis. The basis of the Alcotest 80 breath analyser was the conversion of acidified potassium dichromate to green chromium sulphate and visual examination of the extent of the colour change.

Other reagents used in the past included potassium permanganate and iodine pentoxide.

More sophisticated versions of the Alcotest 80 equipment were undergoing trials which would enable direct print outs of alcohol levels to be obtained in police stations. They would be admissible as

evidence in court and would do away with the current practice requiring forensic science laboratory analysis.

For the future Dr Denney foresaw the legal maximum being reduced to 50 mg/100 ml; that the sampling of suspect drivers would become greater and that it would be extended to cyclists and pedestrians who were currently exempt and finally the more sophisticated instant breath analyser would be more widely used to obtain evidence.

During the extensive question time it became clear that there was no way of cheating the breath test or altering the blood alcohol. However a lining of fat on the stomach was extremely effective in reducing the rate of alcohol absorption from the stomach and milk, cream and fish and chips were recommended.

A vote of thanks was proposed by Mr H. Worsdall to which the audience warmly responded.

A.J.N.

## OCCA 32

The following pages contain a review of the exhibits on the stands at the Exhibition which are classified into the following categories:

**Additives, driers, surfactants etc.**

**Chemical intermediates**

**Extenders, fillers, gellants**

**Laboratory apparatus and testing equipment**

**Manufacturing equipment and containers etc.**

**Pigments**

**Resins**

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

### Ordinary Members

CABELDU, NIGEL CHARLES, PhD, CChem, MRIC, 18 Hauxley Drive, Red House Farm, Gosforth, Tyne & Wear NE3 2SQ. (*Newcastle*)

CULLERES, JOSE, Avda de Madrid 64-66 3° 1ª B, Barcelona 28, Spain. (*General Overseas*)

DIANA, JOSEPH, c/o Dulux Ltd., Box ST 92, Southerton, Salisbury, Zimbabwe. (*Zimbabwe Branch*)

FRASER, IRENE, Nuodex Canada Ltd., 34 Industrial Street, Toronto, Ontario, Canada. (*Ontario*)

GIMENEZ, ANDRES B., C/Mas, No. 122, 1° Hospitalet, Barcelona, Spain. (*General Overseas*)

HANRATH, JOE, 3 Annette Close, Harrow, Middlesex HA3 7BG. (*London*)

MULI-MUBIRU, JOHN C., BSc, PO Box 1479, Kampala, Uganda, E Africa. (*General Overseas*)

# new members

TURNER, ROSCOE CAMERON, BSc, MNZIC, Shell Chemicals (NZ) Ltd, PO Box 2901, Wellington, New Zealand. (*Wellington*)

### Associate Members

BLEWMAN, MICHAEL JOHN, PO Box 892, Wellington, New Zealand. (*Wellington*)

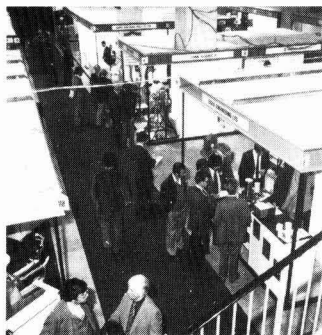
BRIDGE, MURRAY WILLIAM, Box 38020, 2 Manchester Street, Petone, New Zealand. (*Wellington*)

HODGES, PAUL ADRIAN, 26 Laurier Road, London NW5. (*London*)

MATTHEWS, MICHAEL JOHN, Buckley & Young Ltd, PO Box 30-48, Lower Hutt, New Zealand. (*Wellington*)

MILES, TIMOTHY MARSHALL, Harrisons & Crosfield NZ Ltd, PO Box 1996, Wellington, New Zealand. (*Wellington*)





# OCCA-32 Exhibition

Cunard International Hotel, London, 13-15 May 1980

**New style Exhibition**  
a prestigious and memorable event

## EXHIBITION REVIEW

The Thirty-second Annual Exhibition of the Oil & Colour Chemists' Association was held for the first time at the Cunard International Hotel, Hammersmith, London W6 from 13-15 May 1980 and the new arrangements which allowed varying types of exhibits on four floors of the hotel met with approval from both exhibitors and visitors.

### The international forum for the surface coatings industries

From the 124 organisations represented at this unique annual international forum for the surface coatings industries were exhibits from:

Austria, Belgium, Denmark, East Germany, Holland, Hungary, Japan, Poland, Sweden, Switzerland, USA and West Germany.

### Visitors to OCCA-32

Admission to the exhibition was free but visitors were asked to complete registration cards and an analysis of these has

shown that visitors to the Exhibition were drawn from the following countries:

Australia, Austria, Argentina, Belgium, Canada, Chile, Cyprus, Denmark, Ecuador, Eire, Fiji, Finland, France, East and West Germany, Greece, Hong Kong, Hungary, India, Iran, Iraq, Italy, Japan, Jordan, Malaysia, Netherlands, New Zealand, Norway, Poland, Portugal, Singapore, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Turkey, USA and Venezuela.

Over 16 per cent of visitors completing cards came from overseas and an analysis of cards (both from the UK and overseas) by job function confirmed that the OCCA Exhibition has not only a wide appeal but is also able to attract the top level of the industries as follows:

Description	Percentage
Director/Owner	13.86
Management	18.96
Section Head/ Group Leader	4.27
Chemist/Physicist/ Technologist	20.45
Lab Assistant/ Technician	7.88
Sales & Marketing	16.38
Buyers	3.13
Administration/ Secretarial	4.10
Lecturer/Student	0.81
Other	3.82
Cards not completed	6.34



The fountains on the terrace outside the Queen Mary Suite

### Layout of the Exhibition

The exhibition was staged in the New Hall and Queen Mary Suite, in both of which stands were erected, and in syndicate rooms of the Mezzanine and third floor. Ample seating facilities were available as well as refreshment bars and restaurants.

### Exhibition Reception

Despite the fact that the dates for the Exhibition coincided with a strike in France on the first day, the Day of Action by the TUC on the second day and Ascension Day (a public holiday on the Continent) on the third day, exhibitors reported that there was a good flow of new visitors each day. As had been expected because of travelling difficulties, the second day which had often been the busiest day on previous occasions was on this occasion not as busy as the first and third days.

The Exhibition Committee's guests to a reception on that day included many distinguished visitors from other societies and organisations, as well as the Chairman of the Greater London Council (Mr Bernard Brooke-Partridge) for whom this



A seating area adjacent to the refreshment bar in the Queen Mary Suite





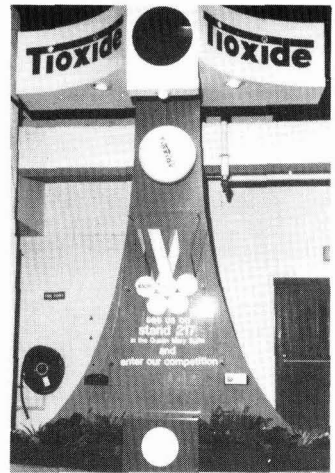
The OCCA Information Centre at which interpreters were also present to help exhibitors and visitors

was his first public engagement since taking office. Councillor Mrs W. Gumbel, JP of the Greater London Council and Mr D. Thompson (Member of Parliament for Sowerby). After the reception the party was conducted round the exhibition during the afternoon.

**Information Centre**

Details of the Association's optional

Professional Grade, membership, subscriptions to the *Journal* and a preliminary notice about the next Association Conference to be held at Bath 17-20 June 1981 were displayed at the Information Centre and copies of OCCA publications, including the newly-published Monograph No. 1 on "Marine Finishes" were available for purchase. Interpreters were present to help visitors and exhibitors.



A mobile feature by an exhibitor at the entrance to the exhibition in the New Hall

**OCCA-33 Dates and Venue**

Already a number of requests have been received regarding space for OCCA-33 which will take place at the same venue from 28-30 April 1981. Copies of the Invitation to Exhibit will be despatched in July and any organisation which has not previously received a copy but wishes to do so should write to the Director and Secretary, at the Association's address as soon as possible.



The first official engagement of the Chairman of the Greater London Council (Mr Bernard Brook-Partridge) was to visit the stands at OCCA 32. He is depicted (centre) with the President of the Association, Dr Francis Smith (left) and the Director & Secretary of the Association, Mr Robert Hamblin (right) outside the room on the mezzanine floor occupied by Cray Valley Products Ltd

# Exhibition Report 1980

## Additives, Driers, Surfactants etc

### BLAGDEN CAMPBELL CHEMICALS LTD

*Shamrock* micronised waxes and thixotropic additives for printing inks.

*Busan* barium metaborate/*Buckman Laboratories Inc. USA*

*Cabosil* finely divided silica.

### CIBA-GEIGY PLASTICS & ADDITIVES LTD

*HT.1947GB*, a new low risk acid hardener suggested as an alternative to conventional anhydride hardeners in conjunction with *T.1946GB epoxy resin* in the manufacture of powder coatings.

### CRAY VALLEY PRODUCTS LTD

*Antisettle CVP*, a thixotropic agent recommended for use in weaker aliphatic solvent based systems.

*Crayvallac MT*, a new additive to cover the range of uses between *Antisettle CVP* and *Crayvallac SF*, a structuring agent having good high temperature stability and resistance to "seeding". Forms stable gels with stronger solvents.

### DOW CHEMICAL CO. (AGENTS K&K / GREEFF CHEMICALS LTD)

*Dowcil 75*, in-can preservatives for water based systems such as adhesives, dispersion paints, and metal working fluids.

*Methocel Cellulose Ethers*, yields paints having improved storage stability and good viscosity characteristics.

### DURHAM CHEMICALS LTD

Data on *Nuosept 95*, a low toxicity biocide and *Nuodex 87* were presented together with details of other biocides in the Company's range.

Recent information on *Nuodex* and *Curwen* driers is available.

*Durham zinc dust*, performance data on this range of anticorrosive pigments was demonstrated, as well as the range of Talc products produced by *S. A. Des Tale de Luzenac*.

### S. A. FLORIDIENNE

*Micro Powders*, exhibited their range of *Polyfluos* products, also other synthetic and polyethylene waxes.

The full range of *Johncryl* acrylic polymers manufactured by *S. C. Johnson and Son Inc.* was on show.

*Johncryl 678*, a hard resin for good gloss, water alcohol and glycerol based inks.

*Johncryl 67*, a hard resin of excellent gloss.

*Johncryl 74F*, for overprint varnishes.

*Johncryl 77*, for high gloss and water resistance.

*Johncryl 89*, styrenated acrylic dispersion for high gloss, fast drying water flexo and roto inks and coatings.

### GRILON (UK) LTD

*Grilonit H82049* and *CH82050* were on display – phenol free aliphatic polyamines having fast curing properties and excellent mechanical and chemical resistant properties when used as curing agents.

### HARLOW CHEMICAL CO LTD – HARCO/RCL

*Cuprosec Driers* and *Cuprinol* were publicised.

### N. L. CHEMICALS

*Polytrope 1131*, a rheological additive for unsaturated polyester resins and *Bentone 128* the latest addition to this range of *Bentone* gellants for use in printing inks were exhibited.

Data on *Rheolate 1*, a new rheological additive for acrylic and styrene/acrylic emulsion paints was also displayed.

### VICTOR WOLF LTD

*The Wolfamid 500* series of polyamides for use in thixotropic alkyd resins were shown, together with the recently introduced *Wolfamid 26*, an alcohol soluble polyamide for ink formulation. This has a high alcohol solubility, good solvent release and water resistance.

## Chemical Intermediates

### BLAGDON CAMPBELL CHEMICALS LTD

Exhibited information on their solvents and chemical intermediates.

### CIECH

Provided data on a wide range of intermediates and chemicals manufactured by *Ciech Petrolimpex*, *Ciech Plastofarb* and *Ciech Polfa*. Organo-tin antifouling compounds were also publicised.

### DURHAM CHEMICALS LTD

Publicised *Nuosept 95* a low toxicity biocide, as well as the *Nuodex* and *Curwen* range of driers.

### DOW CHEMICAL CO. AGENTS K & K – GREEFF CHEMICALS LTD

Featured *Dowcil 75*, an active low toxicity biodegradable in-can preservative.

### S. A. FLORIDIENNE NV

*Micro Powders Inc.* exhibited their range of synthetic and polyethylene waxes. The unique high slip range of *Polyfluos* waxes was technically presented.

### HARLOW CHEMICAL CO. LTD

Featured their range of *Cuprisec* driers.

## SCOTT BADER CO. LTD

Exhibited information on *Texicryl 23 - 255* a flow and levelling aid for gloss and semi-gloss water based paints.

### Extenders, fillers and gellants

## MORRIS ASHBY LTD

Publicised the range of *Plastorit* additives, of interest as special extenders in certain types of anticorrosive paints.

## CAVADELL LTD

Exhibited their range of *Gelor* gellants and additives for the surface coatings industry. These are organically modified clays produced by *Co. pro. chi. SA* and impart increased viscosity and structure reinforcement.

The company also showed their range of pre-gels in various solvents and *Gelor* with a polar additive.

## DURHAM CHEMICALS LTD

Presented the range of French talc products made by *S. A. de Talc de Luzenac*.

## H. HAEFFNER AND CO. LTD

Introduced *Exomax* mineral fibre, as an alternative to asbestos in surface coatings. Also publicised was the range of *Myanit Dolomite* fillers; these are available in varying mesh sizes for use in plastics, paints, adhesives, jointing compounds and rubber compounds.

## LAWRENCE INDUSTRIES

Exhibited the *Englehard Minerals and Chemicals inc.* range of specialist clays, aluminium silicates, and calcined Kaolin extenders. *Satintone 5* the newest addition to the calcine kaolin range combines a high brightness with small particle size, this latter addition enables some degree of thixotropy to be obtained.

The micronised *Attapulgate (Attagel 50)* is an efficient structuring agent, and is suitable for both aqueous and solvent based systems.

## MICROFINE MINERALS AND CHEMICALS LTD

Showed their range of *Microcarb* chalk whittings. Both standard and surface treated grades are available in a range of controlled particle size distribution.

A full range of talcs, barytes and marble carbonates are also available to the industry.

*Microfine Minerals* also offer *Micronex* products, which are specially formulated to any customers requirements.

## N. L. INDUSTRIES

Exhibited data on *Rheolate 1*, a new rheological additive for acrylic and styrene acrylic media, and *Polytrope 1131* an additive for polyester resins.

The *Bentone* range of gellants was also publicised including *Bentone 128*, the latest addition to this series for printing inks, where ease of incorporation is of importance.

## Laboratory apparatus and testing equipment

## BAIRD AND TATLOCK (LONDON) LTD

A number of new developments in instrumental measurement were on display.

*Brookfield Rheology Viscosity Recording System*, this instrument provides a continuous record of viscosity as a function of time and temperature.

*Wells Brookfield Micro Viscometer* for the determination of viscosity where very small samples must be accurately measured.

*Wells Brookfield cone and plate viscometer, Colora K4.DS*, this has a circulating bath and temperature control.

## CONTRAVES INDUSTRIAL PRODUCTS

Featured a number of new viscometers.

*Rheomat 115*, a concentric cylinder measuring system which gives higher rotational speeds (780 rpm max.) wide shear rates, digital LED displays, torque indication of 0-1000% $\infty$  without switching, shear range selection using modules and integral temperature regulation chamber. This instrument is complemented by the microprocessor controlled *Rheoscan 115*, an integrated programmer/recorder, which enables a wide variety of rheograms to be automatically plotted.

*Rheotemp*, a high temperature measuring system to obtain measurements up to 350°C. This is available with either a concentric cylinder or cone and plate measuring system.

*Rheomat 30* was shown coupled to a calculator and plotter enabling completely automatic viscosity measurement to be recorded.

The *Covitemp* process viscometer for use in hazardous areas and signal conversion equipment for siting in a control room was shown.

Standard products on view included the 15 speed *Rheomat 15T* and the *STV* and *TV* control instruments.

## C & W SPECIALIST EQUIPMENT

*The Mebon Prohesion Cabinet* provides a novel method of testing and evaluation of paints, particularly primers.

*The Humidity Cabinet TBM 4N* complying with BS 3900 F2 has a separate control module incorporating an optional chart recorder.

*The Salt Spray Cabinets* operating to BS 3900 F4 and ASTM B117 were also exhibited.

## COULTER ELECTRONICS LTD

This company exhibited a wide range of instruments including the *Coulter Nano Sizer* designed for measuring the average particle size in the range 40-3000 nm of colloidal suspensions and emulsions.

*Coulter Counter model TA11 and Population Count Accessory*, a rapid particle size analyser giving a 16

point size distribution typically within 90 seconds. It covers an overall size range of 0.6-800 microns.

*Micro Meritics Sedigraph 5000 D* analyses particles within the range 01-50 microns yielding a direct plot of weight per cent versus diameter on a chart recorder. The analysis time is typically 45 minutes.

*Auto Pycrometer*, capable of measuring specific gravities to an accuracy of  $\pm 0.002$  gm/cc. Other standard instrumentation exhibited included the *Micromeritics High Speed Area Analyser* for surface area determination, and the *Model 7500 Series HPLC System*, a fully integrated liquid chromatography system available either as individual items or as a complete system. Both gradient and isocratic options are available.

#### EIGER ENGINEERING LTD

This company exhibited a 0.1 litre "Mini Motormill" which produces realistic laboratory samples of 50-350 ml in 10-20 minutes. It is completely self-contained with built-in pump and pre-disperser for either batch or continuous production.

Also exhibited was the 1 litre *Laboratory Motormill*, this has an interchangeable rotor, designed for optimum gloss and colour development of very thin to quite viscous products.

#### ELCOMETER INSTRUMENTS LTD

On show was the *Elcometer 250 S* the latest instrument in a series of portable coating thickness gauges, having a digital read out. The *250 FS* has been developed for non-ferrous coatings on ferrous substrates and the *250 NS* for non-conductive coatings on non-ferrous metals. These instruments have instant switch over from imperial to metric units, a hold feature (read out retained until the next reading is taken) and auto-off switch when not in use.

The *Elcometer 151* a refined version of the *Elcometer 150* as well as the *205 High Voltage DC Porosity Detector* were exhibited, also the *Gloss gard II*, a small fully portable digital glossmeter, the *Taber Abraser Model 503* and a representative range of the *Erichsen Instruments*.

#### ENGLMANN AND BUCKHAM ANCILLARIES LTD

This Company exhibited the *Photomarker Colour Analysis Systems*.

The *Photomatch PM 300* is specially designed for shade and colour matching. The *Photomatch PM 400* measures colours in terms of the standard three colour scale. This is a lightweight portable instrument incorporating an instantaneous self-contained data printer giving an alpha numeric coded record of results. Samples are numerically coded to colour data and automatically advanced for easy identification. Multiple readings can be averaged and automatically combined into a standard.

The latest addition to the range, the *Photomatch 500* is designed for both reflectance and transmittance measurements of solid materials, powders, liquid films and glass samples.

The unit has automatic calibration, immediate digital display, and selection of YXZ, Yxy, Lab or  $\Delta L \Delta a \Delta b$  and  $\Delta E$  data together with an optional alpha numeric character printer.

#### F. M. K. INTERNATIONAL LTD

Owing to industrial problems, this company was unable to exhibit their *Check Scan* self-contained microprocessor designed to control up to three electronic balances. The unit offers the user a sophisticated and durable check weighing unit, easily operated by non-technical personnel after minimal training. The instrument virtually eliminates errors in the weighing of materials, and the information provided by the unit on the quantity of materials used enables a close control to be maintained on stock levels.

#### JOHN GODRICH

This Company exhibited their range of environmental testing cabinets including the *Credit Humidity Cabinet* this new addition enables tests to ASTM 2247 or ISO 6270 to be carried out. The *Liebisch S - 400 Salt Spray Cabinet* conforming to ASTM B117, BS, DIN and CASS tests was shown for the first time.

Technical data on the *KS 300 Sulphur Dioxide (Kesternich) Cabinet* and the larger version of the Salt Spray Cabinet the *F1000* was available.

#### GLEN CRESTON MACHINERY LTD

This company, agents for *W. A. Bachofen A.G.* exhibited a laboratory size and pilot scale *Dyno Mill*.

#### M.S.E. SCIENTIFIC INSTRUMENTS

A wide range of viscometers of various types was demonstrated, as well as other instrumental testing apparatus.

The *Mettler FP 61 automatic melting point recorder* was on show. This instrument has variable heat input allowing the temperature to be rapidly raised to a pre-determined value, after which the temperature increase can be controlled at a slower rate. An automatic recorder can be attached if required. (Vitraton.)

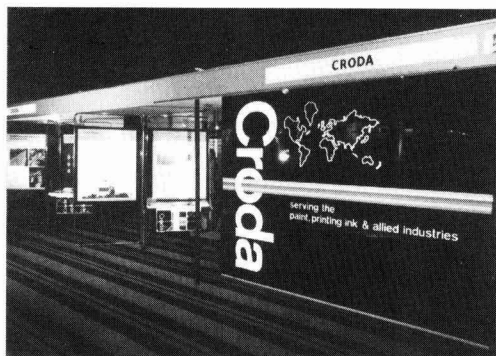
The *Haake PK 100* cone and plate viscometer having a wide range of cone sizes up to the plate diameter of 10 cm, with a standard temperature range of up to 200°C and a read-out of 0.1°C.

The *Haake RV12* viscometer, using transducer and electronic technology, and having a shear range of 50,000 to 1 and a full-scale torque deflection of half a degree is ideally suited for thixotropic products.

The *Haake RV2* is a versatile steady shear viscometer, having a range of  $10^6$  to 1, and a maximum torque of 5 Kg cm.

The *Viscotester VT181/24* is a hand-held viscometer giving precise measurements at known shear rates. It can be upgraded by the addition of a wide range of attachments to give a versatile development instrument.

The *Mettler DL40 Memotitrator* is a microprocessor controlled titrator capable of acid/base, redox, and chloride determination. The results are displayed on a print out.



## MACBETH DIVISION OF KOLLMORGEN (UK) LTD

The following instruments were exhibited:

*The MS 4045 Colour Measuring System* an on-line colour monitor for continuous checking of colour on coil and web fed machines, it displays variations from previously set quality standards.

*The MS 2000 Spectrophotometer* and the *MC 1010 Colourmeter* are fast accurate instruments yielding easily understood information to the operator.

## MICROSCAL LTD

This company exhibited a range of instruments for the examination of adsorption/desorption phenomena, optical and X-ray sedimentation modes of particle size determination, light fastness testing, and powder sampling.

*The Microscal Flow Microsedimentometer* is used to determine heats of interaction at solid/liquid interfaces, particularly adsorption/desorption phenomena such as surface area determination.

*The Wide Angle Photosedimentometer* uses the gravitational/optical sedimentation technique to determine the size distribution of powders in the range 100 to 2.0 micrometers.

For repeated analyses the Scanning version *WASP* is suggested.

Two X-ray sedimentometers are available, the *Microscal - Ladal X-ray Sedimentometer* offers comparatively rapid analyses of sub-sieve powders, the scanning model covers the range 75 - 1 micrometers and the centrifugal model 5 - 0.01 micrometers.

*The Light Fastness Tester* is an inexpensive compact and simple means of making repetitive and multiple light fastness tests.

*The Spinning Riffler* is designed to produce statistically representative powder samples by means of a vibrating chute and rotating sample tube table. Sixteen samples are taken on each run.

## THE Q-PANEL COMPANY

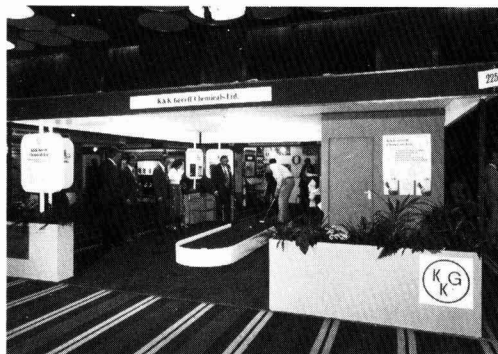
The following items of equipment were shown.

*The Q.C.T. Condensation Tester* for testing coatings for resistance to condensation in the form of rain or dew.

*The Q.U.V. Accelerated Weathering Tester* evaluates the resistance of materials to both moisture and sunlight. The condensation system is simple, and the effect of sunlight is simulated by an array of eight special fluorescent lamps. Light emission is concentrated in the critical UV wavelengths to give closer control and faster testing.

## SARTORIUS INSTRUMENTS LTD

A selection of electronic analytical and top-pan balances were exhibited. The electronic range of balances now includes the new 80-0.0001 g top loading





balance and the range of balances available now covers weights from 0.1 microgram to 60 Kg.

Data processing equipment includes keyboards for specific applications such as formulations and gross/tare/nett + - weighing.

#### SCALE SERVICES

This company exhibited a selection of *Sauter* electronic balances including the new *RL4* automatic dual range electronic balance with weighing ranges of 0-1200 g  $\times$  0.01 g and 0-3500 g  $\times$  0.1 g. A heavy duty electronic balance the *RA 25 kg*  $\times$  1 g mixture balance having three separate display characteristics, individual weight of the last ingredient, total nett weight of combined ingredients and total gross weight (container and ingredients) was also on show. It is available in a wide range of capacities.

#### SHEEN INSTRUMENTS LTD

Apart from the standard range of paint testing instruments, a new *Portable glossmeter* was displayed having three alternative heads. This was a pre-production model.

#### VICKERS INSTRUMENTS

This company featured the *Joyce-Loebl Disc Centrifuge* capable of producing absolute particle size distribution curves in the range 0.01 to 30 microns. The Photosedimentometer attachment produces comparative size distribution curves rapidly by the continuous monitoring of particles as they move past a light beam.

*Magiscan Image Analyses Systems* were featured. These offer a wide variety of software-based automatic image analyses systems.

#### Manufacturing equipment, containers etc.

#### EIGER ENGINEERING CO

Exhibited their range of *Eiger Motormills*. These direct drive agitated bead/sand mills are available in sizes ranging from 10 to 75 litres.

#### FILLWORTH LTD

Two ranges of mills were publicised, the *Fillworth* and the *Glenfield*, ranging from simple stirrers to the unique Fillworth patented *Batchmaster*.

This latter series *VGM*, is available in sizes ranging from 50 to 600 gallons and up to 4000 gallons by special order.

A recently developed portable rotor/stator high shear mixer the *FG/HD* range is available in sizes ranging from 1-25 HP.

The *Glenfield DMD High Speed Mixer* and the *Clip on Stirrer* were also displayed.

#### GLEN CRESTON MACHINERY CO

The range of industrial size *Dyno Mills* were publicised on this stand, including details of the newly developed *Dyno Mill KD 175*.

An example of the *Bachofen Turbula Mixing Pulsater* for dry mixing was on display.

#### JOHN GODRICH

Exhibited a range of *Chemicol* mixers which are available in sizes ranging from laboratory equipment to industrial.

The *Rotostat Type X* range was also shown together with the *Type T*.

These machines are designed to process high and low viscosity fluids.

The *Robojet* axial jet mixer for effective mixing and agitation without air intrusion, and the new *Rapidex* anchor stirrer for agitation were shown for the first time.

#### H. HAEFFNER & CO. LTD

Demonstrated the *Westerlins* line of high speed dissolvers.

#### JENAG EQUIPMENT LTD

This company displayed their enclosed *Self Cleaning Strainers*. The air operated unit has a low cost monofilament mesh of polyester or nylon, and the back-washing action provides a reverse flow of liquid through the straining mesh to maintain it in a clean condition.

#### MARCHANT BROTHERS LTD

This stand featured its established range of *Triple Rolls* which range in size from 77  $\times$  150 mm to 40  $\times$  1000 mm.

These machines can be fitted with manual or hydraulically applied roll pressure and roll heating and/or cooling. Most machines have a two speed drive, whilst the machine design can be matched to suit a particular range of products.

#### MASON & MORTEN (ENGINEERING) LTD

Three types of machinery were featured on this stand:

The *Co Ball Mill*, the *Toothed Colloid Mill*, and the *Corundum Stone Mill*.

The *Co Ball Mill* has a narrow grinding chamber through which the suspension is forced to flow, thus yielding a fine product of narrow particle size range. Having a high surface to volume ratio, the grinding chamber cooling is efficient, allowing heat sensitive products to be treated.

The *Toothed Colloid Mill* is designed for the coarse grinding of pigment particles in a range down to approximately 0.1 mm, and for the emulsification and homogenising of any liquid.

It is a useful item of equipment for pre-treatment of products prior to the use of the *Co Ball Mill*.

The *Corundum Stone Mill* treats suspensions of particulate solids and reduces the particle size to about 10 microns.



Information on *Fryma Mills*, rotary pumps and vacuum deceleration plants was also available.

#### MASTERMIX ENGINEERING CO. LTD

This company is now specialising in the design and manufacture of complete systems for the production of surface coatings with an emphasis on automatic control of all processes.

The following products were featured:

*Mastermill*, a range of horizontal bead mills recently increased by the introduction of the *Mastermill 5* a 20-100 litre/hour production unit.

*PMD Range*, this series of high dispersers is available with capacities ranging from 1350-15000 litres, and all are fitted with a high and low speed head and a low speed cage. Most machines are fitted with the *Mastermix Autoraise* system giving automatic control of the high speed disperser position.

*Deaerator*, this machine enables rapid deaeration of all pastes and liquid materials. It is available in capacities ranging from 1000-3000 kg/h.

*Change Can Dispersers*, a range of heavy duty change-can dispersers with a power requirement of 11 kw upwards.

#### VEB KOMBINAT NAGEMA

This company exhibited the products of *Maschinenfabrik Heidenau*. These include triple roller mills ranging in size from 280 x 540 mm to 400 x 1000 mm, both inclined and horizontal types are available.

#### NETZSCH (UK) LTD

Exhibited a range of *Horizontal Bead Agitator Mills*. The *Netzsch John System Horizontal Mills* are designed for the production of chip quality NC and polyamide flexigraphic inks from dry colour premixers.

The *LME Series of Horizontal Mills* have proved extremely successful in the manufacture of automotive primers, these are associated with the *Netzsch Molinex Agitators*.

#### ROBAN ENGINEERING LTD

This stand featured a selection of *Tokheim* positive displacement flowmeters, which are available in a variety of materials and construction, together with the *R3000* series of solvent pumps. This includes a low speed version for resins and thinned varnishes.

Details of the *R400* road tanker offloading pump were available.

#### WERNER AND PFLEIDERER (UK) LTD

The *Twin Screw Compounding Extruder Type ZSK 30*, was featured as a production unit for powder coatings.

This machine converts a dry premix of polyester, epoxy, acrylic etc., resins fillers and additives into a well dispersed hot viscous strip for subsequent cooling and grinding.

The *WK 200* powder cooler was also featured as a supplement to the *ZSK 30*. The range of compounding extruders covers capacities from 5-50 kg/h to 1500 kg/h.

#### Pigments

##### MORRIS ASHBY LTD

Featured information on *Zincoli* zinc dusts, for zinc rich and other anticorrosive primers, *Zincoli* zinc oxide for fungistatic and pigmentary uses, and *Zincoli* colloidal zinc oxide of current interest in powder coatings.

Also exhibited was information on the *Deanox* synthetic iron oxides, both red and yellow shades and *Deanox* red lead.

##### BLAGDEN CAMPBELL CHEMICAL'S LTD

Exhibited *Busan II.M.I* barium metaborate (*Buckman Laboratories USA*) as an anticorrosive pigment in both solvent and water based primers. It also has fire retardant properties and may be used as an extender for antimony trioxide.

##### CHEMOLIMPEX

Listed both chromium trioxide and zinc chromes among their products.

##### CIECH

Listed zinc chromate, zinc tetroxy chromate, chrome yellow, basic lead sulphate and ultramarine among the products of *Ciech Plastofarb*.

##### DURHAM CHEMICALS LTD

Exhibited exposure panels demonstrating the performance of *Durham* zinc dusts in anticorrosive primers.

##### FOSCOLOR

Examples of this company's dilute and concentrated dispersions of individual pigments in epoxy, polyester, and acrylic resins for direct colouration of powder coatings were shown, also their range of dry tinters for gloss emulsion paints.

##### H. HAEFFNER & CO. LTD

Introduced *Hitox* a buff coloured pigment consisting mainly of rutile TiO<sub>2</sub>, its use is recommended in as a cheaper alternative to titanium dioxide where the colour is not an important factor. Also publicised was Haeffners range of synthetic and natural iron oxides, and their range of organic pigments.

##### INDUSTRIAL DISPERSIONS LTD

Data on the types of pigment dispersion were exhibited.

The *Long Oil Alkyd (LOA) Range* with high pigmentation for use as stainers or for total pigmentation.

The *Glycol Based (GLY) System* designed for use in aqueous systems and for decorative alkyd paints.

The *Universal Non-Aqueous (UNA) System* for use in a wide range of media such as acrylics, chlorinated rubber, short oil alkyds, epoxies, polyester, polyurethanes and vinyls.

Other ranges available include epoxy, polyester, plasticisers, and oil dispersions, as well as transparent iron oxides.

#### LAPORTE INDUSTRIES LTD

This exhibit featured the *Tiona* range of  $TiO_2$  pigments with special reference to *Tiona 535*. This versatile grade was developed to give exceptional gloss and stability in semi-gloss and gloss emulsion paints, and critical industrial finishes. It possesses a high level of durability not normally associated with high gloss grades of  $TiO_2$ .

Other grades described were *Tiona 472* and *Tiona 552*, stressing their applicability in high solids, ambient temperature cured and water based coatings and *Tiona 535* as a cost effective pigment in vinyl silk emulsion paints.

#### N. L. CHEMICALS in association with KRONOS TITANIUM PIGMENTS LTD

Apart from the wide range of *Kronos* titanium dioxides, one new grade was exhibited.

*Kronos 43E* developed for emulsion paints, also shown was *Kronos CL220* a pigment giving excellent performance in powder coatings.

*Nalzin SC1*, a lead, chromium free anticorrosive pigment was also featured.

#### SCOTT BADER & CO. LTD

Featured their range of *Crylic* pigment pastes specially formulated for use in polyester resins, the range is also being developed for other applications.

#### SILBERLINE LTD

Several new aluminium pigment products were introduced, including *Sparkle Silver 5306AR* and *Sparkle Silver 5101AR*, these have outstanding DOI and distinctiveness of image clarity, compared with other grades of pigments. The standard grades of aluminium pigment were publicised as was a new range of leafing aluminium flake the *Eternabrite* series, produced by *Silberline Manufacturing Co. USA*. These products have excellent storage and leafing retention properties.

#### SWADA (LONDON) LTD in association with H. HAEFFNER & CO. LTD

This company's range of daylight fluorescent pigments was exhibited with the accent on their new products in the *Thermoset T Series*, particularly *Apollo* and *Gemini Red*.

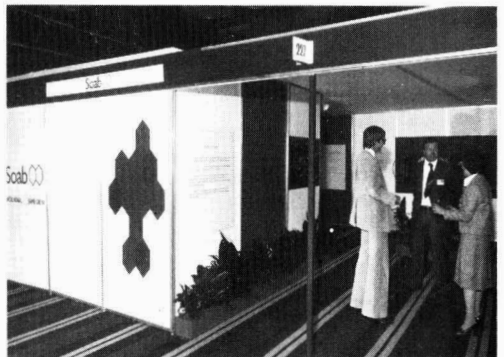
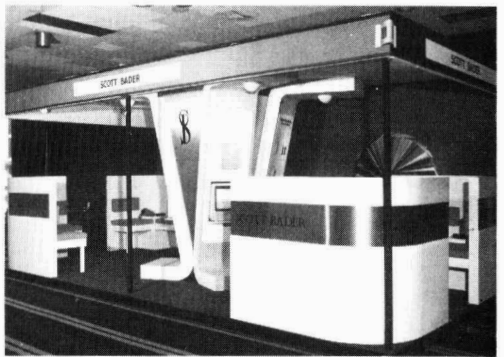
These have improved strength without loss of brightness, and possess improved solvent and light fastness.

Two additions to the *E. Extra Strength Fiesta Series* have been made, *Fine Orange E4/1* and *Blaze E5/1*.

#### TIOXIDE INTERNATIONAL LTD

This stand featured two new additions to their range of *Tioxide Pigments*.

*Tioxide R-TC90*, a durable chloride grade with excellent gloss, dispersion and hiding power



characteristics in a large range of aqueous and non-aqueous finishes. The second is a superdurable grade having all the requisite properties for a long life in industrial finishes.

*Tioxide T-TC4* was also publicised as a multipurpose pigment having superior brightness.

The *Tiotainer* packaging concept was also featured, as a new method of rapidly discharging pigment into dispersion equipment.

## Resins

### BLAGDON CAMPBELL CHEMICALS LTD

This company exhibited a range of thermoplastic resins manufactured by *Neville-Cindu Chemie BV Holland*. These included:

*Necires LF and LX* having good compatibility with polymers, oils, plasticisers and solvents.

*Nevroz*, an ink grade modified hydrocarbon resin.

*Nevchem* alkyl-aromatic resins, non-saponifiable, non-polar and non-reactive.

*Necires* epoxy extenders are liquid hydrocarbon products designed for use as extenders and plasticisers for solvent free and high build epoxy formulations.

### BRITISH INDUSTRIAL PLASTICS LTD

Illustrated the characteristics and performance of the following "Beetle" resins:

*BA540*, a semi drying, short oil alkyd suitable for fast curing and catalysed alkyd/urea wood lacquers and low-bake alkyd melamine finishes.

*BA503*, an oil free alkyd of high acid value, compatible with "Beetle" urea and melamine resins. It gives good adhesion to difficult heat sensitive substrates such as PVC.

*BA531*, a carboxyl terminated saturated polyester for use with epoxy resins in powder coatings. Suitably formulated systems yield films with good mechanical properties as well as heat, corrosion and humidity resistance.

*BA691*, a low odour isobutylated urea resin.

*BE692*, a melamine resin suitable for low-bake systems.

### CHEMOLIMPEX

Hungarian synthetic resins were publicised.

### CIBA-GEIGY PLASTICS AND ADDITIVES CO.

Exhibited data on a new range of epoxy resins, hardeners and polyester products for powder coatings.

*X9 110* polyester resin for use with epoxy resins in powder coatings yields films of good flexibility and stability.

*Aqueous Powder Suspensions*, this new development enables thinner films to be applied by conventional means whilst giving the high performance properties of powder coatings.

A complete range of the technical data of *Araldite* products was also featured.

### CRAY VALLEY PRODUCTS LTD

This company's entire range of resins was featured, *Synolac Alkyds*, *Gelkyd* thixotropic binders, *Synocryl* thermo-setting acrylics *Synocure* cold-curing acrylics, *Unithane* urethane polymers and *Versamid* polyamides.

Among newer products were *Super Gelkyds* a range of thixotropic binders of improved performance, and the extended range of *Crayvallac* structuring additives.

A display of operating information retrieval equipment was of considerable interest.

A new acrylic resin for powder coatings was also featured.

### CRODA

All *Croda* divisions contributed to this stand.

High solids systems based on *Croda* resins were featured as were water soluble systems.

Silicone co-polymers and their applications were displayed.

*Croda* alkyds, vinyl modified alkyds, urethane modified resins and hard resins were also featured.

### GRILON (UK) LTD

In collaboration with *Emser Werke AG* a range of products for powder coatings and water dispersible systems were shown.

*Grilesta P7304* for exterior applications having good gloss retention and weathering properties.

*Grilonit H88092*, a new anhydride curing agent with good storage stability.

*Grilonit GE38.2031*, a water dispersible epoxy resin having good gloss retention and improved solvent resistance.

*Grilonit LX2501.80*, an epoxy resin which when cured produces a more highly cross-linked structure than that obtained using bisphenol resins.

### HARLOW CHEMICAL COMPANY LTD HARCO/RCL

Displayed on this stand were the Company's range of water dispersible resins.

*High Opacity Emulsions* giving rise to improved opacity in coatings.

*Revacryl 480*, a flexible emulsion with particular application in roofing compounds.

*Emultex 586*, a PVA homopolymer exhibiting versatility in packaging and adhesives.

*Emultex 501*, an emulsion for compounding into remoistenable adhesives.

*Mowilith DHK*, a resin for two pack water resistant wood adhesives.

*VA/E Emulsions*, a number of new developments in this field were demonstrated.

#### HERCULES POWDER CO. LTD

On display were details of this company's wide range of resins and water soluble polymers. The current range includes those based on rosin, modified rosin and hydrocarbon monomers. Others in this range include aliphatic, aromatic, functional, pure monomer and terpene hydrocarbon resins.

Recently introduced products include harder, higher melting point resins, phenolic derivatives and hydrocarbon resins, new water soluble polymers designed for use in emulsion polymerisation, adhesives and the building industries were highlighted.

#### K & K - GREEFF CHEMICALS LTD in association with KIRKLEES CHEMICALS LTD

Kirklees Chemicals Ltd promoted their range of "Viking" emulsion polymers.

#### PARAGON CHEMICALS LTD

Exhibited a wide range of resins under the *Paragon* trade mark.

*Paragon 834*, a high quality decorative medium.

*Paragon 807 and 812* thixotropic resins for all types of finishes.

*Paragon 786* polyurethane resin for industrial finishes having good alkali resistance.

*Paragon 687*, an epoxy modified medium for universal primers.

*Paragon 337*, a stoving medium used in conjunction with white spirit tolerant urea formaldehyde resins.

*Paragon 744* specially formulated for wrinkle finishes.

*Paragon 418* oleoresinous medium for metallic paints.

#### SANYO-KOKUSAKU PULP CO. LTD

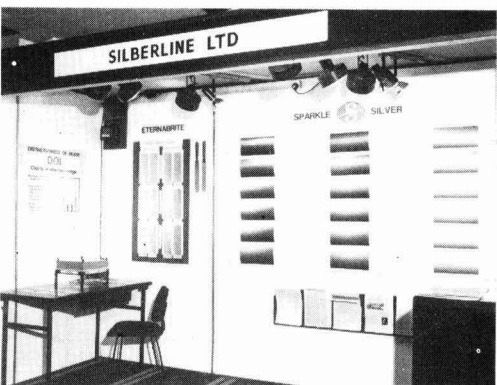
The range of *Superchlon Chlorinated Polyolefines*, including *Chlorinated Polypropylene (CPP)* and *Chlorinated Polyethylene (CPE)* were exhibited. Performance of coatings and formulations based on these resins were available.

#### SCHERING CHEMICALS LTD

This company's range of resins includes:

*Eurepox\** - epoxy resins, *Euredur\** - hardeners for epoxy resins, *Euresyst\** - epoxy resin systems, *Eurelon\** - thermoplastic polyamide resins, *Euretek\** - adhesion promoters for PVC, plastisols and polyurethane resins for sealants.

A new development - the *Polyurethane resins* have been produced for one-component sealing compounds having excellent properties as regards short skinning time (10-45 min.), fast through hardening at low temperature no foam build up, excellent light fastness, good shelf life, and high elasticity and good resilience.



## SHELL CHEMICALS LTD

This exhibit highlighted a number of new *Epikote* resins for powder coatings. *Epikote 2035, DX 304, DX 306* and *DX 307*. Also a new medium viscosity liquid *Epikote DX 235* has been introduced together with a high molecular weight *Epikote OL*.

Developments in aqueous latices; *Veova 10* based reactive latices, and hydroxyl-rich *Epikote/Cardura E.10 resins* were on view.

## SOAB AB

The following additions to the well known *Soab* range were exhibited.

*Soalkyd 1430* – a saturated polyester for appliance finishes.

*Soalkyd 7711* – a saturated polyester recommended as the main bonder in water dispersible stoving finishes.

*Soalkyd 3142* – an air drying isocyanate modified TO alkyd for use in interior finishes requiring good household chemical resistance and abrasion resistance.

*Soalkyd 3160* – a medium oil chain stopped soya alkyd for general purpose industrial finishes.

*Soalkyd 3495* – similar to *Soalkyd 3160* having excellent hardness.

*Soalkyd 9485 VT* – an air-drying vinyl toluenated short oil alkyd with excellent drying properties and compatibility with short and medium oil length alkyds.

## SYNTHETIC RESINS LTD

This company gave details of their range of powder coating resins, water based resins, UV curing systems and high solids resins. Particular importance was given to *Velporex 68 – 648 AF* and *Velporex 68 – 659 AF* as complete ink varnishes. *Velporex 68 – 659 AF* is used in sheet fed and infra red offset inks.

## UCB, S.A.

A wide range of products designed to be non-polluting were featured.

*Ebecryl*<sup>®</sup> oligomers and *Uvecryl*<sup>®</sup> photoactive agents for UV and EB curing systems.

*Crylcoat*<sup>®</sup> polyester resins for electrostatic powder coatings.

The series of radiation curing materials distributed by *Honeywell and Stein Ltd* includes oligomers (urethane acrylates, epoxy acrylates, polyester acrylates, and straight acrylates). Photoactive compounds and polyfunctional monomers such as BEEA, BUDA, DEGDA Ebecryl 150, HDDA, NPGDA, OTA 480, PETIA, TEGDA, TMPTA and TPGDA.

*Crylcoat* reactive polyester resins for thermosetting electrostatic powder coatings were also described. (*Distributed by Brandhurst Ltd*).

## VINYL PRODUCTS LTD

The display publicised a range of polymer emulsions which were broadly based on the following categories: categories:

Air-drying and forced drying wood finishes with excellent solvent resistance (*Vinacryl 4039*). Forced drying finishes for fibre and particle board. Mineral fibre board finishes with long term durability. Metal finishes for equipment finishing (*Vinacryl B 40130, Vinacryl 7175*). Durable high build exterior coatings. Conventional external decorative finishes (*Vinamul 3401*). Interior decorative finishes (*Vinamul 34067*). Adhesives (*Vinamul 3253, 3260, 9910, Vinacryl R71181, Vinamul 8450, 8455, 9900*). Roofing compounds (*Vinamul 3240*).

## SCOTT BADER CO. LTD

Highlighted two developments from its range of emulsion and water solution polymers.

*Texicryl* styrene/acrylic copolymer for water resistant ceramic tile adhesive to BS5385.

*Polidene* fire retardant and moisture resistant vinylidene chloride polymers.

---

*The Exhibition Committee is indebted to the Hon. Editor, Mr D. S. Newton for his work in the compilation of this report. All photographs in the Exhibition Report were taken by the Exhibition Official Photographer, RON LUCAS PHOTOGRAPHY LTD.*

## Jordan Award

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

The rules of the Award are:

1. The Award will be made for the best contribution to the science or technology of surface coating by a Member of any nationality working in

either the academic or industrial field who is under the age of 35 at the date of application.

2. The final date for submission of applications will on this occasion be 31 December 1980 and it is hoped to present the award at the Bath conference in the following June.

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

4. There will be two methods of application. First, by the submission of a

paper describing original work by the candidate which is offered for publication in the *Journal* or has been so published during application. The alternative method will be by recommendation by a superior for work which for reasons of commercial secrecy cannot be published; in this case the candidate will be expected to submit a dissertation on a topic relating to his work and demonstrating his superior knowledge 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 Association's offices.

# OCCA-33 Exhibition

28-30 April 1981 Cunard International Hotel  
Hammersmith, London W6

---

## PRELIMINARY ANNOUNCEMENT

---



*Motif designed by Robert Hamblin*

## The annual focal point for the surface coatings industry

The aim of the Exhibition is the presentation of commercial and technical information relating to raw materials, plant and equipment used in the paint, polymer, printing ink, colour, adhesive and allied industries, both in their manufacture, processing and application.

The Exhibition Committee will be particularly pleased to welcome exhibits from companies relating to the new energy efficient, low-polluting technologies, including powder coatings, high solids coatings, radiation curing, water-based coatings and other developments.

The main part of the Exhibition will be in two sections. The entrance to the Exhibition will be on the ground floor in the new Exhibition Hall, in which exhibitors of heavy machinery, plant and equipment or those wishing to have the traditional style of stand will be situated.

On the first floor, additional exhibitors, mainly of raw materials, laboratory equipment or other small exhibits, will be accommodated in the Queen Mary Suite, in which the stands will be of a modular design. The Queen Mary Suite is a large pleasant room which is decorated and carpeted as an integral part of the hotel.

In addition, several suites and rooms will be available on the intermediate Mezzanine floor and third floor for those companies who wish to use that type of facility to exhibit, or to entertain their visitors in addition to their stands in the main halls.

Admission to the Exhibition will be free, and visitors will be asked to complete registration cards which will be available in advance from the Association with copies of the *Official Guide*. Copies of the *Official Guide* will be charged at £1.50 each, and both registration cards and copies of the *Official Guide* will also be available at the Exhibition.

The Exhibition provides an ideal opportunity for organisations to display and discuss their products and services to a wide spectrum of visitors from all over the world.

The Association is a member of the Association of Exhibition Organisers. This Exhibition has been registered to publish an Exhibition Data Form through the Exhibition Data Division of the Audit Bureau of Circulations to the standards laid down by the Joint Industry Committee.

Organisations wishing to receive further details should contact the Director & Secretary, Mr. R. H. Hamblin, Oil & Colour Chemists' Association, Priory House, 967 Harrow Road, Wembley, Middlesex HA0 2SF, England (Tel: 01-908 1086, Telex: 922670 OCCA G).



CHLORINATED POLYPROPYLENE  
&  
CHLORINATED POLYETHYLENE



It'll help you  
in formulating  
**High build chlorinated  
rubber-type paints** for  
Ships, Tanks, Bridges,  
and other steel works,  
with outstanding  
exterior durability,  
storage stability and  
airless sprayability.

Try Superchlon for  
your formulations.

For detailed information, please  
contact:



Sanyo-Kokusaku Pulp Co., Ltd.

CHEMICALS SALES DEPT.

1-4-5 Marunouchi, Chiyoda-ku, Tokyo, Japan

Telex J24279 SKPULP

Cable SANKOKUPA TOKYO

**OIL & COLOUR CHEMISTS'**



**ASSOCIATION**

## **Marine Finishes**

Reprints are now  
available of the OCCA  
Monograph number 1 on  
Marine Finishes by  
Dr T. A. Banfield from the  
Association's offices.  
These bound copies  
reprinted from the  
February and March  
issues of the *Journal*  
cost £2 including post  
and packaging.

## SYNTHETIC ESTERS



## TECHNICAL FATTY OILS

FISH, NEATSFOOT AND LARD OILS

### HIGHGATE AND JOB LIMITED

35 REGENT ROAD, LIVERPOOL L5 9TB

Phone: 051-207 0447

MURRAY STREET, PAISLEY Phone: 041-889 3207

**Paint**  
RESEARCH  
ASSOCIATION

## Patents, Patent Information and the Paint Industry

Chemical patents serve two purposes. Their primary function is to provide protection for an invention. Their secondary value is that they constitute the main source of technical information for many industries, including the paint industry, and provide an indication of the trend of technological development.

The world of patents is growing in complexity.

The significant new developments in patent procedure are changes in national patent laws, the introduction of European patents and the first steps towards international patents. On the information side, there has been a steady growth of patent abstract services and in computerised searching techniques. Matters of patent law and procedure are the province of the patent agent but sophisticated modern searching methods are requiring specialised information scientists. It seems desirable that all those concerned with technical innovation should have a broad overall picture of the subject to facilitate communication with the professional experts. That is the purpose of this survey, which also includes statistics on the international situation, reports of legal actions concerned with paint products, bibliographic references to where more detailed information can be sought, and a glossary of terms.

The subject is considered from three viewpoints: **legal and business aspects; information from and about patents; and patents as indicators of economic trends.**

**Price: £20.00** (Paint RA Members: £15)

*Available (prepayment only) from:* Information Department, **Paint Research Association**, Waldegrave Road, Teddington, Middlesex TW11 8LD.

## CLASSIFIED ADVERTISEMENTS

Classified Advertisements are charged at the rate of £5.00 per single column cm. Advertisements for Situations Wanted are charged at £1.50 per line. A box number is charged at £1.00. They should be sent to D. N. Buddles, Assistant Editor, Oil & Colour Chemists' Association, Priory House, 967 Harrow Road, Wembley, Middlesex HA0 2SF. JOCCA is published EVERY month and Classified Advertisements can be accepted up to at least the 12th, and in exceptional circumstances the 20th of the month preceding publication. Advertisers who wish to arrange for an extension of the copy deadline should contact the Assistant Editor, D. N. Buddles, at the address given above (telephone 01-908 1086, telex 922670 OCCA G).

## SITUATIONS VACANT



### LABORATORY MANAGER DESIGNATE

F. S. W. COATINGS LTD., a subsidiary of the Sherwin Williams Co., Cleveland, Ohio, USA is rapidly expanding and wish to appoint a Senior Chemist to its Decorative Coatings Laboratory.

The ideal candidate would have at least five years experience formulating emulsion paints for the decorative market, and ideally, would also have experience in emulsion fillers and sealants.

The candidate will head up a team responsible for development and quality control and will report directly to the Plant and Technical Manager.

It is expected that this position will lead directly to appointment as Laboratory Manager.

Salary is negotiable and relocation assistance will be given.

Written applications giving brief career and personal details should be addressed to the:

**Plant and Technical Manager,  
F. S. W. Coatings Ltd.,  
Virginia,  
Co. Cavan,  
Ireland**

### Industrial Finishes – The Present and the Future

The Manchester Section of OCCA is to hold a one-day Seminar for Students entitled "Industrial Finishes – The Present and the Future". This is to be held on Friday 19 September 1980 at the All Saints Building of Manchester Polytechnic.

Four papers, each of approximately one hour's duration will be presented under the following headings:

1. Finishes for Paper,
2. Wood Finishes and their Application,
3. Can and Coil Coatings,
4. General Industrial Finishes.

The purpose of the Seminar is to give students a broad background to industrial finishes. Fees for the Seminar will be £10.80 for members and £18.30 for non-members (including VAT). Further details are available from

**Mr G. T. Flood  
Ciba-Geigy Plastics & Additives Company,  
Pigments Division,  
Roundthorn Estate,  
Wythenshawe,  
Manchester M23 9ND**

## MISCELLANEOUS

#### Paint Technologist

A person with first-hand knowledge of paintmaking – able to read and carry out paint formulations is required for a paint factory in Malta.

Qualifications are not important the emphasis being placed on industrial experience, particularly in the fields of Gloss enamels, Undercoats, Primers, Plastic emulsion paints etc.

The post is Tenable for 6 months, 1 year or more. Salary is negotiable. Please write with details to: **Box No. 486.**

#### Patent for sale

The Proprietors of British Patent No. 1381023 for "Improvements in or relating to powder lacquering", desire to negotiate the sale of the patent, or for the grant of licences thereunder. Particulars from: **Marks & Clerk, 57-60 Lincoln's Inn Fields, London WC2A 3LS**

## JOCCA

The largest circulation of UK publications to the surface coatings industries – sent each month to over 80 countries with an estimated average readership of over 22,000.

AT ANY TIME DAY OR NIGHT  
TELEX YOUR CLASSIFIED  
FOR JOCCA – Telex 922670 (OCCA G)

See above for details of rates for Classified Advertisements.

## SITA Opportunities in Paint and Ink

SITA Limited has become the leading U.K. Selection Consultancy which specialises in Surface Coatings appointments.

We are currently handling the following appointments:

1. Oil Inks Laboratory Manager	West Country	£9,000
2. Two progressive jobs for HNC General Industrial Paint Technologists	Midlands	£5,000
3. Wood Finishes Product Manager	N. London	£6,000+ car
4. Technical Development Manager Business Machine Coatings	London	£8,500
5. Wood Finishes Lab. Manager	London	£8,000
6. Young Wood Finishes HNC Chemist	London	£5,000
7. Coil Coatings Product Manager	London	£8,800+ car
8. Powder Coatings Chemist	Midlands	£8,000
9. UV Chemist as No. 2 to Technical Manager	W. London	£7,000
10. Assistant Analyst	London	£5,000
11. Metal Coatings Team Leader	London	£8,000



Candidates are invited to apply, in absolute confidence, to:  
**G. P. Birtles, Esq., SITA Limited, 15a The Broadway,  
Wimbledon SW19 1PS. Tel: 01-947 8175.**

# JOCCA

## READER ENQUIRY SERVICE – JULY 1980

For further information please circle no more than three items:

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20  
 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40  
 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60  
 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80  
 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100  
 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120  
 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140  
 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160  
 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180  
 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200

Name .....

Job Title .....

Company .....

Address .....

Country ..... Telephone .....

Please also send information on the following items relating to the above:

Send enquiries to:

### Journal of the Oil and Colour Chemists' Association

Priory House, 967 Harrow Road, Wembley, Middx., HA0 2SF, England  
 Telephone: 01-908 1086 Telex: 922670 (OCCA G)

AT ANY TIME DAY OR NIGHT  
 TELEX YOUR CLASSIFIED FOR JOCCA  
 Telex 922670(OCCA G)

See page vii for details of rates for Classified Advertisements.

## INDEX TO ADVERTISERS

<b>G</b>		<b>P</b>	
Glen Creston Ltd .....	Cover	Paint Research Association .....	vi
<b>H</b>		<b>Q</b>	
Hardman E., & Son Co. Ltd .....	ii	Q-Panel Co .....	ii
Highgate & Job Ltd .....	vi	<b>S</b>	
<b>I</b>		Sanyo-Kokusaku Pulp Co. Ltd .....	v
Industrial Dispersions Ltd .....	Cover	Sheen Instruments Ltd .....	Cover
<b>J</b>		Sub-Tropical Testing Service .....	Cover
Johns-Manville International .....	i	<b>T</b>	
		Thorn Lighting Ltd .....	Insert
		Tioxide International Ltd .....	iv
		(BTP) Tioxide Ltd	

**AT YOUR SERVICE to develop finer, more durable products**

The fast, economical weather tests of

**SUB-TROPICAL TESTING SERVICE, INC**

established 1929

**Sub-Tropical Testing Service is known and utilised world wide**

Our 51st Year



Send for free  
Sub-Tropical colour  
brochure

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

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

Mr. C. Hubbard Davis, Founder, Sub-Tropical Testing Service, Inc. (1904-1977)  
P.O. Box 560876, 8290 S.W. 120th Street, Miami, Florida, U.S.A. 33156

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

**PRE-DISPERSED PIGMENT  
CONCENTRATES**

**Standard Ranges**

**Or To Your**

**Specification**

**INDUSTRIAL**

**DISPERSIONS LTD.**

**Coach Road Alresford -**

**Colchester Essex CO7 8 EA**

**Tel Wivenhoe(0206 22) 4516**





# INSTRUMENTS TEST

- ABRASION ✓
- CORROSION ✓
- DEFORMATION ✓
- DRYING TIME ✓
- FINENESS OF GRIND ✓
- GLOSS ✓
- HARDNESS ✓
- IMPACT RESISTANCE ✓
- OPACITY ✓
- VISCOSITY  $\frac{10}{10}$  ✓

**Consult  
us - we  
manufacture them!**

**SHEEN INSTRUMENTS LIMITED**

Sheendale Road, Richmond, Surrey, England, TW9 2JL  
Telephone 01-940 0233 and 1717 Telex: 929476 APEX G

