Vol. 65 No. 5 JOCCAB 65(5) 171-210 (1982) May 1982

ANNUAL GENERAL MEETING – LUNCHEON LECTURE

To be held at the Piccadilly Hotel, London W1
Wednesday 16 June 1982

Dr Rhodes Boyson, MA, MP, Parliamentary
Under Secretary of State for Education will discuss:

"THE ROLE OF GOVERNMENT IN EDUCATION AND SCIENCE"

Further details and an application form on page iv

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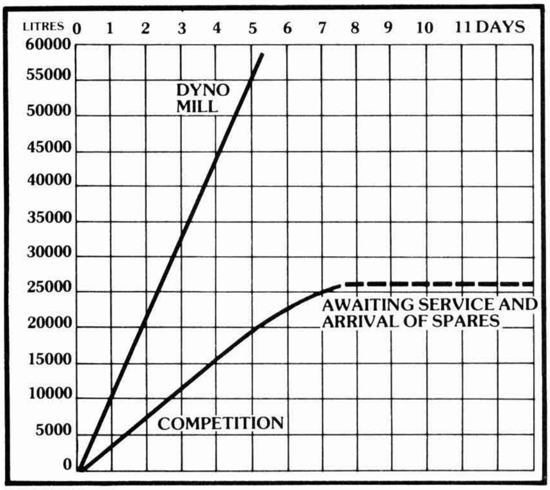

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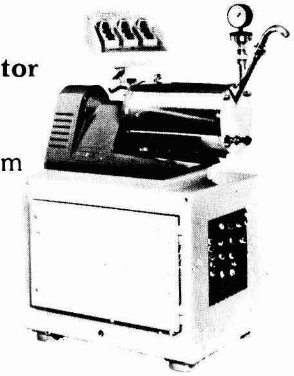

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Transactions and Communications

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

OIL & COLOUR CHEMISTS' ASSOCIATION

Annual General Meeting – Luncheon Lecture

Wednesday, 16 June 1982

On the occasion of the 1982 Annual General Meeting, the London Section has arranged a luncheon and lecture which will precede the Annual General Meeting and take place at the same venue, i.e. The Piccadilly Hotel, London W.1.

The lecturer will be Dr Rhodes Boyson, MA, MP, Parliamentary Under Secretary of State for Education, who will deliver a lecture entitled:

"THE ROLE OF GOVERNMENT IN EDUCATION AND SCIENCE"

The programme of events will be as follows:

12.30 p.m.	Reception in the Margaret Suite (Cash Bar)
1.00 p.m.	Luncheon – Margaret Suite
2.00 p.m.	Lecture – Edward Suite
3.00 p.m.	(or as soon thereafter as the lecture shall have terminated) Annual General Meeting – Edward Suite

Members not wishing to attend the luncheon and lecture will, of course, be able to participate in the Annual General Meeting at the time shown above. **Please notify me so that seating arrangements can be made.**

Tickets for the luncheon/lecture are priced at £11.50 each, inclusive of wine and VAT.

Application for tickets should be made on the form below as soon as possible.

R. H. HAMBLIN,
March 1982 *Director & Secretary.*

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OCCA ANNUAL GENERAL MEETING
LUNCHEON/LECTURE – 16 June 1982

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Priory House, 967 Harrow Road,
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J. Oil Col. Chem. Assoc., 1982, 65, 171-177

Transactions and Communications

Amine cured epoxy systems for ballast tanks – the influence of the nature of the solvent mixture on film formation, properties and performance

By G. Cinti*, N. Schromek† and G. Torriano*†

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Summary

The influence of the composition of the solvent mixture on pot life, drying, hardening and performance, with particular regard to salt and fresh water resistances, was investigated for an amine adduct cured system. Great differences in the performance of the films were observed in relation to the chemical nature of the solvent mixtures employed. The solvent mixtures studied were characterised on the basis of the solubility parameter theory. The range of solvents used was extended to a series of compounds with different chemical natures, with flash points above 23°C.

Keywords

Types and classes of coatings and allied products

tank coating

Processes and methods primarily associated with

drying or curing of coatings

drying
film formation

Raw materials for coatings

binders (resins, etc.)

amine cured epoxy resin

solvents

solvent

Properties, characteristics and conditions primarily associated with

bulk coatings and allied products

pot life

dried or cured films

hardness
performance
salt water immersion test
solvent retention
water resistance

Systèmes époxydiques pour water-ballasts, durcissables par des adducts aminés: l'influence de la composition du mélange solvant sur la formation, les propriétés et le rendement de leurs films

Résumé

Pour un système époxydique durci par de l'adduct aminé, on a examiné l'influence de la composition du mélange solvant sur le délai maximal d'utilisation après mélange, de séchage, le durcissement et sur le rendement, particulièrement à l'égard de la résistance à l'eau salée et à l'eau douce. Des différences marquées dans leur comportement ont été décelées, dépendantes des caractéristiques chimiques du mélange solvant employé. Les mélanges solvants examinés ont été distingués au moyen de la théorie du paramètre de soublité. Le choix des solvants a été étendu à une série de composés de nature chimique diverse et de point d'éclair supérieur à 23°C.

Mit amineaddukt gehärtete epoxysysteme für ballastwasser-tanks: einfluss der natur des lösungsmittelgemisches auf die filmbildung, eigenschaften und leistung

Zusammenfassung

Der einfluss der lösungsmittelzusammensetzung für eine mit amineaddukt gehärtete epoxyfarbe auf topfzeit, trocknung, härtung und leistung, mit besonderer beachtung des widerstandes gegen saltz- und süsswasser, wurde untersucht. Es wurden grosse unterschiede im verhalten, in abhängigkeit von der chemischen natur der in der formulierung der verschiedenen prüfmuster verwendeten lösungsmittelgemische, gefunden. Die getesteten lösungsmittelgemische wurden auf basis der theorie der löslichkeitsparameter charakterisiert, wobei die wahl der zu prüfenden lösungsmittel auf eine serie von verbindungen verschiedener chemischen natur, mit einem flammpunkt von über 23°C fiel.

Table 1
Solvent mixtures

By weight	A	B	C	D	E	F
Xylene	32.10	36.25	41.00	36.25	36.25	36.25
EAK		15.50	15.50	29.80	21.45	21.45
Cyclohexanone		7.15	7.15	15.50	2.40	2.40
2-ethoxyethanol acetate		15.50	15.50			
Butyl acetate		7.15	2.40			
2-ethoxyethanol	67.90	18.45	18.45	18.45	18.45	18.45
2-nitropropane					21.45	
1,1,1-trichloroethane						21.45
By volume						
Xylene	33.50	37.00	42.00	36.40	37.20	39.10
EAK		16.80	16.90	31.90	23.40	24.70
Cyclohexanone		6.80	6.80	14.30	2.30	2.50
2-ethoxyethanol acetate		14.30	14.30			
Butyl acetate		7.30	2.30			
2-ethoxyethanol	66.50	17.80	17.70	17.40	18.50	18.70
2-nitropropane					19.30	
1,1,1-trichloroethane						15.00
Solubility parameters						
δ_d	8.07	8.13	8.16	8.20	8.16	8.16
δ_A	6.48	4.44	4.38	4.27	4.55	4.00
δ_{hb}	5.59	3.32	3.21	3.36	3.14	3.19
δ_B	9.06	8.89	8.80	8.72	8.90	8.63

Table 2
Solvent characteristics

Solvent	Boiling point (°C)	Vapour pressure (torr at °C)		Flash point (°C)	Solubility with water				Viscosity		Volatility	
					S in W		W in S		cP	at °C	Ethyl ether=1	Butyl acetate=1
					%	at °C	%	at °C				
MEK	79.64	90.6	25	–4	24.0	20	10.0	25	0.432 0.365	15 30	2.8	6
MIBK	116.5	20.0	25	14	1.7	25	1.9	25	0.542	25	6.7	1.8
EAK	160.6	2.0	20	48	0.26	20	0.9	20	2.453	15	57.3	
Cyclohexanone	155.65	4.8	25	42	2.3	20	8.0	20	1.803	30	40	0.3
2-ethoxyethanol	135.6	5.3	25	49	∞		∞		2.05 1.85	20 25	43	0.2
n-butanol	117.66	6.18	25	34	7.45	25	20.5	25	3.379 2.271	15 30	33	0.5
Toluene	110.625	28.5	25	4	0.0515	25	0.0334	25	0.5516 0.5866	25 20	6.1	2.4
Xylene (m)	139.103	8.3	25	25	0.0196	25	0.0402	25	0.617 0.581	20 25	13.5	0.6
Butylacetate	126.114	13.0	25	24	0.43	20	1.86	20	0.770 0.628	15 30	12.5	1
2-ethoxyethanol acetate	156.30	1.09	20	43	22.9	20	6.5	20	1.025	25	52	0.2
2-nitropropane	131.18	10.23	25	24	1.50	25	0.62	25	0.770 0.721 0.677	20 25 30	10	1.1
1,1,1-trichloroethane	74.0	120.7	25	none	0.132	20	0.034	25	0.903 0.725	15 30		2.4

Introduction and objective

Refs, 1-7

Amine adduct cured epoxy systems have recently been the object of a number of studies concerning curing kinetics[1] and mechanisms[2], the solvent system design[3], the effect of the solvent on residual strain in clear coatings[4,5], etc. The aim of the present investigation is to make a contribution to the knowledge of the influence of the chemical nature of the solvent mixture on film performance; in particular on the resistance to water immersion, as well as on pot life, drying and hardening of high-build coatings.

Materials

Refs, 6,7

The systems studied were PVC-26 paints formulated with titanium dioxide and silicate extenders at a w/w ratio of 1:1.4; the binder was a solid epoxy resin with an epoxy equivalent of 475-575; the hardener was an *"in situ"* adduct of the same resin with aliphatic polyamines. The resin was available as a 75 per cent solution in xylene, the solvents of the hardener were xylene and 2-ethoxyethanol. Thus, certain amounts of xylene and 2-ethoxyethanol were present in all the solvent mixtures tested. Solvent mixtures widely differing in chemical nature were used including a chlorinated compound[6] and a nitro-derivative[7]. The solvent mixtures used are shown in Table 1. Table 2 shows the principal characteristics of the solvents considered.

Experimental

Refs, 2,8-12

Chemical resistance tests

The resistance to fresh water (tap water) and artificial salt water of six paints of film thicknesses 100 µm and 200 µm was tested. The paints, designated A-E, were formulated according to the above reported criteria, with the solvent mixtures of Table 1.

The test panels were mild steel plates of dimensions 150 mm x 100 mm x 3 mm, grit-blasted to SA 3 degree.

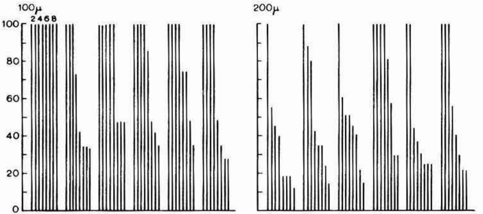
Paints were applied by conventional air spraying. Films were allowed to dry in a well aerated room for 10 days at 16-18°C.

Blistering was evaluated according to ASTM – D 714. No rusting was detected. The results, quantified according to criteria reported in the Appendix, are given in figures 1 and 2.

Curing and hardening

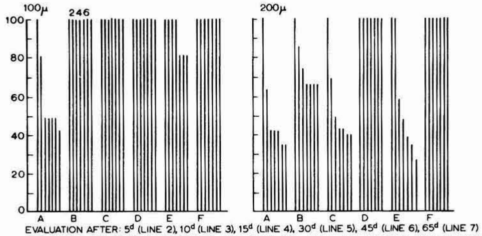
The application of paints A-F showed that pot life is strongly affected by the nature of the solvent mixture. To get a deeper insight into this effect, a series of clear varnishes were formulated with the same composition as the vehicles of paints A-F, i.e. with the solvent mixtures of Table 1.

Viscosity increase for varnishes A,B,D,E and F from mixing time up to gelation was determined by means of a c/p viscometer at a shear rate of 10^4 sec^{-1}. The results are shown in Table 3.



EVALUATION AFTER: 5^d (LINE 2), 10^d (LINE 3), 15^d (LINE 4), 30^d (LINE 5), 45^d (LINE 6), 65^d (LINE 7), 100^d (LINE 8)
BLISTERING EVALUATED ACCORDING TO ASTM-D-714; 100 = FILM UNAFFECTED, 0 = FILM DESTROYED

Figure 1. Fresh water immersion – blistering resistance



EVALUATION AFTER: 5^d (LINE 2), 10^d (LINE 3), 15^d (LINE 4), 30^d (LINE 5), 45^d (LINE 6), 65^d (LINE 7)
BLISTERING EVALUATED ACCORDING TO ASTM-D-714; 100 = FILM UNAFFECTED, 0 = FILM DESTROYED

Figure 2. Salt water immersion – blistering resistance

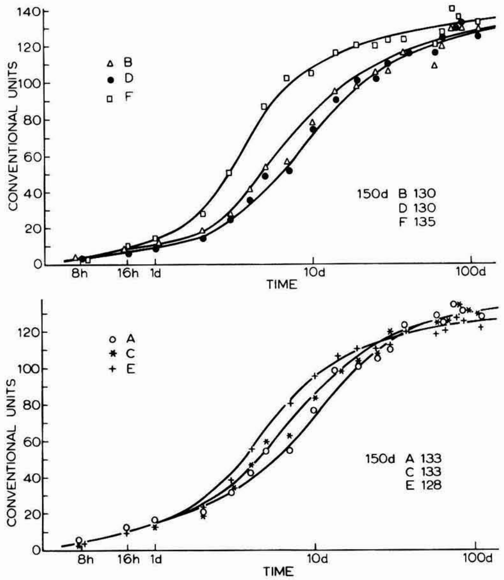


Figure 3. Film hardening

Fitting the results was carried out with an exponential regression on the basis of a 3-constant model.

Film hardening was studied with pigmented A-F films laid down on crystal plates by means of a 400 µm manual film applicator. Hardness was determined according to DIN 53157 at 20°C. Reliable, reproducible data are obtained by means of this technique when the first stage (wet stage) in film formation is completed and the dry stage sets in; in this instance 12-15 hours after the laying down of the films. The results are given in Figure 3.

Table 3
Viscosity increase after addition of the curing agent

Time after mixing, (hours)	Viscosity (Pas)				
	A	B	D	E	F
0.30	0.070	0.070	0.070	0.070	0.100
2	0.080	0.075	0.075	0.075	0.110
4	0.090	0.080	0.080	0.080	0.125
6	0.110	0.085	0.085	0.085	0.140
8	0.130	0.090	0.090	0.090	0.160
14.30	0.320				
16.30	0.430	0.120		0.140	0.280
17.30	0.530				
18.30	0.620				
19.30	0.780				
20	0.930	0.140		0.170	0.375
21.30		0.145		0.180	0.420
23		0.155		0.200	
24		0.160	0.120		0.490
24.30				0.220	
26		0.175	0.130	0.235	0.590
27.30					0.640
28		0.200	0.140	0.270	0.650
29					0.740
30		0.215	0.145	0.305	0.840
30.30					0.880
31					0.930
31.30					0.990
32		0.240		0.350	
40		0.395	0.190	0.630	
42		0.450	0.195	0.780	
43			0.210	0.860	
44		0.500	0.215		
45.30		0.550	0.225		
46.30		0.600	0.235		
47.30		0.640			
64			0.450		
66			0.470		
68			0.530		
69			0.560		
70			0.600		
71			0.615		
72			0.630		
72.30			0.650		

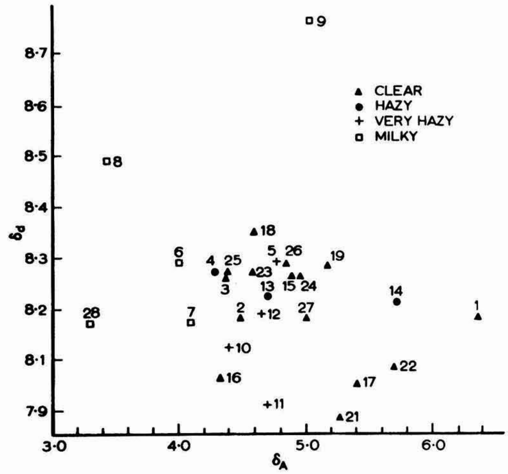


Figure 4. Compatibility chart

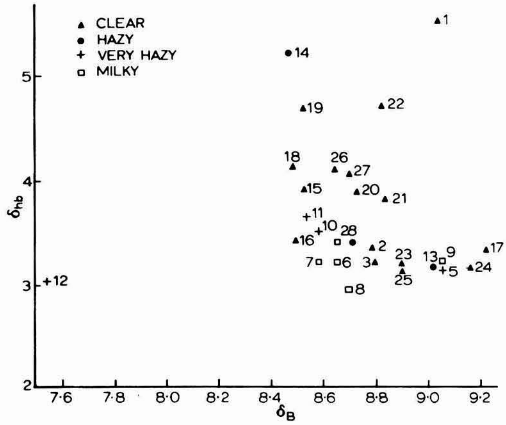


Figure 5. Compatibility chart

Table 4
solvent mixtures

By volume	1^a	2^a	3^a	4^b	5^c	6^d	7^d	8^d	9^d	10^c	11^c	12^c	13^b	14^b
EAK		15.48	16.77	35.81	14.04	17.10	28.90		26.39	25.60	29.37	31.75		
1,1,1-trichloroethane						21.43	26.60							
Xylene	35.16	34.64	42.26	33.76	35.80	36.90	24.60	82.44	22.50	36.46	22.77	30.11	45.98	43.46
Cyclohexanone		4.48	6.73	13.12	4.63	4.95						6.91		
2-ethoxyethanol acetate		18.00	14.19										35.75	
Butyl acetate		9.62	2.42											
2-nitropropane					27.17				32.93					
MIBK										15.79	24.70			
2-methoxyethanol acetate												13.01		
n-butanol														39.32
Toluene														
2-ethoxyethanol	64.84	17.78	17.63	17.31	18.36	19.62	19.90	17.56	18.18	22.15	23.16	18.22	18.27	17.22
δ_d	8.08	8.08	8.15	8.16	8.19	8.19	8.07	8.39	8.66	8.02	7.91	8.10	8.12	8.11
δ_A	6.37	4.50	4.37	4.30	4.77	4.03	4.11	2.45	5.04	4.41	4.69	4.66	4.66	5.72
δ_{hb}	5.50	3.32	3.25	3.38	3.16	3.21	3.22	2.95	3.17	3.50	3.65	3.05	3.16	5.21
δ_B	9.04	8.79	8.81	8.70	9.05	8.65	8.59	8.70	9.05	8.58	8.53	7.55	9.02	8.47
By volume	15^a	16^a	17^a	18^a	19^a	20^a	21^a	22^a	23^a	24^a	25^a	26^a	27^a	28^d
EAK								31.58	23.31			19.55		48.70
1,1,1-trichloroethane											15.72			
Xylene	53.47	38.55	23.87	62.62	52.65	54.18	22.63	22.43	23.31	38.38	40.53	23.16	23.70	23.08
Cyclohexanone									2.25	2.35	2.48	10.63		11.44
2-ethoxyethanol acetate			56.84			13.07	22.45			20.52	21.66		16.92	
Butyl acetate	14.21												11.66	
2-nitropropane									19.72	20.18				
MIBK		41.73					27.27							
2-methoxyethanol acetate														
n-butanol	14.82			19.93	30.00	15.02						15.38	15.73	
Toluene												14.44	14.77	
2-ethoxyethanol	17.50	19.72	19.29	17.45	17.35	17.73	27.65	45.99	17.84	18.57	19.61	16.84	17.22	16.78
δ_d	8.16	7.96	7.95	8.25	8.18	8.18	7.88	7.98	8.17	8.16	8.17	8.10	8.08	7.98
δ_A	4.49	4.33	5.41	4.60	5.18	4.77	5.28	5.69	4.58	4.95	4.40	4.92	5.01	4.50
δ_{hb}	3.96	3.40	3.33	4.09	4.67	3.89	3.81	4.70	3.17	3.13	3.16	4.00	4.04	3.30
δ_B	8.53	8.50	9.22	8.49	8.53	8.73	8.83	8.82	8.90	9.16	8.89	8.67	8.70	8.67

a = clear, b = hazy, c = very hazy, d = milky

For clear varnishes it was observed that ready mixed products – clear up to gelation – gave rise after gelation (network formation) in the containers to bulky products which were either clear or hazy or even milky. On account of this, further investigations were carried out for a better understanding of the solvent/binder compatibility. To this end, a series of 28 solvent mixtures was studied. Their composition, together with the results of the compatibility tests, are shown in Table 4, from which the compatibility charts of figures 4 and 5 were drawn.

The bi-dimensional plot of Figure 4 is based on the Hansen[9] three-component approach to the solubility parameter[8,9], where the polar and the hb contributions are grouped as:

$$\delta_A = (\delta_p^2 + \delta_{hb}^2)^{\frac{1}{2}}$$

The plot of Figure 5 is based on the two-component (physico-chemical) approach by Bagley *et al.*[10], in which the term δ_B includes the volume-dependent terms and corresponds to the physical polar and non-polar effects, whereas the other term is the residual parameter arising from "chemical" (notably hydrogen-bonding) effects, i.e. δ_{hb}.

Chemical resistance tests

Immersion tests demonstrate the powerful influence of solvent mixture type employed in the various paints on blistering resistance. This is to be expected especially when high-thickness films are considered, which have problems as regards solvent release. The fact that the results obtained with 200 µm thick films are generally worse than those obtained with films of 100 µm thickness is accounted for by a higher retention of solvent in the thicker films. Solvent release is, in fact, still far from complete after 10 days air drying, so that blistering is favoured particularly if solvents are retained which are capable of solubilising appreciable quantities of water. In these instances, the chemical nature of the solvent still present in the film overshadows the effects of the quantity entrapped. With 200 µm thick films, the worst results were produced by paint A, which was formulated with a high quantity of the water-miscible 2-ethoxyethanol; the best results were obtained with solvent mixtures of low water-in-solvent solubility, paints D,F.

With 100 µm thick films, paint A gave bad results in salt water, but, rather surprisingly, good results in fresh water, where all the other paints exhibited some blistering. In salt water, paints B,C,D,F were good, E slightly inferior.

Good correlation of film degradation in salt and fresh water immersion tests was found for the various paints, although the average degree of blistering was lower in the less aggressive ion-rich salt water.

Table 5

Coefficients of the equation: $\eta = B_1e^{(B_2t + B_3t^2)}$

Paint	B_1	B_2	B_3	Sum of the squares
A	0.784	1.5215×10^{-2}	5.3389×10^{-3}	0.2710
B	0.716	2.2069×10^{-2}	5.0583×10^{-4}	0.0267
D	0.766	1.3824×10^{-2}	2.1638×10^{-4}	0.1002
E	0.730	2.6131×10^{-2}	7.1783×10^{-4}	0.0993
F	1.072	4.1538×10^{-2}	8.9789×10^{-4}	0.4883

Reaction rate and pot life

There is, here, a strong influence due to the chemical nature of the solvent mixture. Reaction rate increased, pot life decreased from D to A; intermediate values were found for B,E and F.

Viscosity versus time data were fitted into an equation of the exponential type at three parameters:

$$\eta = B_1e^{(B_2t + B_3t^2)}$$

where B_1 is the viscosity at zero time after mixing, B_2 and B_3 are connected with the rate of the chemical reaction, which starts immediately after mixing and causes a viscosity increase, and with the rate of the network formation, which causes an additional viscosity gain and leads to gelation. The product B_1B_2 gives the slope at zero time (initial reaction rate), and B_3 is associated with the curvature. The parameters of the equation are shown in Table 5. An inspection of Table 5 shows that if sample B is taken as a reference standard, slower reaction and network formation rates are found for sample D (the lowest values of B_2 and B_3). This can be ascribed to a reaction between the polyamine curing agent and the ketones contained at a high level in the solvent mixture (the formation of ketimines). As regards the other solvent mixtures, a strong accelerating action was recorded for the chlorinated solvents; B_2 and B_3 of sample F have high values. The high values of B_2 and B_3 of samples A and E are consistent with the accelerating action due to the presence of either high hb solvents (sample A), or high polarity solvents[2] (sample E).

There are differences in the kinetics between A and E. The former is characterised by a lower initial rate and a subsequent very high viscosity increase up to gelation. The latter shows a higher initial rate but a lower subsequent viscosity gain, which involves a postponed gelation time.

Film hardening

An inspection of the hardening curves of Figure 2 shows that all the curves have the similar S-shaped form. The final hardness is nearly the same for all paints and it is suggested that networks with the same characteristics are eventually formed, independently of the nature of the solvent mixture. Hardness gain with time, however, shows differences which set in two days after film laying. Differentiations between the various curves reach a maximum after 6-12 days, from this time onward differences are reduced until similar final values are attained.

Hardening after 10 days shows the increasing order:

$$F >> E > C > B > A > D$$

which is different to that of pot life, i.e. the viscosity increase in the ready mixed paint, which follows:

$$A > F > E > B > C >> D$$

An examination of the rate of network formation in the ready-mixed paint and of the rate of film hardening highlights a particular behaviour of paint A. Here the ready-mixed paint displays the highest rate of network formation, the film laid down was found to attain the dust-free stage sooner than paints B,C and D. Film hardening, on the other hand, was slower than for all the other paints with the exception of paint D. Solvent diffusion cannot account for this situation since 2-ethoxyethanol diffuses faster[11] than the ketones and acetates of paints B,C and D. A long-lasting, massive retention phenomenon of the oxydrilated 2-ethoxyethanol is suggested, due either to interactions with the highly oxydrilated binder or to entrapping in the film by the fast build-up of the network[11]. To confirm this, further tests are needed; nevertheless the severe blistering exhibited by paint A in immersion tests appears to validate the above suggested retention phenomenon.

Solubility and compatibility

An examination of figures 3 and 4 shows that plotting δ_{hb} versus δ_B gives a better location of the single points, which allows a better definition of the various domains to be obtained than plotting δ_d versus δ_A. In other instances, e.g. with families of vinyls, the plot of δ_d versus δ_A proved to be more suitable for a consistent description of solubility and compatibility[12].

Conclusions

- The influence of the solvent mixture on water resistance was investigated. Amongst the formulations tested, formulations D and F proved to be the most satisfactory. The results obtained suggest formulating paints with a very low content of, or, if possible, even free from, glycolethers.
- Pot life is strongly affected by the solvent mixture. It was shown that chlorinated solvents exert a strong accelerating action on the curing rate, as do highly polar and hb solvents. Ketones, on the other hand, have a marked retarding effect.
- Network formation in the ready-mixed paint was described on the basis of a 3-parameter exponential model.
- Film hardness developed during the 120-150 days following paint laying. The final values of hardness were similar for all the paints, independent of the nature of the solvent mixture. 8-12 days after application, when

hardening was still far from completion, a strong influence of the solvent mixture on film hardness was observed.

The order of increasing hardness of the various films at this time does not correspond with that of the rate of curing of the ready-mixed paint. In some instances (paint A), this cannot be explained on the basis of the order of increasing retention of individual solvents and other mechanisms must be considered.

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Appendix

Blisters on either face of the sample tested are quantified according to the following formula:

$$Bl = A \times I \times D + 100\,(1 - A)$$

where A is the percentage of area involved in the degradation, I is an index of blistering according to the following scale:

No blister	= 10
Very few	= 9
Few	= 8
Few-medium	= 7
Medium	= 6
Medium dense	= 4
Dense	= 2
Destroyed	= 0

and D is the dimension of the blister according to ASTM D 714.

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The dielectric behaviour of the natural resins mastic and dammar

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Summary

The dielectric relaxation of two natural resins, mastic and dammar, has been analysed by the Cole-Cole method in the temperature range 20-150°C. Two distinct relaxation processes were found for the temperature ranges 60-90°C and 70-100°C for mastic and dammar respectively. Typical single Cole-Cole patterns were obtained at and above 100°C and 110°C for mastic and dammar respectively. A marked decrease in different dielectric parameters was noticed above the melting points of both resins. The dielectric behaviour exhibited by both resins was found to be similar to that exhibited by two other natural resins, Manila copal and shellac, reported earlier.

Keywords

Properties, characteristics and conditions primarily associated with

materials in general

dielectric constant
glass transition point
melting point

Raw materials for coatings

binders (resins, etc.)

dammar resin
mastic resin
natural resin

Le comportement diélectrique des résines naturelles, à savoir la gomme mastic et le dammar

Résumé

Les données concernant la relaxation diélectrique des deux résines naturelles, à savoir la gomme mastic et le dammar, ont été analysées, aux températures de 20 à 150°C, par la méthode de Cole-Cole. Deux distincts processus de relaxation ont été trouvés dans le cas de températures de 60 à 90°C et de 70 à 100°C à l'égard de la gomme mastic et du dammar respectivement. A et au dessus de 100 et 110°C à l'égard de la gomme mastic et du dammar respectivement, des typiques motifs simples de Cole-Cole ont été obtenus. Une importante diminution des différents diélectriques paramètres était notée au dessus des températures de fusion de toutes les deux resines. Le comportement diélectrique mis en évidence par les deux resines se démontrait semblable à celui de deux autres résines naturelles, à savoir le copal Manille et la gomme laque, et dont on a déjà rendu compte.

Das elektrische verhalten der naturharze, bzw. mastix und dammar

Zusammenfassung

Die dielektrische relaxationsdaten über zwei naturharze, bzw., mastix und dammar, sind bei temperaturen von 20 bis 150°C mittels der Cole-Col'sche methode analysiert worden. Zwei unterschiedenen relaxationsverfahren wurden bei temperaturen von 60 bis 90°C und von 70 bis 100°C bzw., für mastix und dammar gefunden. Typische einfache Cole-Col'sche motive wurden bei und über 100 und 110°C für bzw., mastix und dammar erhalten. Eine wichtige verminderung an die verschiedenen dielektrischen parameter wurden bemerkt als die temperatur die schmelztemperaturen der beiden harze überschritt. Die dielektrische verhalten, das sich die beiden harze entfaltet, wurde gefunden ähnlich zu sein als dasjenige, das von zwei anderen naturharze, manilakopal und schellack entfaltet wurde und das früher berichtet wurde.

Introduction

Refs, 1-6

Dielectric relaxation processes in semi-crystalline and amorphous polymers have been studied widely[1]. The existence of many relaxation processes (α,β,γ etc.) has been noted, and a molecular interpretation of these relaxation processes has been put forward[1]. The information available regarding the dielectric behaviour of natural resins is, however, comparatively scant and the topic requires detailed investigation. Recent studies on the dielectric behaviour of the natural resins Manila copal[2], shellac[3] and its constituents[4] have revealed the existence of multi-relaxation processes below their melting points. A transition from many relaxation processes to a single relaxation process was observed during the transition of the resins from the solid to the liquid state. Conformational changes of the resin molecules have also been reported above their melting points[2-4]. The present paper reports on an analysis of the dielectric relaxation data obtained previously by Bhattacharya[5] of two more natural resins, mastic and dammar, by the Cole-Cole[6] method in the frequency range 1-500 kHz and in the temperature range 20-150°C. The Cole-Cole method was not applied in Bhattacharya's work. This has thrown

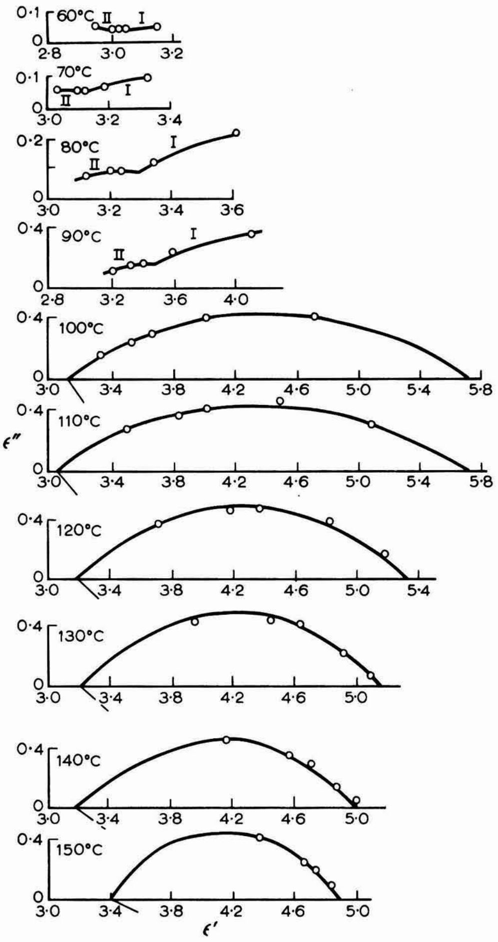

Figure 1. Cole-Cole diagrams of the natural resin mastic at different temperatures

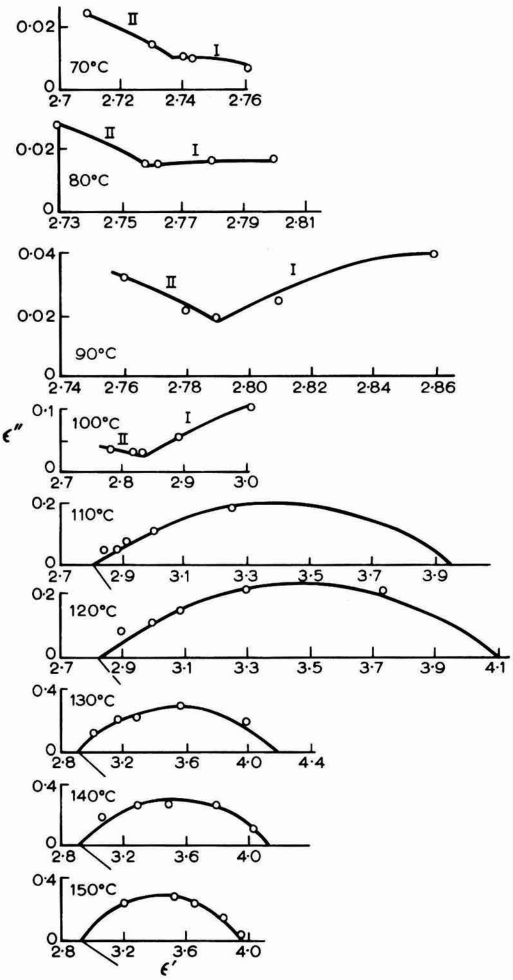

Figure 2. Cole-Cole diagrams of the natural resin dammar at different temperatures

further light on the relaxation processes and on the conformational changes undergone by both types of resin molecule due to the increase in temperature from 20 to 150°C.

Theoretical

The method of analysis of the data was similar to that described previously for the natural resins Manila copal[2] and shellac[3].

Results

Refs, 5,6

The Cole-Cole patterns for the resins mastic and dammar were drawn with the data obtained by Bhattacharya[5] and are shown in figures 1 and 2 respectively. Both the dielectric constant and dielectric loss were reported almost constant in the observed frequency range (1-500 kHz) in the temperature range 20-50°C for mastic and 20-70°C for dammar[5]. The ε'' versus ε' plots (not shown in the figures) for both the resins at these temperatures revealed the same information. The relaxation at 60-90°C for mastic and at 70-100°C for dammar consisted of two overlapping Cole-Cole patterns (I and II in figures 1 and 2). Single Cole-Cole curves were obtained between 100-150°C for mastic and 110-150°C for dammar respectively.

The different dielectric parameters evaluated from the Cole-Cole diagrams for the resins mastic and dammar are shown in tables 1 and 2 respectively; the ε_0 and ε_∞ values obtained from the plots are shown, together with the corresponding experimentally determined values. It may be seen from the tables that the ε_0 and ε_∞ values obtained from the Cole-Cole plots differ from the values obtained experimentally. The variation of the static dielectric constant (ε_0) with temperature for both the resins has been

Table 1

Different dielectric parameters of mastic derived from the Cole-Cole diagrams at different temperatures

Temperature (°C)	Low frequency dielectric constant		High frequency dielectric constant		Dielectric increment (Δε)	Relaxation time (τ) (s)	Cole-Cole distribution parameter (α)
	Observed value[5]	From Cole-Cole diagram	Observed value[5]	From Cole-Cole diagram			
20	2.88		2.79		0.09		
30	2.91		2.82		0.09		
40	2.96		2.85		0.11		
50	3.04		2.90		0.14		
60	3.14		2.95		0.19		
70	3.33		3.03		0.30		
80	3.62		3.12		0.50		
90	4.12		3.20		0.92		
100	4.72	5.7	3.32	3.09	2.61	4.74×10^{-5}	0.61
110	5.08	5.66	3.50	3.02	2.64	1.12×10^{-5}	0.60
120	5.19	5.32	3.72	3.18	2.14	2.27×10^{-6}	0.46
130	5.1	5.14	3.96	3.2	1.94	6.61×10^{-7}	0.43
140	5.02	5.0	4.18	3.17	1.83	2.98×10^{-7}	0.39
150	4.96	4.88	4.36	3.38	1.50	2.24×10^{-7}	0.31

Table 2

Different dielectric parameters of dammar derived from the Cole-Cole diagrams at different temperatures

Temperature (°C)	Low frequency dielectric constant		High frequency dielectric constant		Dielectric increment (Δε)	Relaxation time (τ) (s)	Cole-Cole distribution parameter (α)
	Observed value[5]	From Cole-Cole diagram	Observed value[5]	From Cole-Cole diagram			
20	2.71		2.66		0.05		
30	2.71		2.66		0.05		
40	2.72		2.67		0.05		
50	2.72		2.68		0.04		
60	2.74		2.69		0.05		
70	2.76		2.71		0.05		
80	2.80		2.73		0.07		
90	2.86		2.76		0.10		
100	3.01		2.78		0.23		
110	3.25	3.95	2.83	2.81	1.14	4.32×10^{-4}	0.58
120	3.74	4.1	2.90	2.66	1.44	2.48×10^{-5}	0.56
130	3.97	4.2	2.99	2.9	1.3	1.39×10^{-5}	0.47
140	4.02	4.12	3.06	2.92	1.2	3.97×10^{-6}	0.4
150	3.97	3.96	3.20	2.92	1.04	1.10×10^{-6}	0.34

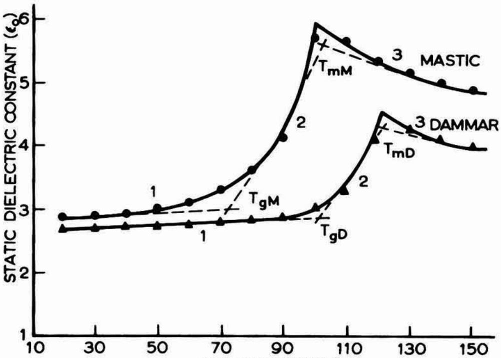

Figure 3. Variation of static dielectric constant (ε_0) with temperature of the resins mastic and dammar

illustrated in Figure 3. The temperature profiles of ε_0 for both the resins indicate three distinct slopes (1, 2 and 3 in Figure 3). ε_0 was almost constant up to 50°C and 80°C for mastic and dammar respectively. It then increased sharply, reached a maximum around 100°C and 120°C for the respective resins, and then decreased with the further rise in temperature. Two transition points (TgM and TmM) may be noted for mastic around 72°C and 103°C respectively. For dammar, similar transition temperatures were noticed around 100°C (TgD) and 120°C (TmD).

The values of the dielectric increment $\Delta\varepsilon$ ($= \varepsilon_0 - \varepsilon_\infty$) of the resins at different temperatures are shown in column 4 of tables 1 and 2. At temperatures for which single Cole-Cole curves were obtained, data were determined using ε_0 and ε_∞ values taken from the Cole-Cole diagrams. $\Delta\varepsilon$ values at other temperatures were calculated from the experimental data. The variation with temperature of $\Delta\varepsilon$ (not shown in the figures) was found to be identical to that of ε_0. The relaxation times (τ) for the resins mastic and dammar at temperatures for which complete Cole-Cole curves were obtained were calculated following Cole and Cole[6] and are shown in tables 1 and 2 respectively. A marked decrease in τ from a value of 4.74×10^{-5} sec. to 2.24×10^{-7} sec. was observed for mastic for an increase in temperature of 100°C to 150°C. For dammar, a similar decrease from 4.32×10^{-4} to 1.10×10^{-6} sec. was observed due to a rise in temperature of 110°C to 150°C.

The Cole-Cole distribution parameter (α) for the resins at different temperatures are shown in the last columns of tables 1 and 2. For both resins a marked decrease in the values of α was noticed with the rise in temperature above their melting points.

Discussion

Refs, 2-19

The transformation points around 72°C (TgM) and 103°C (TmM) for mastic, and around 100°C (TgD) and 120°C (TmD) for dammar were attributed to their respective glass transition and melting points. Thus, the glass transition and melting points of the resin dammar were found to be greater than those of mastic. Bhattacharya[5], however, has reported only one transformation point each for both resins: around 113°C for dammar and 80°C for mastic. Similar transformation points have also been reported earlier for the natural resins Manila copal[2], shellac[3] and hard and soft lac resins[4]. The observed greater ε_0 and $\Delta\varepsilon$ values of mastic compared to those of dammar (tables 1 and 2, and Figure 3) indicate that for mastic the effective dipole moment per motional unit is greater than for that of dammar. The values of the ratio between the glass transition and the melting points for mastic and dammar were found to be 0.92 and 0.95 respectively. These values are quite different to those of semi-crystalline (0.667) and amorphous polymers[7]. For natural resins Manila copal, shellac and its constituents and also for eleven other natural resins, similar high Tg/Tm values were obtained[8]. The high Tg/Tm ratio is a characteristic of the natural resins. The different slopes in the ε_0 versus temperature plot (Figure 3) indicate three distinct phases of the resins during their transition from the solid to the liquid state.

The two relaxation processes as observed in the Cole-Cole diagrams for temperatures 60-90°C and 70-100°C for mastic and dammar respectively, suggest relaxation of the different segments and/or polar groups of the resins. This information was not available from the dielectric dispersion and loss curves of the resins obtained by Bhattacharya[5]. Similar multi-relaxation processes have been observed for the natural resins Manila copal[2], shellac[3] and its constituents[4] below their melting points. The relaxation below the melting points for both the resins arises from the combined α and β processes, as has been suggested for hard and soft lac resins[4]. Overlapping Cole-Cole patterns, analogous to those obtained in the present study, have also been reported for the natural resins Manila copal[2], shellac[3], hard and soft lac resins[4], and also for poly(ethylmethylacrylate)[9], mixtures of isoamyl bromide and 1-propanol[10] and polyethylene isophthalamide[11].

The relaxation above the melting points of both resins has been attributed to α-process molecular orientations, as it has been for other natural resins[2-4]. The transition from two relaxation processes to single Cole-Cole curves (figures 1 and 2) suggests changes in the spatial distribution of the polar groups/segments of the resin molecules. This phenomenon has been reported also for Manila copal[2], shellac[3] and its constituents[4]. For many polymers like poly(trichlorotrifluoroethylene)[12], poly(vinylidene fluoride)[13], styrene and acrylonitrile copolymers[14], methacrylate homopolymers[15] etc., the high temperature relaxation was interpreted as arising from molecular motion.

The marked decrease in relaxation time observed for both the resins suggests that changes in conformation of the resin molecules are taking place in the liquid phase. A similar phenomenon was observed for Manila copal[2] and shellac[3], and was interpreted as arising from compactness of the resin molecules resulting from crosslinkages. The marked decrease in the Cole-Cole parameter (α) obtained for mastic and dammar above their melting points reveals that the resin molecules became dielectrically more symmetrical, undergoing conformational rearrangement. Analogous observations have been reported for natural resins Manila copal[2], shellac[3] and also for hard and soft lac[4]. A few polymers[16,17] and biopolymers[18,19] have also exhibited decreases in the distribution parameters which were attributed to structural changes in the molecules. Thus, the dielectric behaviour of mastic and dammar has been found to be similar to that of two other thermoplastic natural resins, Manila copal and shellac, reported earlier[2-4]. A molecular interpretation of the data is difficult because the natural resins are chemically not well defined.

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Getting the most from your test budget*

By J. L. Scott

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Summary

Research plays a vital role in the development and marketing of a new product. An indispensable part of the research budget is proving the serviceability and durability of the product; and, for those involved in the coatings industry, this means weatherability testing to determine exterior durability. Ideally, durability tests should be conducted by accelerated methods to cut the lead-time to marketing, thus resulting in a reduced research budget. The realisation of less money expended on testing represents a saving which may be passed ultimately to the consumer making everyone just a little happier. A few guidelines which may be applied to establish comprehensive test programmes to obtain the most data for the least amount of money are discussed. Certainly a good many of the ideas presented are not new or startling, but are an attempt to recall a basic, economic approach to a vital part of new product development and marketing. Exterior durability tests and laboratory accelerated testing are explored.

Keywords

Properties, characteristics and conditions primarily associated with

dried or cured films

exterior durability

the environment

exterior exposure

Equipment primarily associated with

analysis measurement or testing

weatherometer

Processes and methods primarily associated with

analysis, measurement or testing

accelerated testing
accelerated weathering
exterior exposure testing
laboratory test

the environment

weathering

Comment profiter au maximum de votre budget de développement

Résumé

La recherche joue un rôle indispensable dans le développement et le marketing d'un nouveau produit. Un élément inéluctable du budget de recherche est la vérification de la fiabilité du produit; et pour ceux qui s'intéressent de l'industrie de peintures, cela veut dire les essais de résistance aux intempéries destinés à déterminer la durabilité à l'extérieur. Par préférence, les essais de durabilité devraient être effectués par les méthodes accélereés afin de réduire l'intervale avant que l'on puisse mettre le nouveau produit sur le marché, et également le budget de recherche. Etant donné que la diminution de la somme dépensée sur les essais de vérification est, en effet, une économie que l'on peut transmettre au client enfin, et par conséquent peut rendre un peu plus content. L'auteur discute quelques points de répère qui doivent être respectés afin d'établir des programmes d'essais globaux destinés à rendre les données les plus compréhensives contre la dépense minimale en argent. Certes un bon nombre des idées ci-presentées sont ni nouvelles ni revolutionnaires, mais seulement une tentative de rappeler un abord économique de base à un aspect essentiel du développement et du marketing d'un nouveau produit. L'auteur considére critiquement les essais de résistance aux intempéries et également les essais de vieillissement accélérés au laboratoire.

Wie man seine Forschungsgeldleistung maximisieren kann

Zusammenfassung

Die Forschung spielt eine wichtige Rolle in der Entwicklung und dem Marketing eines neuen produkts. Ein unentbares element des forschungsgelds besteht aus der feststellung der benützlichkeit und beständigkeit des produkts und deshalb für jede die in der lackindustrie beruftätig sind, heisst das bewitterungsprüfung um die witterbeständigkeit zu bestimmen. Am besten sollte man bewitterungsprüfungen mittels schneller methoden durchführen um den zeitaufschub zu vermindern, eher man das neue produkt auf den markt bringen kann, und dabei eine verminderung an das forschungsgeld zustande bringt. Wenn es angenommen würde, dass eine verminderung an das prüfungsgeld eine einsparung darstellt, die man dem kunden schliesslich hinreichen kann und dabei jederman ein ganz klein wenig glücklicher machen kann. Es wird einige richtlinien diskutiert, die auf die festellung eines umfassenden prufungsprogramms angewandt werden können, um die ausführlichsten daten gegen die wenigste geldausgabe zu erhalten. Sicher sehr viel der hierdargestellten ideen sind weder neu noch überraschend, sondern ein versuch eine gründlegende sparsame methode zur ausführung eines wesentlichen teils der entwicklung und des marketings eines neuen produkts in gedächtnis zurückzurufen. Bewitterungs- und laborschnellprufungen werden überlegt.

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*Paper presented at the South African Division's 8th National Symposium.

Introduction

I doubt that any of you will disagree when I say that our economic situation today is not exactly what we would like. Almost every nation is experiencing spiralling inflation and recession or depression. What does all this have to do with weathering? Money – pure and simple – money!

Government and consumer groups are placing overwhelming pressure on manufacturers to increase production of more durable goods at lower costs. Either these demands are met, or the life cycle of the offending company will come to an abrupt end.

We all recognise the important role that research plays in the development and marketing of a new product. Further, an indispensable part of the research budget is proving the serviceability and durability of the product. For those of us involved in the coatings industry, this means weatherability testing to determine exterior durability.

Ideally, durability tests should be conducted by accelerated methods to cut the lead-time to marketing, thus resulting in a reduced research budget. The realisation of less money expended on testing represents a saving which may be passed ultimately to the consumer making everyone just a little happier.

It is the intention of the author to discuss a few guidelines which may be applied to establish comprehensive test programmes to obtain the most data for the least amount of money. Certainly a good many of the ideas presented are not new or startling, but are an attempt to recall a basic, economic approach to a vital part of new product development and marketing. Exterior durability tests and laboratory accelerated testing are explored.

Back to basics

Before addressing exterior long-term and laboratory accelerated testing, I would like to offer some observations made over the past 17 years on a few basic areas. These are the mundane, day-to-day routine of sample preparation, packing and shipping and test site selection. Please do not take offence at my presumption in discussing matters which are proprietary to the producer, but keep in mind that if the test station does not receive the specimens in good condition, the programme is defeated before it begins.

Sample preparation

I would not attempt to dictate how a coating should be applied to a substrate, but I will mention that when gloss and colour are characteristics of primary importance, flatness of the test specimen is a must. Distorted panels cause variations in instrumental or visual readings which may lead to erroneous interpretation of the values. Additionally, any attempt by the test station to flatten curved panels may result in stress, causing weakening in certain areas leading to premature loss of adhesion, blistering and/or cracking of the film.

Packing

Make sure the coating is completely dry prior to packing. I know this sounds rather primary, but it is surprising how many panels are packed while the surface is still tacky. This results either in the wrapping paper sticking to the surface, or, worse, the panels sticking together causing severe damage when they are separated.

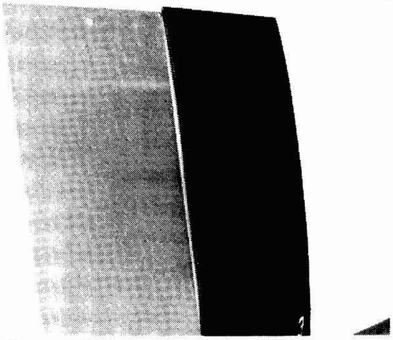

Figure 1. Flat versus curved panels

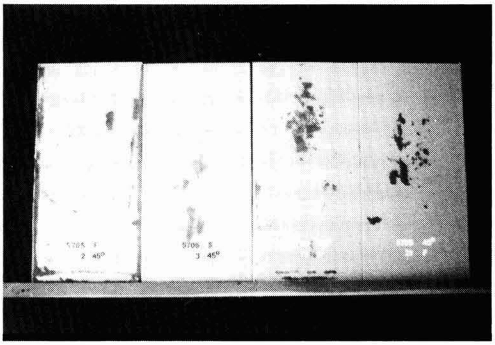

Figure 2. Severe damage occurs when the coating is not completely dry prior to packing and the wrapping paper sticks to the test surface

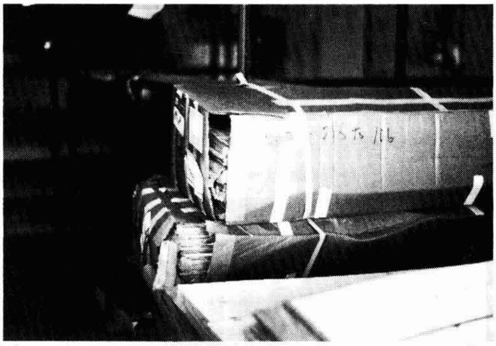

Figure 3. Damage inflicted on a cardboard container during shipment

Shipping

Select a container that will withstand the violence of the delivery service – whatever it may be. No matter how

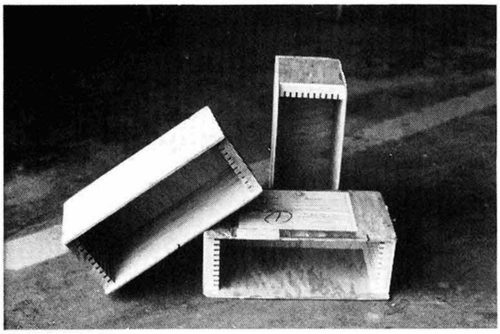

Figure 4. Wood containers suitable for shipping panels

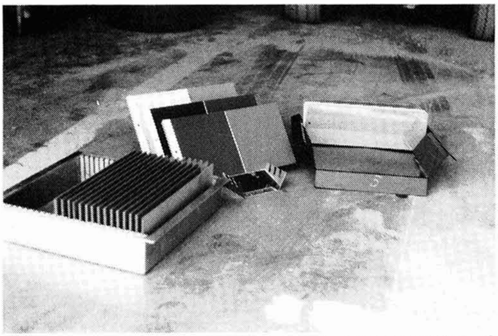

Figure 5. Three containers which assure proper handling of coated panels

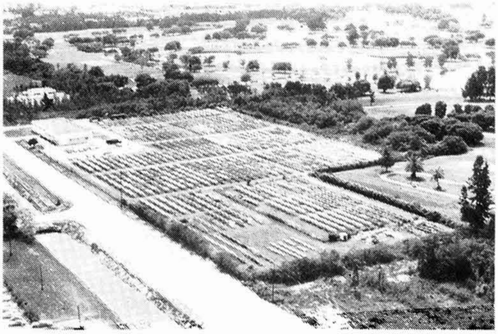

Figure 6. Aerial view of SFTS and surrounding environment

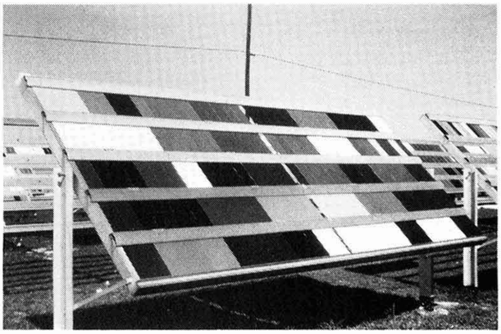

Figure 7. Standard panel exposure rack

Figure 8. Test stand modified to retain clapboard siding and window sections

Figure 9. Test stand modified to retain coil-coated siding with eave overhang

carefully the individual specimens are wrapped, if the container comes apart during shipment, nothing can save the test.

Do not select a method of shipment based on cost alone, but rather choose a system which provides some procedure by which tracer action may be initiated in case of lost packages. Although it does not happen frequently, packages have been misplaced in the billions of tons of freight criss-crossing the world daily; and, without tracer capability, the little savings which may be realised by using a less expensive system, is soon erased.

Site selection

Ref. 1

If you find it necessary to use a commercial firm, select the exposure station which is to perform your exterior durability tests carefully, based on location, facilities, instrumentation and personnel. Do not be hesitant in asking questions. If the company under consideration is reputable, it will be only too happy to co-operate. Some of the questions you may consider are:

Location

Does the location of the test station offer a climate which will provide the most useful test results[1]? Ask for a full report and how their specific location relates to other areas of the world. Any commercial testing firm should be able to answer with a minimum of difficulty.

Exposure facilities

Are the test racks used to retain the test specimens designed to provide the best mounting possible for the material to be tested? Are they flexible enough to allow testing at any specified fixed angle or for variable angle exposures? Can special requests be handled promptly and correctly? Commercial exposure stations should be able to handle *any* exposure submitted in exact accordance with existing practices or client instructions. Beware of companies placing restrictions on numbers and sizes of specimens that may be tested.

Instrumentation (climatological)

Does the facility under consideration maintain a complete climatological monitoring programme? What instruments are used and how often are they standardised? You may wish to ask for a few years' reports in order to determine completeness of data. These reports should be archival in nature and immediately available.

Performance evaluation

Does the test station have the instrumentation necessary to conduct periodic performance evaluations such as gloss, colour, weight, hardness, film thickness, chip resistance, etc. A great deal of time and money may be saved if intermediate evaluations can be accomplished by the test station rather than having the specimens transported back and forth, or having to submit replicate sets for periodic returns.

Personnel

Does the station have personnel qualified and experienced in the technical areas necessary? Are the personnel capable of consulting and/or designing special test procedures to meet specific requirements?

Research

Is the station engaged in environmental research? Research projects are a good indicator of the company's initative and technical abilities.

Special tests

Special tests are in use for the coatings industry. Know what they are and how they are being used. Some of these tests represent accelerated methods while others provide more realistic results. These special tests include black boxes (heated and unheated), controlled temperature testing, and end-use simulation. Most commercial test stations have brochures which answer the majority of these questions, and will gladly provide additional information

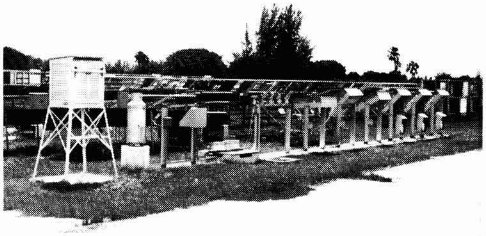

Figure 10. Climatological instrumentation area

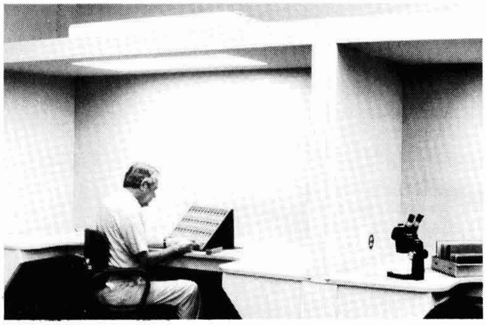

Figure 11. MacBeth inspection booth for materials evaluation

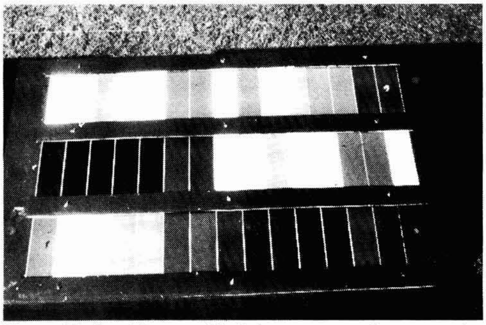

Figure 12. Special test – black box exposure for automotive coatings

Figure 13. Special test – truck cab

upon request regarding their facilities, prices, or weathering in general.

I think I have laboured the above points long enough, and you are probably more interested in durability testing.

Table 1

*Factors affecting the durability of coatings**

Climatological factors

- Radiation
  - Solar
  - Nuclear
  - Thermal
- Temperature
  - Elevated
  - Depressed
  - Cycles
- Water
  - Solid (snow, ice)
  - Liquid (rain, condensation)
  - Vapour (high relative humidity)
- Normal air constituents
  - Oxygen and ozone
  - Carbon dioxide
- Air contaminants
  - Gases (oxides of nitrogen and sulfur)
  - Mists (aerosols, salt, acids, alkalies)
  - Particulates (dust, dirt, sand)
- Freeze-thaw
- Wind

Biological factors

- Micro-organisms
- Fungi
- Bacteria

Stress factors

- Stress, sustained
- Stress, periodic
- Physical action of water as rain, hail, sleet and snow
- Physical action of wind
- Combination of physical action of water and wind
- Movement due to other factors such as settlement

Incompatibility factors

- Chemical
- Physical

Use factors

- Design of system
- Installation and maintenance procedures
- Normal wear and tear
- Abuse by the user

*Adapted from Masters, L. W. RILEM/ASTM/CIB Symposium, Otaniemi, Espoo, Finland, 1977 Aug.

Durability testing

Refs, 2-7

Cause and effect – the basis of all durability testing

Once a material has been subjected to an environmental test, the "effect" is obvious – degradation. Unfortunately the "cause" is not as simple to determine. It is generally agreed that the degradation of coatings exposed outdoors is caused by weather, essentially sunshine, temperature, moisture and wind, and also local pollutants and contaminants. A more complete list of factors affecting the durability of coatings is presented in Table 1. Further, it is recognised that the elements of weather are synergistic, but the component most often singled out is sunshine or solar irradiation which reaches the earth's surface. More specifically, our interest is focused on the short wavelength part of sunlight known as ultraviolet[2] (290-400 nm).

Instrumentation is available for precise measurement of wind direction and velocity, temperature, relative humidity, rainfall (quantity and duration), total time of wetness, pollutants, total solar irradiation and total ultraviolet. Therefore these elements of weather are no longer mysterious or exotic. The unknown remains the amount of energy at specific wavelengths in the ultraviolet region, and especially those areas considered to make up the activation spectra causing degradation.

Timing the test

Historically, outdoor durability tests have been timed by three methods: calendar (days, weeks, months or years), ultraviolet sun hours (UVSH), and/or total irradiation (langleys). Laboratory accelerated tests have had to suffer the clock hour, while both types of tests could be performed to a predetermined change in either a standard or the actual exposure specimen. With the exception of the latter, none of the methods is satisfactory; but until now, they have been the only units with which we have had to work.

Calendar

A high confidence level cannot be established on test results which constantly change, yet this is a fact of life we have to face. The variability of weather does not lend itself to obtaining repeatable results. "Average weather just does not exist within the span of time for test purposes."[3] or "Weather cannot be reproduced."[4] are just two remarks indicating variability. "... poor repeatability/reproducibility should be expected because of differences in climatic conditions between geographical areas and seasonal variations at a specific location."[5] more or less puts the situation in a nutshell.

Ultraviolet sun hours (UVSH)

Once we examine the definition of a UVSH, the shortcomings of this unit become obvious. A UVSH is any cumulative 60 minutes when the intensity of incoming solar radiation is above 0.823 g cal/cm^2. The same problem exists with total irradiation (langleys), in that neither the UVSH nor the langley take into consideration the quality of sunlight. It is quite possible to monitor nearly the same amount of UVSH and irradiation on a day in December and a day in June, yet for the northern hemisphere, it is believed that the ultraviolet content of June sunlight is twice that of December. Koller[6] indicates that summer sunlight may contain well over three times as much

Table 2
*Average climatological data**

Location	Climate	Sunlight		Rain	Temp.
		Hours of sunshine	Langleys	(mm)	(°C)
Teesside	Temperate	1360	90,000	55	8.5
Brixham	Temperate – marine	1680	101,000	98	11.0
Durban	Sub-tropical – maritime	2280	133,000	101	20.5
Johannesburg	Sub-tropical – continental	3290	164,000	75	15.8
Burnie	Temperate	2150	120,000	90	12.8
Melbourne	Temperate	2060	120,000	66	14.8
Miami	Sub-tropical	3000	150,000	152	23.8
Phoenix	Desert	4000	190,000	16	20.8

*Provided by BTP Tioxide Limited, UK, 1972

ultraviolet as winter sunlight and states, "The four months, May, June, July and August together, supply about 62 per cent of the yearly total; November, December, January and February together supply only about 7 per cent of the yearly total". Though he does not mention it, I wonder if Koller would just reverse the figures for the southern hemisphere?

Separating spectral distribution

Literature is sprinkled with references to programmes which have attempted to separate the spectral distribution of sunlight. However, none of these projects has been successful on a continuing basis. We are still in the guessing stage as to what coatings are actually resisting outdoors during their test period. Programmes currently under way at South Florida Test Service of Miami, Florida using the LM2A developed by Atlas Electric Devices Company of Chicago, and at DSET Laboratories Inc. of Phoenix, Arizona with a spectroradiometer[7] developed by that company, are encouraging. Preliminary results indicate that both these programmes may be successful, and the LM2A may provide an inexpensive system which can be used throughout the world. If so, this significant step forward will solve one of the final unknowns relating to the cause of degradation and provide the basis for conducting more reliable accelerated tests which correlate well with long-term testing.

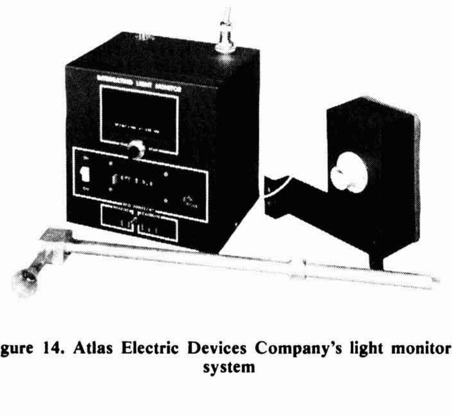

Figure 14. Atlas Electric Devices Company's light monitoring system

In the meantime, we must rely on existing information for calculating the amounts of ultraviolet, which is one of the important keys in conducting accelerated tests.

The major problem in correlating accelerated testing to outdoor durability tests is that we simply do not know what is happening in natural sunlight. We know more or less what is occurring in the laboratory devices, but cannot relate these tests realistically to outdoor exposures. At the moment we do have more information on which to base test parameters and must break away from the historical "because we have always done it that way".

A logical approach to durability testing

Refs. 8,9

Standard weathering year

We have already been told by learned people that average weather does not exist, and that weather cannot be reproduced. They may be correct, but it is my opinion that we should try to prove them wrong – at least as far as possible. Average weather may not exist, but with accurate climatological data and within acceptable limits we can predict the weather profile that may be expected during a test year at any geographical location selected for outdoor durability testing. Having this information and applying it with care seems a much more logical approach to durability testing than the hit-or-miss methods employed to date. The average climatological data for several locations throughout the world are presented in Table 2. Two important categories of information are missing from this table: total time of wetness and black panel temperature. These data are vital to our approach to durability testing and must be estimated based on available information. Tables 3 and 4 provide the comparative distribution of irradiance, and the total energy below 400 nm for artificial light sources, respectively.

Table 3
Comparative distribution of irradiance

Bandpass	Sunlight[1] (%)	6500W[2] xenon* (%)	Open flame[2] carbon arc (%)	fluorescent[2] (%)
Below 300 nm	0.01	0.01	0.5	14.0
300 – 340 nm	1.6	1.5	2.5	70.0
340 – 400 nm	4.5	5.0	11.0	13.0
Total below 400 nm	6.1	6.5	14.0	97.0
400 – 750 nm	48.0	51.5	34.0	3.0
Above 750 nm	46.0	42.0	52.0	0.0
Total above 400 nm	94.0	93.5	86.0	3.0

1. Calculated from CIE Pub. No. 20 (TG-2.2), 1972. 2. Kinmonth, R. A. and Norton, J. E., *JCTAX*, 1977, **49**, 633. *Borosilicate inner and outer filters.

Table 4
*Total energy below 400 nm – artificial light sources**

Source	J/cm²s	J/cm²h
Open flame carbon arc	0.013460	48.5
Single enclosed carbon arc (508 mm diameter drum)	0.012640	45.5
Single enclosed carbon arc (762 mm diameter drum)	0.005056	18.2
Twin enclosed carbon arc	0.010112	36.4
2500W xenon	0.009890	35.6
6500W xenon	0.007250	26.1

*Calculated from Atlas Electric Devices Company published data for borosilicate inner and outer filters.

Exterior durability tests

Assuming that the CIE data on the distribution of irradiance for natural sunlight are correct, let us develop what could be a standard weathering year profile for Durban, SA:

Test duration	Mean temp.(C)	RH(%)	Total wet time	Total irradiation below 400 nm
1 year	20.5	70	2190 h (25%)	34 kJ/cm²

Based on this profile, rather than conducting tests for a designated calendar period, we would stipulate that specimens be exposed to a total of 34 kJ/cm² or multiples thereof depending on the number of years we wish to simulate. This is quite simple and requires no special effort if the test facility maintains an ultraviolet radiometer.

This small change in testing procedure could save actual months of exposure time and increase the possibility of obtaining repeatable test results regardless of when an exposure starts. In most geographical areas, temperature, relative humidity, rainfall and total wet time will be about the same for test durations of twelve months or longer. Conducting the test only for the time required to produce predefined changes in either the test specimen or a specific standard may also save time in that the test will run no longer than necessary.

Laboratory accelerated weathering

The majority of the people with whom I have spoken recently regarding the operation of their laboratory accelerated weathering equipment when asked what criteria they were using for their testing, have replied that they are using the No. 7 cam (102 minutes of light only followed by 18 minutes of light plus water spray). As near as I have been able to determine, the wet/dry cycling, operating black panel temperature (63 ± 5°C) and relative humidity (normally whatever humidity occurs) do not relate very well to any known natural climatic condition. Yet these are the test parameters used by most laboratories for accelerated durability tests, the results of which are expected to correlate to some geographical area.

Table 5

*Programmed environmental testing – one year simulation**

Location	Operating black panel Temp.[2] (°C)	Relative[1] humidity	Wet-time[1] (spray cycle)	Total irradiation below 400 nm
Durban	50 ± 3	70	90/30	34 kJ/cm^2 (1300h)
Johannesburg	45 ± 3	55	95/25	42 kJ/cm^2 (1610h)
Miami	54 ± 3	75	90/30	38 kJ/cm^2 (1456h)
Phoenix	50 ± 3	30	114/06	49 kJ/cm^2 (1877h)

*6500W Xenon Weather-Ometer with borosilicate inner and outer filters. IR reduction may be required to achieve low temperature conditions.

1. Relative humidity and wet-time are estimates used as an illustration in the absence of actual data.

2. Operating black panel temperatures are estimates based on actual measurements made at South Florida Test Service and assuming the difference between ambient and black panel temperatures would be the same for all locations.

NB: Clock hours listed represent time requirements for manually adjusted xenon equipment. The number of clock hours required using equipment with a xenon source and fitted with light monitoring systems will vary depending on selected operating wattage.

A better approach

There are some laboratories which are investigating other wet/dry cycles, as in the case with the South African Bureau of Standards in Pretoria. In 1965 J. E. Fullard presented data covering 20 years of laboratory accelerated weathering[8]. Results of tests utilising several wet/dry cycles are presented, and the report states: "It would be unrealistic to expect correlation between a constant and a variable. We are quite satisfied if we can obtain correlation for individual types of paint, especially in relation to the typical characteristics of the type of paint for one special set of climatic conditions." I can only assume that the climatic conditions referred to would be somewhere in the vicinity of Pretoria, yet upon examining the variety of cycles used, not one of them represents a simulation of that climate. I do not mean to slight the work performed by the South African Bureau of Standards, and, since the report was published some fifteen years ago, attitudes could have changed. However, the approach to accelerated laboratory testing represented in the report is, I believe, quite indicative of most tests being carried out today.

Programmed environmental testing

Current laboratory accelerated testing equipment produced by Atlas Electric Devices Company of Chicago include light monitoring systems which enable the user to programme an accelerated test to exact amounts of energy at specific wavelengths. These sophisticated new instruments are also programmable for temperature, relative humidity, wet/dry cycling (total wet time), and even pollutants (NO_2, SO_2 and ozone). By using these instruments as they are intended and by programming to certain amounts of energy, the clock hours required to simulate exterior durability testing may be significantly reduced and better correlation obtained. The latest concept in laboratory accelerated weathering is programmed environmental testing, whereby we make use of all the climatological data available and the programmability of the instruments to simulate as closely as possible the specific geographical area in which we are interested. If your only reason for conducting accelerated tests is materials comparison (is coating "C" better than coating "X"), you probably will not be interested in this concept. But, if your goal is to develop an accelerated durability test method which provides reliable results that can be used with confidence to predict the performance characteristics of a coating; then, perhaps, you will share my enthusiasm for programmed environmental testing. Consider, for instance, the test parameters presented in Table 5 as programmed environmental testing to simulate one year of outdoor exposure in Durban, Johannesburg, Miami and Phoenix compared to the previously mentioned usual test parameters.

Programming the Weather-Ometer

Now that we have examined the conditions which should exist to simulate as closely as possible the natural weather profile of an area, you might well ask "how do I programme my Weather-Ometer?" With carbon-arcs, it is relatively easy. Calculate the number of clock hours required based on the data in Table 4, programme the wet/dry cycling based on total wet time of the area, and set the black panel temperature and relative humidity controls to the desired levels. Closer programming is not currently available for most devices using the carbon arc as a light source, and we are not able to adjust the voltage in order to control the energy and thus the time requirement.

6500 watt xenon Weather-Ometer

For those using a Weather-Ometer with a xenon source and equipped with light monitoring systems, it is possible to be more precise in programming the test, and you are able to alter the time requirements within certain limitations. With these systems we must know the total irradia-

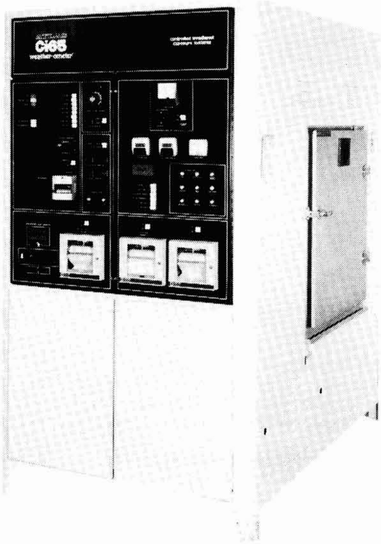

Figure 15. Atlas Ci65 Weather-Ometer

tion at the monitored wavelength required to achieve the test parameter. Then, we are able to choose the rate at which we wish to collect that energy. Obviously, the higher the setting the sooner you will reach the programmed exposure dose. You must increase the lamp wattage proportionally to the increase in irradiance, thereby potentially reducing the life of the lamp. Only you can decide on the economic consideration of acceleration versus operating costs, but effective cost per exposed specimen should remain fairly constant. Unless the irradiance is specified, and until spectral data for natural sunlight becomes available to prove otherwise, Atlas Electric Devices Company[9] states that 0.55 W/m^2 at 340 nm or 1.5 W/m^2 at 420 nm represent the minimum levels of operation at which an accelerated test is provided.

When filtered by suitable borosilicate glass filters, energy from the xenon lamp is an extremely close approximation to direct sunlight at every wavelength of the actinic spectrum. We may assume it reasonable to compare energy for any spectral portion (ultraviolet, visible radiation) of the two sources. Data published in Atlas Bulletin 1400 indicate total irradiance of a typical xenon lamp system with borosilicate filters to be 1144 W/m^2, and the spectral distribution curve indicates that spectral irradiance is about 0.6 W/m^2 at 340 nm and 1.5 W/m^2 at 420 nm. Therefore, their derived equation for spectral irradiation is:

$$Q_\lambda = 3.6\ tkE$$

Where Q_λ is spectral irradiation (kJ/m^2) at wavelength, λ
3.6 is kiloseconds per hour, ks/h
t is time in hours, h
k is a prefix, kilo, equal to 10^3
and E_λ is spectral irradiance, $(W/m^2)_\lambda$ or $(J/sm^2)_\lambda$

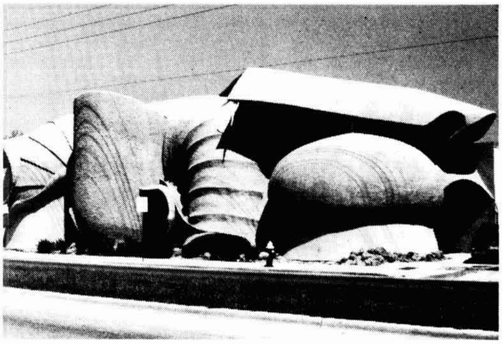

Figure 16. Complex problems presented to the coatings industry

Conclusion

The complexity of modern man's world is increasing at a staggering pace, and as his world changes so do his desires and demands. In the future the coatings industry will be involved with applications unthought of today, and we must explore all avenues to reduce costs while producing better products.

Technology and instrumentation are available today to solve many of our future problems, but we must use what we have for different, innovative approaches to durability testing. Accelerated durability tests which provide results that can be used with confidence for development and marketing must be developed, and research projects are being conducted continually toward this goal. Until such time as the "ultimate" accelerated durability test is designed, we will have to struggle along with the time consuming exterior durability tests. However, by careful planning and execution, we can reduce the time required for outdoor exposures, yet increase our data output. Also; by altering the existing test parameters of laboratory accelerated testing towards programmed environmental testing, we may be able to increase significantly the correlation to exterior durability exposures. The changes in testing procedures discussed could result in reduced research budgets representing savings which may be passed to the consumer.

[Received 13 February 1981

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Hydrogen bonding – key to dispersion?

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Summary

The Hansen, Burrell and Sorenson approaches to hydrogen bonding (γ) and solubility parameter (δ) are summarised and illustrated.

The effect of hydrogen bonding series on the relationship of pigment/binder/solvent is examined over a wide range of colours and white pigments, particularly titanium dioxide.

The hypothesis is presented that during the dispersion process, film formation and the can storage period, the relationship between pigment and solvent may well be more important than that between pigment and resin.

Attention is drawn to the need to develop the relevant correct solvent bases to allow maximum use of the pigment/binder relationship by avoidance of unnecessary flocculation.

Keywords

Properties, characteristics and conditions primarily associated with

materials in general

HLB value
hydrogen bonding
polarity
solubility parameter

Processes and methods primarily associated with

manufacturing or synthesis

pigment/solvent reaction
pigment/vehicle reaction

Enchaînement par liaisons hydrogènes – la clé au processus de dispersion?

Résumé

On résumé sommairement et on explique les points de vue de Hansen, Burrell et Sorenson à l'égard de l'enchaînement par liaisons hydrogènes (γ) et le paramètre de solubilité (δ).

On étudie l'influence qu'exerce l'enchaînement par liaisons hydrogénes en série sur le rapport pigment/liant/solvant pour une gamme étendue de pigments blancs, surtout le dioxyde de titane.

On présente une hypothèse affirmant que, lors du processus de dispersion, de la formation de feuil et du délai de stockage, le rapport pigment/solvant pourrait être éventuellement plus important qui celui entre le pigment et la résine.

On attire l'attention du lecteur sur la nécessité de mettre au point les justes mélanges solvants, afin que l'utilisation maximale du rapport pigment/liant soit assurée par l'élimination de toute floculation inutile.

Wasserstoffbrückenbindung – der schlüssel zum dispergiervorgang?

Zusammenfassung

Die behandlungsmethode von Hansen, Burrell und Sorenson hinsichtlich der wasserstoffbrückenbindung (γ) und des löslichkeitsparameters (δ) werden zusammengefasst und erläutert.

Der einfluss der wasserstoffbrückenbindungsreihen auf die pigment/bindermittel/lösungsmittelbeziehung wird über eine weite reihe bunt- und weisspigmente vor allem titandioxid untersucht.

Als hypothese wird es dargestellt dass bei dem dispergiervorgange, der filmbildung und der lagerstabilitätsdauer, die pigment/lösungsmittelbeziehung wichtiger als diejenige zwischen pigment und harz wohl sein mag.

Um die maximale anwendung der pigment/bindermittelbeziehung zu benützen und unnötige flockulation zu vermeiden, ist man auf die notwendigkeit der entwicklung richtiger lösungsmittelgemische aufmerksam gemacht.

Introduction

As recent research time has passed, one is forced to the realisation that our industry daily becomes less an art and more a science. We have for a long time sought the true connection between the three basic phases in paint and ink – vehicle, solvent, pigment.

Discussion

Refs 1-8

The true value of Burrell's[1] original concept of solubility (which was later shown scientifically to be true) has not been fully exploited or applied by working formulators for over 20 years. This paper aims to expand this latter shortcoming into use in the pigment dispersion field to give direction to further research thought and action with respect to the third phase – pigment.

Hansen[2] pointed out that the concept of compatibility applies not only to vehicles, but to vehicle/pigment combinations. This higher order of compatibility, or incompatibility, is the basic problem that makes the search for a single all purpose tinting paste, suitable for all products, a futile pursuit.

Later, Sorensen's[3] hypothesis confirmed that truly universal tinting vehicles or tinting pastes do not exist, even for systems with fully compatible vehicles.

Carr's[4] comprehensive survey of the practice and theory of pigment dispersion states that:

"There is, therefore, a competition for the resin molecules between the solvent phase and the pigment surface – it would not be surprising if the level of adsorption of any particular resin onto a particular pigment was dependent on the *solvent* used and its solvent power for the resin."

The current paper sets out to demonstrate this point, but prefers to offer the consideration that the competition may well be for the pigment surface between the resin and the solvent.

Carr[4] further suggests "the assumption that toluene rich inks will give somewhat less flocculation is by no means unreasonable." The current paper suggests that the wider generalised case would be covered by substituting "relevant γ" for "toluene rich" thereby leading to major savings in costs by minimisation or elimination of pigment flocculation.

How many times has an attempt been made to disperse pigment "X" into vehicle "Y" to no avail? The early thermoplastic acrylic resins were a classic case of this until benzoated phthalocyanine lakes appeared. It is obvious, then, that the tripartite relationship of vehicle/solvent/pigment has not been adequately explored.

Atlas Powder[5] presented their HLB concept some 20 years ago, in part to facilitate pigment wetting in the aqueous phase of latex paint systems. HLB defines the balance between the hydrophilic components of a surfactant on an arbitrary scale of 0-20, where 0 is completely oleophilic and 20 is completely hydrophilic – a neutral balance surfactant would thus have an HLB of 10. When examined in its effective true light, the HLB reflects the measure of polarity, as also is the parallel effect in γ. So, if the Burrell solvency concept is overlaid with the γ requirement of the pigment and the HLB of the wetting agent system, it should be possible to see an integral connection between vehicle, solvent and pigment.

First, a review of the Burrell-Hansen concepts:

Burrell[1] gives the solubility parameter (δ) as:

$$\delta = (E/V)^{\frac{1}{2}}$$

Where E/V is the energy of vaporisation per cc.

These concepts state that a resin may be expected to be freely soluble in a solvent with a δ value of ± 1.0 varying from that of the resin. This concept may be widened by using a solvent *blend* of Resin (δ) ± 1.0. Thus, two or more *non-solvents* in admixture may become a solvent for the resin. A classic example of this is ester soluble nitrocotton (medium δ) which will dissolve neither in toluene (low δ) nor in ethonol (high δ) but will dissolve in 50:50 mix (medium δ).

Sorensen's[3] comments on compatibility imply that for resins to be compatible, they must at least have overlapping δ and γ characteristics. Solubility parameter is not an easy quantity to measure, but the use of the HLB value to replace γ allows us to develop an HLB plot showing correspondence between pigments and surfactants, e.g. carbon black is organophilic, has low δ, low HLB and low γ, whereas yellow iron oxide is hydrophilic, has high HLB and high γ. It is obvious that for optimum performance they will require differing relevant solvent base/surfactants, similar to the Burrell solvent charts.

Nature follows two general rules – "Keep to a simple solution" and "like prefers like". From these, it can be postulated that an organophilic pigment will prefer to disperse in a low γ value resin, and an hydrophilic pigment will prefer to disperse in a high γ value resin. Thus, it is difficult to disperse carbon black (low γ) in water, whereas most titanium dioxides (high γ) disperse relatively easily in water. It is obvious from this that a pigment requires both resin *and* solvent system to be in close proximity to its own γ, δ and HLB, if optimum properties are to be developed, *and retained*, in the pigment dispersion.

Hansen[2] originally attempted to disperse small amounts of pigment in a series of solvents, the γ of which were known. When the γ of solvent and pigments matched, the pigments dispersed and then settled *slowly*. When they did not match, the pigments agglomerated severely and settled rapidly. On this basis, pigments can be ordered as to a specific γ and HLB as given in Table 5. It follows from the original Burrell concept, that it should be possible to predict, with some degree of accuracy, which combinations of pigments, vehicles and solvents could be expected to give well dispersed, stable systems, as against those which would be likely to flocculate. The further step forward is that products developed from this data should be predictable in their properties. If one is prepared to look even further into the future, why should not surface characteristics of pigments and for example latexes be designed hand in hand for mutual general performance in this regard?

Hoy[8] in the 1978 Matiello lecture states "It is my belief that the coating formulator, utilising the 'basic' concept of the latex particle presented here, and fully aware of the effects that can be created, can more understandably formulate and attain the desired properties of latex coatings."

Further aid will be obtained from the surfactant system. Asbeck[6] in his 1977 Matiello lecture states that the requirements of the surfactant molecule are:

1. The "head" must match the dispersion parameter of the solid surface.
2. The "tail" must match the δ of the vehicle.
3. The two molecular ends "head and tail" must be held together by chemical, ionic or other reasonably strong bonds.

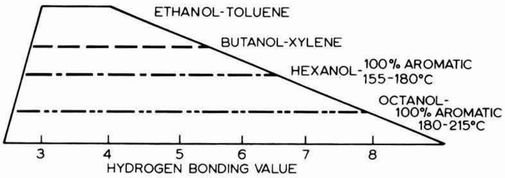

Figure 1. Effect of solvent boiling point

If we also consider zeta potential, the Stern layer and the outer layer of counter-ions acceptable as the basic structure for dispersed pigments, then we must also consider the minimum chain length of the surfactant. This may, perhaps, be of the order of 100 angstrom units.

Ahmad and Yasseen[7] have shown that δ can be calculated for most organic compounds, so that it is obvious that surfactants can be selected for given systems on the basis of Asbeck's description.

Experimental

Ink pigment concentrates

A typical γ series for the purpose of this paper is:

2NP	Heptane	Toluene	Isopropyl acetate	Cyclo-hexanone	Ethanol	Water
1.9	2.2	3.3	6.0	7	8.5	8.5

The initial work performed was to disperse single pigments in solvent blends prepared over the whole γ range. The structure of the experiments is given in Appendix A.

This work established that:

1. At a clearly defined characteristic γ, each pigment gives optimum properties such as:

   Highest tinting strength
   Best gloss
   Lowest viscosity
   Least settling
   Improved adhesion
   Best flow

2. Each solvent series develops these properties at a specific, reproducible level of polarity, the peak of which does not necessarily occur at the same point in varying solvent series, as shown in Appendix B.

3. If the extreme values are taken, e.g. ethanol-heptane, the peaks are not as clearly defined as when using solvents of closer γ to formulate the optimum solvent base e.g., toluene and isopropyl acetate.

For example, with Pigment Yellow 14 (Table 1) in solvent alone:

Ethanol-heptane, optimum required γ	2
Ethanol-heptane/1-propyl acetate, optimum γ	2
Ethanol/2-nitropropane, optimum γ	4

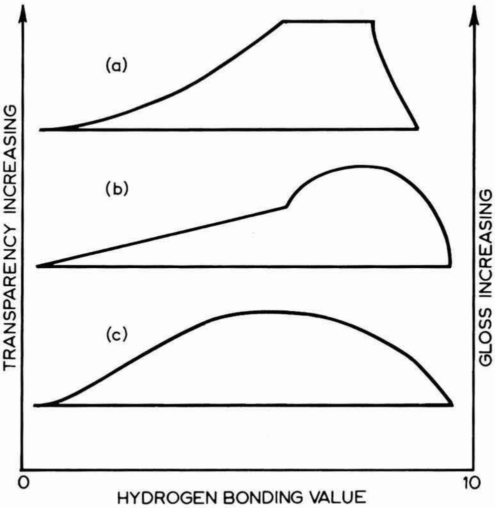

Figure 2. Schematic diagrams of pigment response patterns to varying hydrogen bonding values

So, for Pigment Yellow 14 to show optimum properties in a flexographic ink, the indicated γ for the solvent system is 4, being derived from a blend composed of 34 per cent ethanol and 66 per cent 2-nitropropane.

As the boiling point (i.e., molecular weight) of the solvent system rises, the acceptably usable limits of γ widen, i.e., the peak broadens and flattens – typical behaviours are shown in the schematic diagrams in Figure 2. The plot for beta-Pigment Blue 15.3 in medium melt point reduced phenolic is shown in Figure 1. However, the optimum properties still develop in the γ range of 6-8 for all solvent combinations. The implication is that optimised pigment utilisation exists over a wider range in solvents of higher molecular weight – an important factor for paints and metal decorating finishes. The corollary is that fast drying products such as inks, lacquers and copolymer enamels deserve more attention than they normally receive in relation to the effect of the solvent blend on the pigment used.

In general, cyclic solvents have superior solvency. This can be regarded as equivalent to a move towards a greater degree of γ. Thus, Pigment Blue 15.3 develops even more superior properties if, say, benzyl alcohol or cyclohexanone are used in the solvent blend, with the γ requirements then rising quickly to a more defined maximum e.g., plot (b) in Figure 2.

The concept presented up to this point has concerned itself with the effect in ink pigment concentrates, where solvent content is high and polymer content low.

The effect of vehicle addition

When resin solids are introduced into the dispersion process, as in paint making, the amount of pigment decreases in relation to the vehicle solids and allowance must be made for the interaction between polymer and solvent. If the vehicle influences polarity then the pigment

Table 1
Evaluation of solvents

Formulation	A	B	C	D
Pigment Yellow 14	20	20	20	20
Ethanol	200	10	43	10
2-Nitropropane				
Toluene				47
Heptane		119	157	143
Isopropyl acetate		71		
Hydrogen bonding	8.5	6.0	4.4	4.2
Gloss	best →			poorest
Transparency	good	fair	only fair	poor
Opacity	fair	good	good	fair

Table 2
Effect of solvent structure on useable hydrogen bonding range
Pigment Blue 15-3

Solvent blend	Best range	Good range	Tint strength
Ethanol/toluene	3-4	3-4	poorest
Butanol/xylene	3-4	3-6	↓
Hexanol/arom. 155/180	3-4	3-7	
Octanol/arom. 180/215	3-4	3-9	
Cyclohexanol/arom. 155/180	8	7-8	
Benzyl alcohol/arom. 180/215	9	6-9	best

Table 3
Effect of surface after-treatment on required hydrogen bonding value

			Hydrogen bonding	
Titanium dioxide	Source	After-treatment	Gloss	Opacity
1. Sulfate	A	no	4-6	4-6
2. Sulfate	A	yes:inorganic	5	3
3. Chloride	B	yes:high organic	2	2
4. Sulfate	B	yes:low organic	2	2
5. Sulfate	B	no	2	2
6. Chloride	C	no	7-8	4-8
7. Sulfate	D	no	5	5

peak will be raised dramatically. This is shown in Figure 2, where the schematic "behaviour" (c) would tend to move through (b) to (a) with increasing polarity. Note that Figure 2 (a) has a sharply defined peak, but all three show maxima. The implication is that the pigment type shown in (a) also has a particularly defined polymer/solvent requirement, whereas (b) and (c) pigments allow a wider solvent formulation approach. In general (but not always), organic pigments will require lower polarity solvents, whereas inorganic pigments will require higher polarity solvent bases *unless* they are after-surface-treated to modify this requirement. It now becomes easier to understand why many low solids grinds will suffer colloidal shock on let-down into "cost convenient" rather than "required γ" solvents. Even if this is accepted, the solvent/pigment relationship is more important than the solvent/polymer relationship – it is thus easily seen that the counsel of perfection is that the polymer should easily dissolve in the required solvent of the pigment. It is now easy to see why pigment "X" hesitates to disperse in polymer "Y" in a solvent base often formulated on a cost or particular drying speed basis. The indicated values for optimum gloss and opacity may sometimes not exactly coincide – the reader is referred to the behaviour of commercial grades of rutile titanium dioxide in nitrocellulose gravure ink as shown in Table 3 and Appendix D. The effect of the after treatment applied to the surface of the pigment *cannot* be overstressed.

As shown in Table 3, the preferred result is obtained from titanium # 1 in nitrocellulose – it is balanced in γ requirement for development of best gloss and opacity, as it falls into the γ range required for the maximum solubility of nitrocellulose.

On the opposite hand, titanium # 4 (with its lower γ) is best suited for use in long oil alkyds in mineral spirits – in fact, titanium # 4 does not "flood" to anywhere near the same extent as titanium # 1 in such a vehicle. In mid-tones titanium # 1 needs additives to, in effect, move its γ downwards, whereas titanium # 4 would need additives to, in effect, move its γ upwards if it, in turn, were to be

Table 4
Effect of solvent blend on flocculation

Pigment	Hydrogen bonding value	Gloss	Opacity	Colour
Lake Red C Resinated	4:correct	high	transparent	clean
Lake Red C Unresinated	7:incorrect	low	opaque	dirty

Table 5
Development of optimum solvent hydrogen bonding value and pigment HLB

	Hydrogen bonding value		
I pigment	II press-ready	III optimum	IV HLB surfactant
Sulfate titanium dioxide	7.6	7	13.6 – 1.5%
Pigment Black 6	8.2	2.5	4.5 – 2.5%
Pigment Blue 15.3	8.5	6	12.6 – 3.0%
Methyl violet blue	7.8	7	13.6 – 3.0%
Pigment Red 53.1	8	4	7.5 – 2.2%
Pigment Red 48.2	8	2.8	6.0 – 2.3%
Pigment Red 57.1	7.8	6	11.8 – 2.0%
Pigment Green 36	8.5	7	13.6 – 2.8%
Pigment Yellow 34 (prim.)	7.5	5	9.0 – 1.5%
Pigment Yellow 34 (mid.)	8.2	6	11.8 – 2.0%
Pigment Yellow 14	8.8	2	4.5 – 2.5%
Pigment Red 104	7.6	5	10.0 – 2.7%
Pigment Violet 2	8.6	5	10.0 – 3.0%
Pigment Red 81	8.7	8	16.2 – 2.5%

These values vary slightly with both resin and solvent, as shown in appendices B, C and D.

dispersed in nitrocellulose. This is further illustrated by the case of Pigment Red 53.1 dispersed in "correct" and "incorrect" solvent bases as shown in Table 4.

All derived data show that the influence of the solvent requirement of correct γ outweighs the influence of the polymer. It should be recalled that *most*, not all, polymers utilised in the coatings industry lie in the δ range 7-10. It is thus apparent that the solvent blend becomes the main source of potential variation of γ for the *total* system, and hence greater attention should be given to the solvent balance in all products. Only in certain cases do resins exert in overriding influence on the degree of dispersion attained due to their inherent high polarity, e.g. rosin, carboxylated hydrocarbon resins, alcohol soluble resins, reactive paint grade polyamides and amino-formaldehyde resins – the latter as much from the butanol present as from the resin itself.

Co-grinds

If carbon black (low γ requirement 1) is co-ground with yellow iron oxide (high γ requirement 8.5) the attempt is doomed to failure unless the correct additives are employed to "bridge the gap" in their differing polarities.

A typical offender is the phthalocyanine blue – titanium dioxide combination, where either the white floods or the blue floats. If the tint strength (and brightness) of the expensive blue is to be retained, it needs to be dispersed in a solvent base of γ ca. 6. If solvent bases much removed from $\gamma = 6$ are used, the flooding or floating (or finally flocculation) will be greater as a move from the optimum value of 6 occurs. Also, the γ requirement of the titanium dioxide will have to be simultaneously satisfied – reference to Table 3 shows that good results would be expected from Titanium # 1 with an optimum $\gamma = 4$-6, and poor results from Titanium # 4 with its optimum $\gamma = 2$. Obviously, the opposite effect would occur with, say, carbon black as the co-grind pigment. Transferring now to the polymer nature, for ideal performance the polymer γ should also be of medium polarity, e.g., ester soluble nitrocellulose or ink grade polyamide resin. The approach to an optimised formulation is thus apparent.

It becomes obvious that if, in everyday work, attention is not or cannot be paid to the γ in the system, then a "coupler" – a surface active agent – must be employed.

The role of the surfactant

Following Asbeck's[6] definition of the surfactant, a suitable surfactant must orient to the pigment and to the vehicle. From this it follows that the "head" of the surfactant should have the HLB value required by the pigment, that the "tail" should be of a similar structure to the vehicle, and that the surfactant chain length should be sufficient to bridge the adsorbed layers between the pigment interface and the bulk un-oriented vehicle. Ideally, if our system is correctly balanced we should not really need any form of surfactant, and in general we employ surfactants only when we are in trouble, or when we wish to carry more pigment in the same weight of vehicle.

For example, yellow iron oxides flood badly and settle markedly in long oil alkyds – if we add a small amount of a long chain base, e.g. triethanolamine or tetraethylene pentamine, the problem becomes minimal or disappears – the high γ requirement of the yellow oxide attracts the amine group, the fatty acid chains in the vehicle attract the aliphatic chain (low γ requirement) of the long chain amine and "we bridge the gap". For a water dispersion illustra-

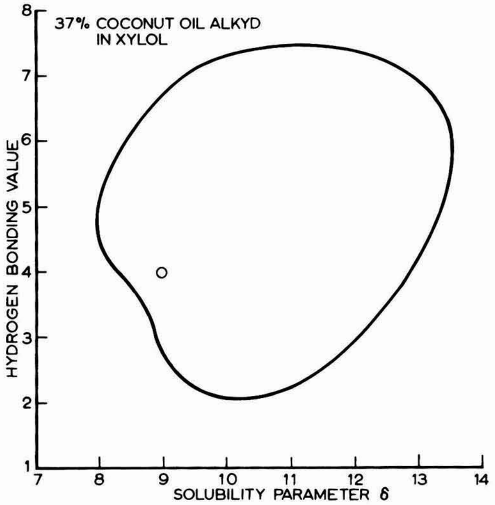

Figure 3. Solvent formulation map

tion, it can be stated that the selected surfactant would have a high HLB number, with a long organic (hydrophilic) chain to achieve the same effect, e.g. a substituted nonylphenol ethylene oxide condensate non-ionic surfactant, of HLB 18-20 would be selected. Hence, it is evident for the formulator that, in general, pigments requiring low HLB surfactants for water dispersion will require low γ in organic solvent dispersion, and pigments requiring high HLB surfactants in water will require high γ in organic solvent dispersion.

Future development

It is evident that this concept may in the future be expanded to develop far more data – all this data will revolve around numbers and, as such, asks to be computerised. It is apparent that the plots for polymer solubility, solvent characteristics, pigment γ and HLB values, together with surfactant HLB and surface tension values could be written into a program such that optimum formulation balance would be printed out.

Proceeding from the Burrell solubility map as shown in Figure 3 via the plot:

$$\delta = (E/V)^{\frac{1}{2}}$$

$$\text{or } \delta = \frac{\text{heat of vaporisation} \times \text{density}}{\text{molecular weight}}$$

versus γ, the corresponding δ and γ values for solvent and pigment can be fed into a computer in conjunction with results such as are given in appendices B, C and D to obtain a printout showing optimum polymer, solvent and pigment balances for maximum performance. As greater knowledge of the relationship between pigment surface/pendant groups and consequent γ becomes available, the formulator will possess a valuable tool for the development of higher performance products.

Conclusion

Further study of the links between the γ of pigments and solvent bases in all coatings is capable of yielding higher performance products at a time when attention to wastage of crucial raw materials is becoming a major concern of coatings formulators.

Acknowledgement

The author expresses his thanks to co-worker and colleague, Mr Ernest Rhode, who contributed so much to the original concept of this paper and who carried out all the experimental work involved. Without Mr Rhode's contribution this paper would not have been possible.

[Received 30 July 1981

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Appendix A

An ink formulator was requested to provide a basic formula for a high speed gravure ink and then to prepare from this basic formula a set of coloured inks.

The ink was required to contain the solvents:

n-Propyl acetate
Ethanol
2-Nitropropane
VM and P naphtha

To allow a wide γ calculation

The formulator was to adjust the inks to press-ready condition, and record any thinner addition figures. The resultant coloured inks varied from full gloss to matt, from dispersed to flocculated, with consequent effects on colour, gloss and transparency.

In Table 5, column II shows the calculated γ of the control solvent base for each colour at the press-ready stage; column III shows the γ to which the solvent base must be formulated to develop optimum performance with each particular pigment using the four specified solvents.

Column IV shows the concentration used of an optimum surfactant blend where required HLB (see postulate below) has a parallel value to the γ requirement of the pigment. The surfactant pair are ethylene oxide/tallow fatty acid amine derivatives, the ratio of which gives the requisite HLB value for each pigment.

Postulate

If the optimum γ for a given pigment/solvent dispersion is known, then the surfactant HLB required for this pigment to be dispersed in water may be found from:

$$2\ \mathrm{HB}_{\mathrm{Solvent}} = \mathrm{HLB}_{\mathrm{Water}}$$

with the reverse approach implied to be true.

Appendix B

Experiment structure
Solvent alone – variation due to nature of solvent blend

Formulation	A	B	C	D	E	F	G	H	I
Perm. Yellow G	20	20	20	20	20	20	20	20	20
2-Nitropropane	8	34	58	83	107	132	156	182	160
Denatured ethanol	192	166	142	117	93	68	44	18	
X2 solvent									40
	220	220	220	220	220	220	220	220	220
Hydrogen bonding	9	8	7	6	5	4	3	2	1
Strength and gloss	——gradually better——►					best	good	good	fair

Formulation	A-1	B-1	C-1	D-1	E-1	F-1	G-1	H-1	I-1
Perm. Yellow G	20	20	20	20	20	20	20	20	20
Denatured ethanol	190	162	134	106	78	50	21	20	10
Toluol	10	38	66	94	122	150	179	95	47
X2 solvent								85	143
	220	220	220	220	220	220	220	220	220
Hydrogen bonding	9	8	7	6	5	4	3	2	1
Strength and gloss	——gradually better——►						fair	good	best

Formulation	A-3	B-3	C-3	D-3	E-3	F-3	G-3	H-3	I-3
Perm. Yellow G	20	20	20	20	20	20	20	20	20
Denatured ethanol	192	150	112	72	32	10	10	10	2
Isopropyl acetate	4	46	80	120	160	162	117	71	42
X2 solvent	4	4	8	8	8	28	73	119	156
	220	220	220	220	220	220	220	220	220
Hydrogen bonding	9	8	7	6	5	4	3	2	1
Strength and gloss	——gradually better——►						good	best	good

Appendix C

Experiment structure
Solvent and resin – two different grades r-TiO_2

Formulation	A	B	C	D	E	F	G	H
Titanium # 6	130	130	130	130	130	130	130	130
Cotton solution	27	27	27	27	27	27	27	27
Dentured ethanol	134	103	72	40	8			
n-Propylacetate	9	40	71	103	135	114	76	
X2 Solvent						29	67	
2-Nitropropane								143
	300	300	300	300	300	300	300	300
Hydrogen bonding	9	8	7	6	5	4	3	2
Strength and gloss	good	best		——gradually decreasing——►				
Titanium # 4	130	130	130	130	130	130	130	130
Cotton solution	27	27	27	27	27	27	27	27
Dentured ethanol	134	103	72	40	8			27
n-Propylacetate	9	40	71	103	135	114	76	
X2 Solvent						29	67	
2-Nitropropane								143
	300	300	300	300	300	300	300	300
Hydrogen bonding	9	8	7	6	5	4	3	2
Strength and gloss	——gradually increasing——►					fair	good	best

Appendix D overleaf

Appendix D

Experiment structure
Surface after-treatment response. Fixed formula

Formulation	1	2	4	5	7
Titanium dioxide # 1	130				
Titanium dioxide # 2		130			
Titanium dioxide # 4			130		
Titanium dioxide # 5				130	
Titanium dioxide # 7					130
Cotton solution	27	27	27	27	27
Denatured ethanol	72	72	72	72	72
n-Propylacetate	71	71	71	71	71
	300	300	300	300	300
Hydrogen bonding	7	7	7	7	7
Opacity	good	low	low	good	excellent
Gloss	excellent	fair	fair	good	flat

Next month's issue

The Honorary Editor has accepted the following papers for publication. They are expected to appear in the June issue:

Epoxy novolac esters *by H. Panda and Rakhshinda*

The testing of new products *by L. Gall*

Spectrophotometric studies on hard and soft lac resins *by D. N. Goswami and N. Prasad*

Aqueous gloss enamels *by A. Mercurio, K. Kronberger and J. Friel*

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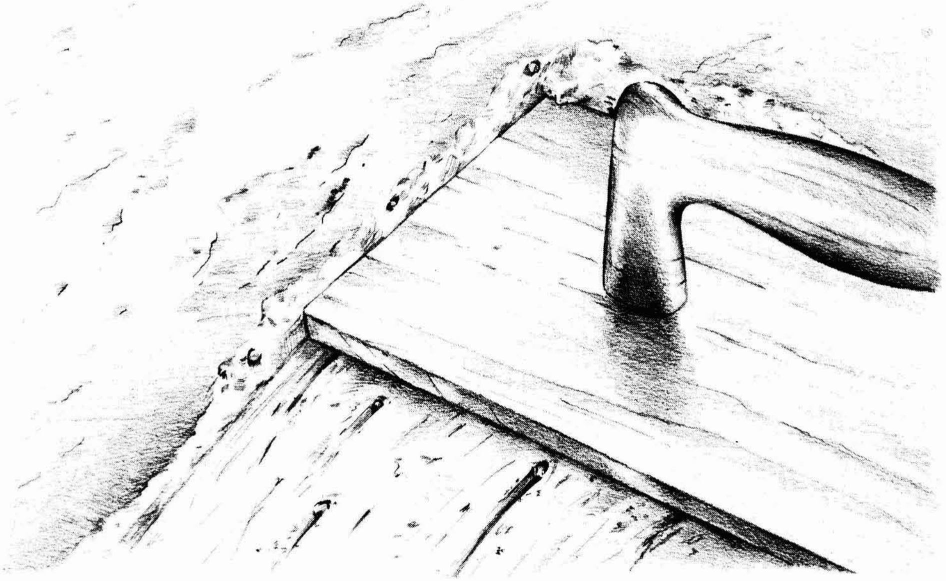

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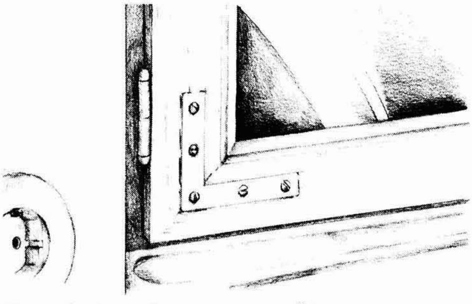

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Yellowing of alkyd paint films

Sir – As an overseas OCCA member, an avid reader of *JOCCA*, and a representative of the titanium dioxide pigment producing industry, I would like to draw your attention to a hidden way of creating prejudice towards titanium dioxide pigments produced by the sulfate route as compared to the titanium dioxide pigments produced by the chloride route.

In the interesting paper by Dr L. A. Simpson on the "Yellowing of alkyd paint films" published in the December 1981 issue of *JOCCA*, the conclusion is drawn in the summary that "a chloride route pigment exhibited slightly less yellowing than a typical sulfate pigment". Further in the text under "The influence of crystal size and method of manufacture" it has been repeated "that pigments produced via the chloride process generally exhibit better colour (i.e. bluer tone) than sulfate process pigments".

To me the use of the highly subjective expression "better colour" is something which should not appear in a scientific text, particularly when it concerns differences which even for an experienced eye necessitate an instrumental or a side-by-side comparison. And after all, why should a bluer tone be better than any other tone?

By reading the whole chapter carefully, the claim in the summary that "a chloride route pigment exhibited slightly less yellowing than a typical sulfate pigment" can be seen to be invalidated, as the same differences of colour indices existed before exposure as at the end of it. This is written in the text: "The rates of yellowing of all three pigmented systems are the same in all three environments" and can be also seen in the figures 4 and 5.

From the practical point of view, it obviously is of no great importance to differentiate between pigment grades on yellowing as long as yellowing is so pronounced and the differences are so small, as reported by Dr Simpson. A careful reader can, however, find a rather meaningful difference between two pigment groups in the results of Dr Simpson's paper which he has passed by without explanation, viz. the difference between the two chloride pigment groups G to J and K to N. In Table 5, the values for Δ CI in ammonia (3 weeks) for resin iv for the pigments G, H, I and J are 26.0, 27.0, 26.0 and 27.0 respectively. In Table 4 the corresponding Δ CI values in ammonia (1 week only!) for the pigments K, L, M and N are 33.0, 32.5, 31.5 and 31.5.

The above figures certainly indicate that in the case of the chloride process pigments K to N, the yellowing proceeds considerably faster than in the case of the pigments G to J or for that matter for any of the other pigments tested, whether anatase or rutile, coated or uncoated, chloride or sulfate. In this regard, I would be interested to learn from Dr Simpson whether he has made or intends to make comparisons of yellowing of alkyd paints between different types of chloride process pigments, and what his conclusions are. In our very limited tests with different types of sulfate pigments, we have come to the conclusion that if it is necessary to have a competitive classification of the yellowing of alkyd paints based on the grades of titanium dioxide used, the winner will be the pigment grade with the highest tint-reducing power, which, logically, compensates strongest for the yellowing of the resin itself. Incidentally, this pigment type is analytically almost identical to the group G to J.

In his paper, Dr Simpson says that the term "titanium dioxide pigment" is rather ambiguous since there are various commercial grades. I trust that in saying this he is fully aware that each of these grades has individual merits as well as demerits which do not depend on the process, chloride or sulfate, as such, but rather on the total skill used in their manufacture. On this basis we can agree that a categorial statement of any betterness cannot be applied to either chloride or to sulfate titanium dioxide grades, but that the value of any pigment grade can only be proved in its intended end-use.

Yours faithfully,
Jouko Valpola,
Technical Service Manager

Kemira Oy
Vuorikemia
Malminkatu 30
00101 Helsinki 10
Finland

Yellowing of alkyd paint films

Sir – I am glad to have the opportunity to respond to Mr Valpola's letter, and offer the following comments:

(i) If yellowing is considered detrimental, then a "white" paint film which exhibits a blue tone (i.e. low colour index) will be more acceptable than one with a red/cream tone to most observers. This is illustrated by the fact that in India, where yellowing is a major problem, and indeed in many other countries, blue toners are commonly used.

(ii) My paper states that most grades of treated rutile titanium dioxide pigment do not affect the *rate* of yellowing although chloride route or fine crystal sulphate route pigments exhibited *slightly* less yellowing (see Figure 4). Perhaps it would have been more precise to state that chloride route or fine crystal sulphate route pigments exhibited less *yellowness* both before and after exposure than sulphate grades.

(iii) I accept the fact that the effect of grade of titanium dioxide pigment (treated rutile) on yellowing is small compared with the total amount of yellowing which is attributable to the resin.

(iv) The results given in tables 4 and 5 simply illustrate the irreproducibility of the ammoniacal test method. With pigments K to N a greater change was experienced in one week than with pigments G to J (tested at a different time)

letters

in three weeks. To compare paints satisfactorily, it is therefore essential that they are exposed simultaneously.

(v) Finally, contrary to Mr Valpola's suggestion it was not the purpose of the paper to imply that the method of manufacture per se has a pronounced effect on the quality that can be achieved. As he says in his final paragraph the skill of the manufacturer is of greater importance. Nevertheless, it is true to say that chloride process pigments have better colour than their sulphate process counterparts.

Yours faithfully,
L. A. Simpson

BTP Tioxide
Stockton-on-Tees
Cleveland
England TS18 2NQ

reviews

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.

Tensid-Taschenbuch

Edited by Dr H. Stache
Revised and expanded edition, 1981
Published by Carl Hanser Verlag, Munich and Vienna
pp. 1015, price 178 DM

This revised and expanded 2nd edition of a handbook dealing comprehensively with surfactants of all descriptions follows quickly on the first edition published in 1978. The editor, Dr H. Stache, has drawn contributions from a number of scientists and technologists.

The contents are divided into three sections: the first one covers the chemistry of surfactants, including a new chapter on their physical chemistry and a detailed survey of applications. Section 2 deals with the relationship between surfactants and the environment. In section 3 one can find physical data of surfactants and the raw materials used in their manufacture. A chapter on relevant laws, rules and guide lines current in the EEC rounds off this section.

The next 208 pages contain an alphabetical list of trade names, followed by a table of surfactants giving chemical composition, the form in which they are supplied, and the field of application. An index and a register of suppliers of surfactants and necessary raw materials concludes the volume.

This book comes in a very handy size (ca. 19 cm by 12 cm) in a flexible plastic binding and contains a great deal of information and facts which are often not readily accessible.

Reader Enquiry Service No. 21 *H. R. Hamburg*

occa meetings

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

Ontario

Tour of converting facility

The technical portion of the January meeting took the form of a plant tour of the Flexible Packaging Department of Dow Chemical Canada Inc., which was attended by about 50 members.

Our host was Mr Bill Muil, manufacturing manager, who welcomed us with a courtesy sign at the door and a round of hot coffee, and who began the proceedings by giving us an overall description of the operation before we went into the plant itself. We were able to tour the premises in comfortably small groups thanks to the assistance of several other employees acting as guides.

This is the only packaging facility in the worldwide operations of Dow Chemical, and is one of the largest converting plants in Canada. It is designed for systematic product flow, from incoming raw materials through processing and semi-finished holding to finished goods storage and shipping. It specialises in laminating, extruding and coating, and also does large volumes of gravure and flexo printing.

Among the products seen in various stages of production were beverage labels, cigarette cartons, spiral oil can stock, coated wallcovering stock and tea bag tags. Substrates included paper and board, foil, plastic films and various laminates and combinations.

Everyone in the party was impressed by the high quality of the work being turned out, and also by the emphasis placed on plant safety and cleanliness.

Mr Muil and his staff were thanked on behalf of the Section by Mr Frans Grootveld, Programme Chairman, who expressed the party's appreciation for a fascinating and well-organised tour.

The meeting re-convened at the Cambridge Motor Hotel for dinner.

J. Ambury

Thames Valley

Election beam curing

The first meeting of 1982 was held on 21 January at the White Hart, Beaconsfield. A lecture entitled "Electron beam curing" was given by Mr Ron Teesdale of J. Durr Ltd.

The many known advantages of solvent-free systems were expounded. This was then allied to the advantages of an electron beam curing (EBC) system.

The basic system for EBC consists of a heated cathode or electron gun from which emitted electrons are accelerated by means of high voltage and impinge on a thin titanium window, through which they pass. After passing through the window the electrons travel through oxygen-free air into the resin system. Cure is effected by the electrons producing free radicals in the unsaturated resin system. The electrons are focussed into a beam and, in fact, the beam scans the window at a high speed so that the object gets many separate pulses of energy. The equipment available has advantages such that the two parts which do deteriorate in use, the electron gun and window, are easily and economically replaced. One of the latest innovations is a system for reflecting electrons so that shaped parts can now be cured, examples such as car parts, wheels etc., were quoted.

The discussion which followed showed the lively interest in the subject, and after a vote of thanks by Mr G. V. G. Hill, Mr R. Teesdale, the lecturer, was acknowledged in the usual way.

A. W. Fell

London

Developments in artists colours

At the meeting held at the Great Eastern Hotel, Liverpool Street on Thursday 18 February 1982 Mr Brian Gilliam, Section Chairman, welcomed a larger than usual audience to a lecture by Mr P. Staples, technical director of Winsor & Newton Ltd.

In his paper, Mr Staples reviewed the past, present and future for the artists colourman, illustrating various styles and trends with some superb slides. The earliest artists used blends of animal fats and earth colours. Following civilisations refined these, adding binders and alternative pigment types. During the Renaissance the nature of artists paints changed. The Italians were using egg tempra binders and refining the purity of lakes and ultramarine blue. Colour blending was achieved by hatching. Vegetable oils were being experimented with in England and Germany. Towards the middle of the 15th century dual layer paintings were becoming fashionable. Normal oils used were walnut and linseed. Eventually the pale egg tempra look gave way to the darker oil appearance and linseed became popular. With the advent of canvas, pictures became larger.

Most studios produced there own blends of pigments and oils. The development of painting from a trade to a pastime gave rise to the artist colourman. The first was Ackerman of the Strand who offered 68 colours in the 18th century.

The meeting of Messrs Winsor and Newton in 1832 gave rise to a company that produced paint in a tube and other innovations. The other important developments have been chrome pigments and titanium dioxide. Modern binder systems have included acrylates, long oil penta soya alkyds and ketone resin varnishes. Mr Staples said he felt the future would mark a drift from natural products. The requirements of various health and safety groups would mean a change in certain markets, especially the USA. Dispersion methods would also undergo a change.

In a lively discussion period the questions ranged from blue pigments for heraldic arms to the structure of stack white lead. The advantages of cold press linseed oil were also discussed.

A vote of thanks was proposed by Mr David Sharpe and the audience responded in the normal way.

B. A. Canterford

Manchester

UV and electron beam: energy efficient methods of curing

Twenty-eight members and guests braved the elements, especially fog and ice, to hear Kevin O'Hara, Cray Valley Products' coatings laboratory manager, deliver his lecture. The venue was new – the Lord Daresbury Hotel in the birthplace of Lewis Carroll near Warrington, Cheshire – the date, Monday 11 January 1982.

For the record, Kevin O'Hara's lecture had no further connection with Alice in Wonderland but was based on detailed descriptions of the technology associated with UV and electron beam curing. The initial subjects discussed were associated with cause and effect, i.e. environment, ecology and energy conservation effecting the introduction of water-borne, powder, high solids and radiation cured coatings. As opposing forces, the UK's resistance to change and the present economic climate have led to a relatively slow rate of growth in the above technologies.

occa meetings

Tangible benefits claimed included better quality, time saving and space saving in comparison with USA trends where the use of afterburners to treat solvent emissions invites penalties for energy wastage. It was claimed that petrochemical costs in the last 10 years had escalated at twice the rate of vegetable oils.

The two types of radiation curing were described as follows:

(A) Ultraviolet

High intensity – Mercury vapour lamps
200 watts/linear inch – use of photo-initiator
Produces free radicals – acrylic and vinyl
Unsaturation in additional polymerisation

(B) Electron beam

No catalyst – relies on energised electrons
Kilo electron volts (KEV)
Penetrating power
Absorbed into coating to product crosslinking in less than 0.1 s.

Both methods are very efficient when compared to conventional methods where the substrate is heated. The mode of action varies between the two methods and can be described as follows:

(A) Ultra violet

Relies on the refractive index of the pigments in the coating for efficiency and it is this property which can be a limiting factor, i.e. high RI values such as titanium dioxide are less receptive to UV

(B) Electron beam

Penetration by electrons – relies on the overall specific gravity of the coating – the higher the SG the greater the energy required, e.g. 170 KEV (at source) would cure 100 microns of white paint with a value of 100 KEV at the surface of the coating.

Further advantages listed by the lecturer were:

1. 100 per cent application solids – no pollution.
2. Reduced energy consumption.
3. "Instant" curing – fast finishing processes.
4. Low heat generation – advantageous for heat sensitive substrates such as plastics, wood etc.

Kevin O'Hara then discussed: "Relative energy consumption" measured in mega-joules/square centimetre of substrate and relative to stated values thus:

1 kW heater = 3.6 mega joules
Gas fired oven = 70 per cent thermal efficiency
Electrical efficiency = 28 per cent
UV curing lacquer = 1
Thermoset acrylic = 23.9
Alkyd/amino = 20.2
High solids oil free polyester = 15.2
Water soluble = 16.5
Acrylic PC = 10.0
AC lacquer = 5.0
UV curing pigmented finish = 7.4
Electron beam curing paint = 2.0 (includes the use of inert gas on surfaces)

Cost comparisons were then described in relation to paper varnishing and the relative usage of acid catalysed or UV cured finishes. It was claimed that UV lacquer required half the energy consumption as a throughput increase of 400 per cent. Energy requirement details and curing coat/10,000 sheets were:

AC = £6.25 (1 kW heater = £0.03)
UV = £0.92

Comparative data included the following:

	AC	UV
NV	38%	100%
SG	0.95	1.05
£/litre	1.20	3.5 – 4.0
Wt/area	15g/m^2(wet)	5g/m^2(dry)
Lacquer cost	£17-20	£17-20
Cost/10,000 sheets	£18	£17-20

Further practical examples were based on printed circuit inks the lecturer then discussed electron beam curing production lines.

Equipment details

170 KEV
80 Milliamps
1.2 metre width
5.0 megagrad wire
80.0 metres/minute
50 sq metres/h inert gas consumption

Paint costs

	Thermosetting Acrylic	2-pack PU	EB
PB 0.75:1			
Paint NV @ 5 poise	52%	60%	100%
Typical binder costs	£820	1000	2200
Applied film cost 100 gm/sq metre dry film	14.5p	18p	13p

Polymers used include:

1. Unsaturated polyesters – in styrene – used with UV
2. Acrylic – subject to majority development
3. Polyester, silicone, epoxies, acrylic and urethane

Raw materials used include:

1. Acrylic acid
2. Hydroxyethyl acrylate
3. N-methylol acrylamide

Classification of coating types include:

occa meetings

1. Epoxy acrylate – based on bisphenol A and acrylic acid
2. Acrylic urethane
3. Polyfunctional acrylates – 9 product ranges but excessive skin irritation levels are claimed, albeit using a discredited test. Tripropyleneglycol diacrylate is widely used due to its low skin irritation properties.

Kevin O'Hara's general conclusion to his lecture outlined the many advantages of UV and EB curing and also the problems associated with direction and metallic substrates in relation to adhesion. On this latter point the use of metallic paints on car wheels was claimed to be successful with a slow curing system. Finally, it was stated that UV and EB curing compliment existing industrial processes.

The general discussion period covered various points thus:

1. Capital costs – electron beam equipment uses high vacuum/inert gas/high voltage and is priced in the range of £0.25 – 0.5m.

UV curing equipment, including the use of fluorescent lamps, can be purchased for £30,000. This method/cost is attractive for inclusion into existing production lines.

2. Energy requirements – in relation to using additional lamps and increased photo-initiator levels. The answer to this question included the important point that UV will only penetrate a certain level of coating.

3. Directional energy – discussed and included the redirection of EB by lead sheets, but also the need to use an alternative coating on the edge sections of objects.

4. Variation in film thickness on differing surfaces, it was claimed it was not a problem in relation to clear varnishes.

5. Exterior durability of UV and EB – there are differences often caused by photo-initiator fragmentation within films causing post UV degradation, EB relatively satisfactory.

6. Shelf life – variation due to resin type occasionally experienced.

7. UV pigmented systems – use of titanium dioxide and zinc sulfide – different grades of titanium dioxide have effect on the cure efficiency.

8. Skin irritation – it has been largely solved and great awareness of this potential problem exists.

9. Metal adhesion/coil coatings – UV and EB have a poor record due to volume shrinkage (10-20 per cent) on non-absorbent substrates. CVP are currently working in this area via several routes, one of which includes pretreatment of the metal. It should be noted that the shrinkage is due to a change in shape and is not a weight loss.

The vote of thanks to this very comprehensive lecture was offered by John Calderbank and warmly received.

Cellulose acetate propionate in liquid printing inks

This student lecture was delivered to an audience of 30 at the Manchester Polytechnic on the 20 January 1982 by Dr K. R. Walker of Eastman Chemical International AG. The lecturer, who is involved in a technical service function and based at Kirby, Liverpool, commenced by describing the structure of cellulose and then went on to detail the two grades of cellulose acetate propionate (CAP) available, these are:

CAP 482 – 0.5	used in gravure inks
CAP 504 – 0.2	used in flexographic inks. It has a hydroxyl content twice that of 482 – 0.5 and has increased alcohol solubility.

CAP has a molecular weight of 27000, a crystalline structure and is crosslinkable with toluene diisocyanate, urea and melamine formaldehyde resins and selective substrates. In printing inks it is always used as a solution. Further properties of CAP in printing inks can be summarised as follows:

1. Colourless
2. Odourless
3. Low flammability
4. Light stable
5. Rapid solvent release
6. High heat resistance
7. Can be crosslinked to improve adhesion and heat resistance, especially with corona discharge systems
8. Compatible with a wide range of resins
9. Stability with metallic pigments
10. Can be overprinted with PVDC emulsion
11. Printable by gravure or flexography – type of solvent influences choice
12. Good pigment-wetting medium – useful for pigment manufacture
13. Can be printed on a wide range of substances

Dr Walker then proceeded to describe various compatibility properties of CAP.

1. Compatibility of modifying resins

Adhesion promoter plus plasticiser, i.e. tri-component formulation.
A triangular graph illustrated compatibility of CAP 482.05 with DBP and neocryl B 810. It is usual to add 10-15 per cent of plasticiser by weight to prevent "curling-up" after ink drying.

2. Plasticiser compatibility

Illustrated examples of CAP 482.05 with DIOP and Plexigum N 742.

For printing on to PVDC/acrylic coated film with CAP/acrylic, the base ink will be CAP 482.05 with acrylic resin/plasticiser/wax (for scratch resistance). The top ink will be based on CAP 504.02 and have the same modification as the base ink but a higher alcohol content. The adhesion would be measured using the sellotape test.

Dr Walker described additional features of CAP/acrylic inks as:

occa meetings

1. Excellent gloss
2. Excellent heat resistance
3. Low odour retention
4. Can be overlacquered with PVDC emulsion
5. Excellent adhesion and scratch resistance
6. Excellent grease and ruckle resistance
7. Unlimited shelf life

The next subject discussed was:

Heat sealing of packages – printed – co-extruded polyolefin adhesion promoters

1. Titanium acetyl acetonate derivative – no reaction in lacquer.
2. Alloxy titanates (Tilcom OGT) – poor shelf life reaction in liquid.
3. Polyethylene imine (Polymin) – 1-2 weeks shelf life the MO of this product is by hydrogen bonding between the polymin and CAP.

Additional advantages:

Printing on wide variety of substrates, low odour, no heat sealing problems and no odour emission during the heating reaction.

4. Amino silanes (silane Z6020) – reacts with hydroxyl compounds.

   Advantages – similar to polyethylene imine but superior shelf life properties.

5. Zirconium derivatives – zirconium propionate.

   Advantages – similar to silane compounds, stable viscosity ratings with a wide range of pigmentation and good adhesion to metallised polypropylene without the use of a primer.

After presenting formulation details, the lecturer described the role of CAP/maleic inks for application to polyethylene and other films. He also discussed CAP/formaldehyde inks for metallised films which exhibit high heat resistance coupled with a six month shelf life.

The lecture was concluded by an open discussion period when the following points were made:

1. Why use CAP when CAB is available? – CAB is more compatible but much softer due to its molecular structure as compared to that of CAP.
2. Plasticiser migration problems? – None on surface printing but lamination processes could produce problems.
3. Adhesion tests – sellotape used by Eastman Kodak.
4. Adhesion promoters – tri-acetyl acetonate most popular due to its use with NC.
5. Do customers specify tests? – Not generally but sellotape, ruckle and heat resistance tests regarded as very important.
6. Is there a reaction between the adhesion promoters and coloured pigments? – Not generally but red pigments based on calcium salts cause problems.
7. What is the percentage usage of CAP compared to NC in the UK? – NC is the main binder for printing inks whereas CAP has 5-10 per cent of the general market but more than 50 per cent of inks for saran coated film.
8. What are the gloss properties of CAP compared to NC? – NC has better wetting of pigments but CAP in chip form satisfactory.
9. Does CAP melt? – Yes, applied heat will result in a softening at its glass transition point, followed by a viscosity decrease and finally charring and oxidation.
10. CAP 504-0.2? – Due to its hydrophillic properties it has better dispersion and solubility than CAP 482-0.5. With regard to chip manufacture, a typical mix is 60 per cent pigment, 30 per cent CAP, 10 per cent plasticiser. Dr Walker confirmed the addition of plasticiser would reduce the glass transition point of the ink.

Ray Stott proposed a vote of thanks to this very detailed lecture, which was acknowledged by a unanimous response from the audience.

F. B. Windsor

news

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.

D H Industries acquires Jenag

D H Industries has announced the purchase from BTR Industries Limited of the business of Jenag Equipment.

Jenag produces the Jenag Automatic Self Cleaning Strainer, which is sold worldwide and made under licence in Japan, for straining paints, inks, adhesives and other liquids.

Jenag is no stranger to D H Industries since the latter was a sales agent for the former's range of machines up to 1967.

The machines will continue to be manufactured at Waterlooville and the existing management and staff will be retained.

The company will be a wholly owned subsidiary of D H Industries and the Board consists of: Mr D. P. Sullivan (chairman) Mr H. M. Sullivan (managing director) Mr K. Bernhard (Swiss) Mr W. Maeder (Swiss) Mr E. C. Wingrove FCCA. The company secretary is Mr D. R. M. Stevens.

Reader Enquiry Service No. 31

news

Buyer for Holliday

The receiver of LB Holliday & Co Ltd, Mr Peter Copp of Stoy Hayward, has announced that the business has been sold as a going concern to a Jersey based consortium headed by Mr Terry Brain.

Holliday, the Huddersfield maker of dyestuffs and intermediate products, went into receivership in October 1981. The company has continued trading during receivership, and rationalisation carried out by the receiver has reduced the workforce from 450 to 320. Despite difficult trading conditions sales were maintained at an annual rate of about £9m and in particular UK sales held up well.

Mr Copp paid tribute to the workforce and to suppliers whose co-operation had made it possible for the business to continue. The purchasers have acquired all the assets at Huddersfield as well as the subsidiaries in Germany, Hong Kong, Canada and Australia.

Reader Enquiry Service No. 32

Ciba-Geigy Pigments move

Ciba-Geigy's Pigments Division moved its United Kingdom Marketing Headquarters from Wythenshawe to Clayton, Manchester on 29 March 1982. The move is part of the Division's re-organisation announced in late 1980 and involves the consolidation of its marketing and technical services facilities on one site. Increased stockholding capacity has been made available at nearby Rhodes, Manchester.

The Division's new address is: Ciba-Geigy Plastics & Additives Company, Pigments Division, Ashton New Road, Clayton, Manchester, M11 4AR. Telephone: 061 223 1341.

Reader Enquiry Service No. 33

More electrostatic lines for BMW

BMW is converting two more of its finishing paint lines at its Dingolfing plant to automatic electrostatic operation. Behr Estabell Turbo Sprayers are to replace existing painting machines using conventional (compressed air) spraying equipment. The new Esta equipment is to be installed during the 1982 works' holidays, and will start productive operation towards the end of August 1982.

Estabell claims a superb finish from its Turbo Sprayers because, with the aid of an electronic control system, the speed of the bell units can be fully varied between 17,000 – 35,000 rpm to adapt perfectly to the spraying material in actual use. Based on its current order book, Behr calculates that by the end of 1982 a total of no less than 70 Estabell plants for body painting will be in operation with leading automobile manufacturers worldwide.

Reader Enquiry Service No. 34

Tor buys Pax Paints

Tor Coatings Group, the Birtley based paint makers, has acquired the entire share capital of Pax Paints Ltd of Newton Aycliffe.

Pax Paints specialises in low flash coatings for the engineering and agricultural markets. This new acquisition is to form the springboard for a major expansion by the Tor Coatings Group into the industrial coatings market.

Mr Alan Ridley, who has had over 25 years experience with a major Eastern paint group, has joined the Tor Group. He has been appointed general manager of Pax Paints Ltd and of Tor Group Industrial Division. Mr Alan Robinson, research manager of Tor Coatings, will now be based at Pax Paints' 8,000 sq ft factory at Newton Aycliffe.

Mr Ted Crabtree, founder and previous owner of Pax Paints Ltd, will be retiring as a full time director in the near future, but will remain as a consultant to the company.

Reader Enquiry Service No. 35

Goodyear/Goodlass Wall anticorrosion paints

Pliolite resin binders for paint, manufactured by the Goodyear Tyre and Rubber Company's chemical division, have been widely used for many years in exterior masonry coatings.

Following several years of development work, paint manufacturers Goodlass Wall have introduced a range of anticorrosion paints based on pliolite binders.

According to Goodyear: testing by British Rail laboratories at Derby confirmed the promising results obtained and practical trials are proceeding on selected test bridges.

Anticorrosion paints based on pliolite binders are claimed to utilise lower aromatic solvent blends, and have improved ultraviolet resistance over traditional chemical resistant coatings drying by solvent evaporation.

Projects with other nationalised industries are said to be underway.

Reader Enquiry Service No. 36

UK Chemical industry investment

Mr Bernard White, Chairman of the Chemical Industries Association (CIA) Economics Committee, announced the results of the CIA's 17th Investment Intentions Survey. The survey shows that over the next three years (1982-84) the chemical industry plans to spend a total of £4,400m on new capital equipment in the UK, representing a level of expenditure in real terms some 11 per cent below that in the previous three year period. However, Mr White also pointed out that new data from the Department of Industry indicates a recent improvement in capital expenditure by the industry which could add some 6 per cent on to the announced expenditure programme.

A significant feature of the survey is the rising proportion of the total industry expenditure on nuclear fuel treatment plant. Over the forecasting period this is expected to rise to 23 per cent of the total compared with 16 per cent in 1981.

"Despite the reduced level of this year's expected future investment programme," Mr White concluded, "it nevertheless represents a very substantial commitment of resources particularly in the light of continuing depressed trading conditions. If achieved, it should ensure an adequate margin of spare capacity in aggregate over projected demand during the first half of the decade, and will maintain the UK's present high share (28 per cent) of total EEC chemical industry investment."

Reader Enquiry Service No. 37

new products

Filling machine

Universal has announced the new Posifill 1000 volumetric liquid filling machine which is available with two interchangeable metering cylinders of up to 400 cm^3 and 1000 cm^3 capacities.

The new machine is semi-automatic and pneumatically operated, allowing flammable liquids to be filled.

Reader Enquiry Service No. 38

New box oven

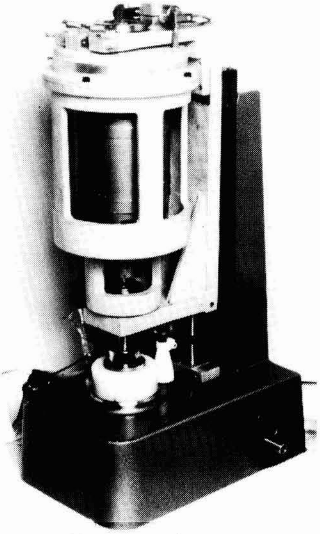
Mindon Engineering Ltd has introduced a range of improved box ovens for the paint finishing industry.

The new ovens are suitable for a wide variety of applications including automobile accessories, furniture, electrical instruments, toys etc.

The units are available in knock-down form to overcome problems of difficult access to customers' premises and for easier handling and transportation. Ready assembled units are also available.

Reader Enquiry Service No. 39

news



New rotary viscometer

Very high shear rate viscometer

Ravenfield Designs Ltd has introduced a very high shear rate rotary viscometer capable of achieving shear rates of the order 10^6 reciprocal seconds at temperatures of up to 150°C.

The principle of operation is that a tapered plug is rotated in a tapered sleeve, the angle of taper being such that a very fine gap can be achieved, of the order 5-6 μm.

Sample insertion and removal is simple and it is claimed that 50 samples can be measured, together with standards and cross-checks, in a normal working day.
Reader Enquiry Service No. 40

Storage and transportation aid

Fort Vale Engineering Ltd, specialist in the supply of equipment for road tankers and storage vessels, is to make two new manlids available to the paint industry.

The Pendle 18 inch light duty manlids are manufactured in mild steel (which may be zinc-plated) or stainless steel. Electro-polishing coupled with clean weld-free lines ensure that the collection of residue on and around the manlid is kept to a minimum, reducing the risk of contamination in later loads.
Reader Enquiry Service No. 41

High pressure fluid heater

A high pressure fluid heater that offers extremely accurate temperature control has been introduced by Graco. The new Vis-Con heater features a solid-state temperature controller and accuracy is said to be within ± 1.5°C. The new heater is claimed to have both FM and CSA approvals as explosion proof for class 1, division 1 and 2, group D, hazardous locations.

The Vis-Con can be used at working pressures of up to 210 bar (3,000 psi) for such applications as hot spray systems or for controlling the viscosity of fluids stored under abnormal or fluctuating temperature conditions.
Reader Enquiry Service No. 42

Low-bake polyester powder coating

Sonneborn & Rieck has developed a new low bake all-polyester powder coating.

A coating thickness of between 40-100 microns, it is claimed, can be used with the new polyester which fully cures in 6 minutes at 200°C or 15 minutes at 150°C.

The company says the new powder is suitable as a single-coat finish on bare metal substrates. It goes on to say that the coatings give excellent resistance to heat, light and corrosion and are suitable for exterior exposure, such as on garden furniture and cycle frames, as well as for domestic appliances of all kinds, telecommunications equipment and other similar products.

The new powder coating, which comprises a thermosetting system based on modified polyester resin, has a solids content of 100 per cent, and a specific weight of 1.2-1.6 kg/litre depending on colour.
Reader Enquiry Service No. 43

One-coat polypropylene finish for hi-fi turntables

Sonneborn & Rieck, in co-operation with Garrard Ltd, has achieved a breakthrough with the use of the former's Jaxacryl one-coat finish for polypropylene.

Garrard, who were developing a new range of direct and belt drive turntables for the hi-fi market, proposed to use polypropylene for the main moulding of each model. Accordingly, they asked Sonneborn & Rieck whether a one-coat finish could be developed for this material.

Sonneborn & Rieck chemists undertook the research and were able to offer a one-coat system which came up to Garrard's required standard. The system can be produced in a full range of colours including metallic finishes and in a variety of gloss levels from satin to matt.
Reader Enquiry Service No. 44

Pretreatment not needed with new powder coating

Drynamels, the Birmingham based coatings manufacturer, has developed a powder system called Dryflex GM which can be applied directly to surfaces covered in residual oils and grease. Oil smeared exhaust systems (as manufactured) have reportedly been successfully coated with the Dryflex GM powder. The film produced is said to be cohesive and un-interrupted, passing bend, scratch, chip and impact testing.

Applications include the above mentioned exhaust systems, others are for factory racking systems and other items where protection against damage is of primary importance, especially during handling and storage.
Reader Enquiry Service No. 45

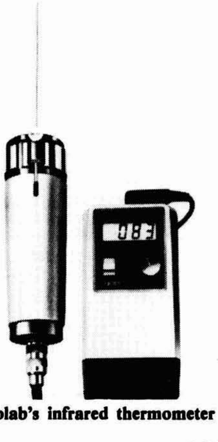
New Ciba-Geigy pigment range

The Pigments Division of Ciba-Geigy Plastics & Additives Company has introduced a new range of pigments developed specifically for liquid packaging inks.

Ciba-Geigy is confident that gloss approaching that achieved by chipping is obtainable by conventional dispersion methods. In addition, the range is said to be characterised by dispersion stability, absence of flocculation and high colour strength.
Reader Enquiry Service No. 46

Thermometer for fragile surfaces

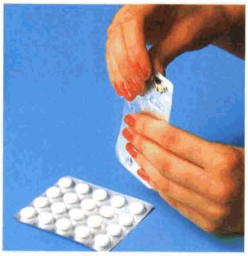
Prolab Instrument Co. is producing a new portable, pocket-size, digital infrared thermometer. Its makers say it is ideally suited to measuring temperatures of fragile or newly painted surfaces as the thermometer does not make contact with the surfaces being measured. It is also said to be very competitively priced with an infrared sensor range of 50-700°C and, a thermocouple range of 0-700°C.
Reader Enquiry Service No. 47

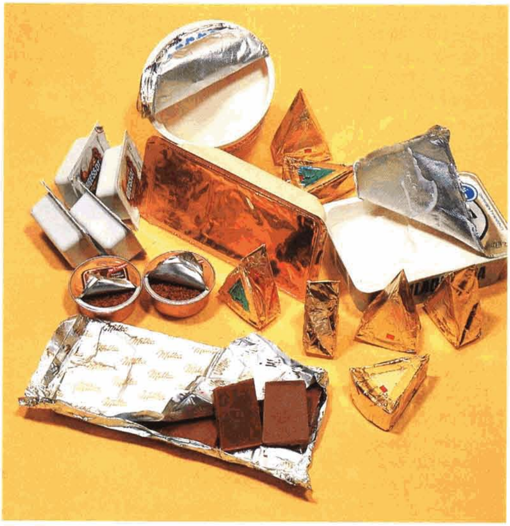


Prolab's infrared thermometer

Vinyl Acetate-Derivatives **WACKER**

VINNOL® resins offer advantages in many fields of application





With its wide range of Vinnol® resins (soluble vinyl chloride copolymers) Wacker-Chemie offers you technical and economic advantages:

Applications:

- Paints for concrete
- Printing inks
- Interior can coating
- Primers/Tie-Coat
- Primer for organosols
- Heat sealable coatings on aluminium foil
- Coatings for high frequency weldable waddings
- Adhesives
- Solvent carbon paper
- Lacquers for synthetic leather
- Coating for magnetic tapes
- Metal paints
- Paper lacquers
- Pigment preparations
- Ship paints
- Road marking paints
- Top lacquer for wall paper
- Heat activated lacquers

Vinnol® resins of the H 40-range (with 40% vinyl acetate) are available with four different solution viscosities and, as combination resins, offer the following **special advantages:**

- Economical resins for blending with acid functional paint resins
- Wide heat sealing temperature range
- Reduction of heat sealing temperature
- High long term flexibility
- High cohesion
- Wide compatibility with nitrocellulose
- Outstanding adhesion to PVC
- Economical combination resin in thick coat systems
- Simple storage
- Very resistant to alcohol, fats and oils, bitumen, chemicals, dry cleaning solvents, salt solutions
- Problem free supply form

COUPON

To: Wacker-Chemie GmbH K 281 e
Division L
Postfach · Prinzregentenstrasse 22
D-8000 München 22

Please send us further information about the following applications.

Name and address

Vinnol® paint resins based on vinyl chloride/vinyl acetate

	% vinyl chloride	% vinyl acetate	K-value
E 15/45	85	15	45
H 15/45	85	15	45
H 15/50	85	15	50
H 40/43	60	40	43
H 40/50	60	40	50
H 40/55	60	40	55
H 40/60	60	40	60

Vinnol® paint resins based on vinyl chloride/vinyl acetate/dicarboxylic acid

	% vinyl chloride	% vinyl acetate	acid number	K-value
E 15/45 M	84	15	7–8	45
H 15/45 M	82	17	7–8	48

Vinnol® paint resins based on vinyl chloride/acrylic ester

	% vinyl chloride	% acrylic ester	others	OH-content	K-value
E 15/40 A	85	15	–	2	40
E 15/48 A	85	15	–	2	48
VE 20/55 A	80	20	–	2,6	53
VCO 401/48	78	15	7	2	48

WACKER

Wacker-Chemie GmbH
Division L
Postfach · Prinzregentenstrasse 22 · D-8000 München 22
Tel. (089) 2109-1 · Telex 529121

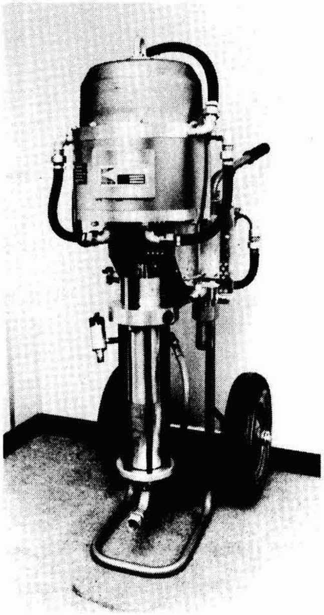
Subsidiaries and Agencies in all European und many overseas countries.

news

Personal monitor

A new re-usable personal monitor for gases and vapours is being launched on to the UK market by Dutom Meditech Ltd.

Called Adsorba™, the new monitor is the result of four years of intensive development work by a Birmingham University research team and is claimed to provide better standards of performance in the critical area of personal monitoring.
Reader Enquiry Service No. 48



The 50.150 pump from Kremlin

New Kremlin pump

Kremlin Spray Painting Equipment Ltd has added the 50.150 pump to its range of spray finishing equipment. The new pump operates on a 50:1 ratio and gives an output of 15 litres/minute at 100 strokes. Input air pressure is 1-6 bars, with a fluid output pressure variable between 30 and 300 bars.

Due to its large wet-end section, the stroking rate is very slow, which has the advantage of increasing the life of the nitrile rubber packings.

The 50.150 pump can be either wall mounted, or trolley mounted for manoeuvrability. It can be used for the supply of viscous materials to multiple airless spray guns, for applying adhesives, and for supplying guns with materials of medium viscosity when the air supply pressure to the pump is too low to obtain satisfactory atomisation with a 30:1 ratio pump. The new pump has also been used by the oil industry for applying anticorrosion coatings to rig components.
Reader Enquiry Service No. 49

literature

World paint industry

The Paint Research Association has announced the publication of the following title "The world paint industry: a review, 1980/81". It deals with such topics as: emerging indigenous industries in developing countries, trading patterns, export opportunities, the narrowing "technology gap" as a result of licensing arrangements, and so on. Price to PRA members: £75.00 and to non-members £100.00. Additional copies can be subsequently obtained at reduced rates.
Reader Enquiry Service No. 50

Coil coating guide

The European Coil Coating Association (ECCA) has issued a completely revised and updated edition of its guideline publication "Coil coating ... why?"

The new guide, published simultaneously in English, French and German, focuses on the applications of the pre-coated product.
Reader Enquiry Service No. 51

Solar reflective paints

The Building Research Establishment has published an information paper on "Solar reflective paints" which are intended for roofs.
Reader Enquiry Service No. 52

Belgian chemical industries directory

The "1981-1982 Directory of the Federation of Chemical Industries of Belgium" is now available.
Reader Enquiry Service No. 53

meetings, etc.

"What's new in powder coating?"

Companies interested in electrostatic powder coating are invited to attend one of the seminars to be held by Volstatic Coatings Ltd, 51-67 Stirling Road, London W3 8DJ (01-992 6931) from 7-11 June under the title "What's new in powder coating?"

The seminars will include descriptions and demonstrations of the latest equipment supported by case histories and a/v presentations.

OCCA A Convention

OCCA Australia will hold their Silver Jubilee Convention at the Southern Cross Hotel in Melbourne from 28 September to 1 October 1983. To support such an important occasion, an exhibition will be held concurrent with the Convention, both at the Southern Cross Hotel.

On Wednesday 28 September the exhibition will open and delegates will register.

On Thursday, Friday and Saturday there will be concurrent lecture streams on technical and commercial subjects.

There will be an official dinner on Saturday 1 October to close the Silver Jubilee Convention with exhibition.

An interesting and informative social programme will be arranged for ladies attending.

Detailed announcements will appear in *JOCCA* at a later date.

Call for papers

Next year's OCCA Biennial Conference will be held at the Viking Hotel in York, England from 15-18 June 1983. The theme will be "The efficient use of surface coatings".

A call for papers has gone out and anyone interested in contributing should notify their intention as soon as possible to the Director & Secretary of the Association at the address on the contents page. See the back outside cover of this issue for further details.

people

The board of SPL (Holdings) Limited has announced **Tom Furman's** appointment as sales director of Kirklees Chemicals. Tom joined Kirklees from K & K-Greeff Chemicals last spring with responsibility for bulk sales of emulsion polymers previously handled by K & K-Greeff Chemicals.

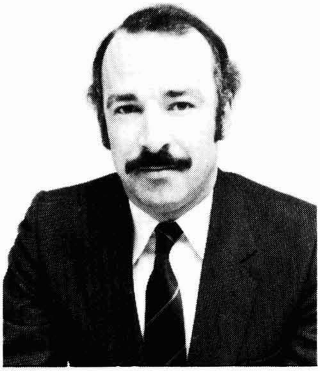
Cray Valley Products appointed **Ian Watson** sales manager of coatings on 1 March 1982.

Croda has announced the following appointments: **Mr G. R. Hembrough,** deputy chairman and managing director of Croda Polymer International will, in addition to his existing posts, act as president of the Croda Inks Federation. **Mr B. A. J. Jewiss** has been appointed financial director. **Mr P. Cadman** has been made operations director.

occa news

News of members

Mr L. J. Bowman in Drew appointment



L. J. Bowman

The International Industrial Division of Drew Chemical Corporation has announced the appointment of Mr L. J. Bowman as sales and marketing manager for Speciality Chemicals, Western Europe. According to Drew this reflects the continuing programme of European investment by the New Jersey based corporation and marks the consolidation and planned extension of the sales of defoamers, biocides, flocculants and related products to the paint, paper, emulsion, polymer and associated industries.

Lester J. Bowman joins Drew from Rohm and Haas, where he held various sales and marketing positions in the European Polymer, Resin and Monomer Division.

Service to the European industries will be directed from the Antwerp offices of Drew, with Mr Bowman reporting to the newly appointed vice-president for Western Europe, Mr B. G. S. Marzano.

Mr Naqvi – manager, Low Flash Factory

Mr S. W. H. Naqvi has announced that his present appointment is that of manager of the Low Flash Factory, Berger Paints Pakistan Ltd. He holds full responsibility with respect to all technical and production aspects of the low flash products produced by Berger in Pakistan.

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

Cyril Williams returns to CVP

Cyril Williams has rejoined Cray Valley Products as commercial manager responsible for administration and day-to-day sales strategies. Initially he worked for CVP as a technical sales representative and left to further his career in 1967 in a number of managerial positions with northern based resin companies gaining commercial and administrative experience both in the UK and overseas.

Cyril Williams has been welcomed back to Cray Valley Products Ltd, where it is felt his wide scope of experience will be an asset to the company.

Moves within Croda

Croda Polymers International has announced a number of new appointments which took effect from 1 April 1982, among them are:

Mr G. H. Hutchinson, who is currently technical director of Croda Inks and who has been with the company since 1959, will become deputy president of the Croda Inks Federation and will provide technical, co-ordinating and marketing support.

Mr Hutchinson is a past Chairman of the Scottish Section Eastern Branch and has received the Association's Commendation Award. He has also served on Council and the Scottish Section Committee.

Dr M. R. Harrison, currently development executive, Croda Inks, will take on executive responsibility for all Croda Inks UK's technical administration as divisional technical manager.

C. Williams

David Rickell – product manager

Mr David Rickell has been appointed by Manchem Limited as product manager for the sale of Pliolite resins within the United Kingdom. Pliolite resins are manufactured by Goodyear's Chemical Division. They are used mainly in the paint, masonry paint, printing ink and anticorrosion industries. Mr Rickell will be based at Manchem's headquarters at Ashton New Road, Manchester M11 4AT, Telephone No. 061-223-7100.

Previous to joining Manchem Limited, Mr Rickell was employed by B & N Chemicals (formerly Cargill-Blagden Limited) as a northern area technical salesman.

Shown at the Bristol Section's dinner and dance held on 26 March 1982 from left to right are Mr R. H. Hamblin (Director & Secretary), Mrs Moore, Mr V. Moore (Chairman, Thames Valley Section), Mrs Redman, Mr F. B. Redman (Chairman, Manchester Section), Mrs Fowkes, Mr G. Fowkes (Chairman, Bristol Section), Mrs Green, Mr Green (President BPVL Club)

Ontario Section

Old Mill Inn, setting for dinner dance

The sixth annual dinner dance was held on 23 January 1982 at the traditionally elegant Old Mill Inn in Toronto. The flawless arrangements were again made by David Wilson, who was assisted by Ian Sharples.

After greeting friends over cocktails, the guests were served a fine dinner whose centrepiece was an Old Mill specialty, roast Brome Lake duckling in sauce Cumberland. Soft background music was provided by Bob and Donna Beach, who later entertained with a full repertoire of dance selections ranging from waltz to disco.

At the Ontario Section annual dinner dance: Derek Laming (Section Chairman), Kay Laming, David Wilson (dance convenor), Jeanette Gray and Alan Gray (Vice-Chairman)

More than 20 firms donated generously toward the prize pool. This provided a dazzling display of gifts for all the ladies, and numerous spot prizes which were awarded throughout the evening.

Several albums of photographs from previous dances and meetings were available for viewing.

It was, again, the social event of the Section calendar, and was described by all participants as a lovely evening and a great success.

J.A.

Scottish Section

Annual dinner dance

The annual dinner dance of the Scottish Section was held in the Albany Hotel, Glasgow, on Friday 15 January 1982. Once again the event was an unqualified success. An attendance of 270 despite the arctic weather conditions prior to the event testified to the justified reputation of the occasion as the highlight of the social calendar both among local members and throughout the organisation as a whole.

That well known Yorkshire Scot, Section Chairman Mr Tom Humphrey, again illustrated ably his mastery of dialect in rendering Robert Burns' address to the haggis.

An innovation at this years event was a raffle to raise funds for the student section. The selection of a gallon of whisky as the main prize ensured the success of the raffle and has handsomely augmented the funds of the section. It is intended to use the profits to provide a sponsored lecture for the students. The gallon of whisky was provided by the Scottish Section and thanks are due to the Chairman of the Scottish Section and Mr E. Burns for donations of additional prizes.

Full credit for a great deal of hard work which ensured a successful and enjoyable evening must go to Mr John Toovey, the Vice-Chairman.

J.H.C.

Shown at the Scottish Section annual dinner dance are (from left to right) Mrs V. A. Moore, Mr T. L. M. Humphrey (Chairman, Scottish Section), Mrs D. J. Morris, Mr F. B. Redman (Chairman, Manchester Section), Mr D. J. Morris (President), Mrs T. L. M. Humphrey, Mr V. A. Moore (Chairman, Thames Valley Section), Mrs F. B. Redman, Mr P. W. Munn (Chairman, Hull Section) and Mrs P. W. Munn.

professional grade

At the meeting of the Professional Grade Committee held on 15 April 1982 the Committee authorised the following:

Admitted as Fellows:

Bridle, Peter Frederick *(London)*
Prigmore, Maurice Henry *(Bristol)*

Admitted as Associates:

Cromarty, Ronald Earling *(Transvaal)*
Horsfall, Anthony John *(Auckland)*
Potter, Arnold John *(Hull)*
Sewell, Anthony Robert *(Auckland)*
Vickers, James Edward *(Auckland)*

Transfer from Associate to Fellow:

King, Raymond John *(Midlands)*

new members

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

AMAND, HENRI GORDON, Runnymede Dispersions Ltd, Ruspidge Road, Cinderford, Gloucestershire *(Bristol)*

BAMKIN, CEDRIC GEORGE, 19 Hamish Place, Pakuranga, Auckland, New Zealand *(Auckland)*

BURGESS, VINCENT, BSc, Crown Paints Ltd, Hollins Road, Darwen, Lancashire *(Manchester)*

CALLOW, THOMAS ALFRED, 6 Cyprus Street, Whitehall, Darwen, Lancashire *(Manchester)*

CORDERY, DAVID CHARLES, Printa Inks Ltd, 65 Alfred Road, London W2 *(London)*

DAVIDSON, RAYMOND ARTHUR, BSc, PO Box 13248, Johnsonville, New Zealand *(Wellington)*

EDWARDS, JOHN DAVID, BSc, c/o Carst & Walker (Pty) Ltd, Box 5500, Johannesburg 2000, Republic of South Africa *(Transvaal)*

KAYE, RUSSELL STUART, BSc, MRSC, 9 Birchdale, Dukes Wood, Gerrards Cross, Buckinghamshire *(Thames Valley)*

KELLOW, ROBIN, Park House, 74 High Street, Gargralie, Skipton, North Yorkshire BD23 3LX *(Manchester)*

LAW, ANTHONY GORDON, Thor Chemicals SA (Pty) Ltd, c/o Woods Warehousing, PO Box 27076, Benrose 2011, Republic of South Africa *(Transvaal)*

MACLENNAN, ALEXANDER HOPE, BSc, PhD, 218 Glasgow Road, Paisley, PA1 3DR *(Scottish)*

MASEFIELD, KEITH ROBERT, NZCS, Oregon Paint Co. Ltd, Alexander Crescent, Otara, Auckland, New Zealand *(Auckland)*

MASSON, CHRISTOPHER RYLE, BSc, MSc, PO Box 2099, Port Elizabeth, 6056, Republic of South Africa *(Cape)*

NDU, LAWRENCE ORAZULUMELUM, BSc, College of Arts, Science & Technology, Oko, Aguata Lga, Anambra State, Nigeria *(General Overseas – Nigerian Branch)*

RUSSELL, GRAHAM JOHN, BSc, Datachem Services (NZ) Ltd, PO Box 38 402, Howick, New Zealand *(Auckland)*

ROWLANDS, MICHAEL PETER JOHN, 51 Philip Avenue, Glen Eden, Auckland, New Zealand *(Auckland)*

TAPPER, SPENCER PURCELL, MSc, 1/88 Koram Street, Remuera, Auckland 3, New Zealand *(Auckland)*

WALKER, PETER JOHN, BSc, MSc, c/o Bayer SA (Pty) Ltd, Inorganic Division, PO Box 1366, Johannesburg 2000, Republic of South Africa *(Transvaal)*

WILSON, ADRIAN, 12 Centenary Square, Dewsbury, West Yorkshire WF12 9HJ *(West Riding)*

WILSON, JOHN HAMISH, BSc, c/o Chemby Marketing Ltd, PO Box 5641, Auckland, New Zealand *(Auckland)*

Associate Members

DICKINSON, KENNETH JOHN, c/o Hoechst SA (Pty) Ltd, PO Box 8692, Johannesburg 2000, Republic of South Africa *(Transvaal)*

HOUSTON, ROBERT W., Tartan Color & Chemical Inc., 6551 Mississauga Road, Mississauga, Ontario L5N 1A6, Canada *(Ontario)*

MCCARTHY, DAVID, Silver Paint & Lacquer Co. Ltd, Wide Lane, Morley, West Yorkshire *(West Riding)*

MCKENDRY, IAN JAMES, T & C Chemicals, Box 1521, 3 Clark Road, Westmead, Pinetown, Durban 4000, Republic of South Africa *(Natal)*

VAUGHAN, PETER KEVEN, BA, 6 Sime Road, Manurewa, New Zealand *(Auckland)*

Registered Students

ALLERS, PETER JACOBUS, c/o Bayer SA (Pty) Ltd, Inorganic Division, PO Box 1366, Johannesburg 2000, Republic of South Africa *(Transvaal)*

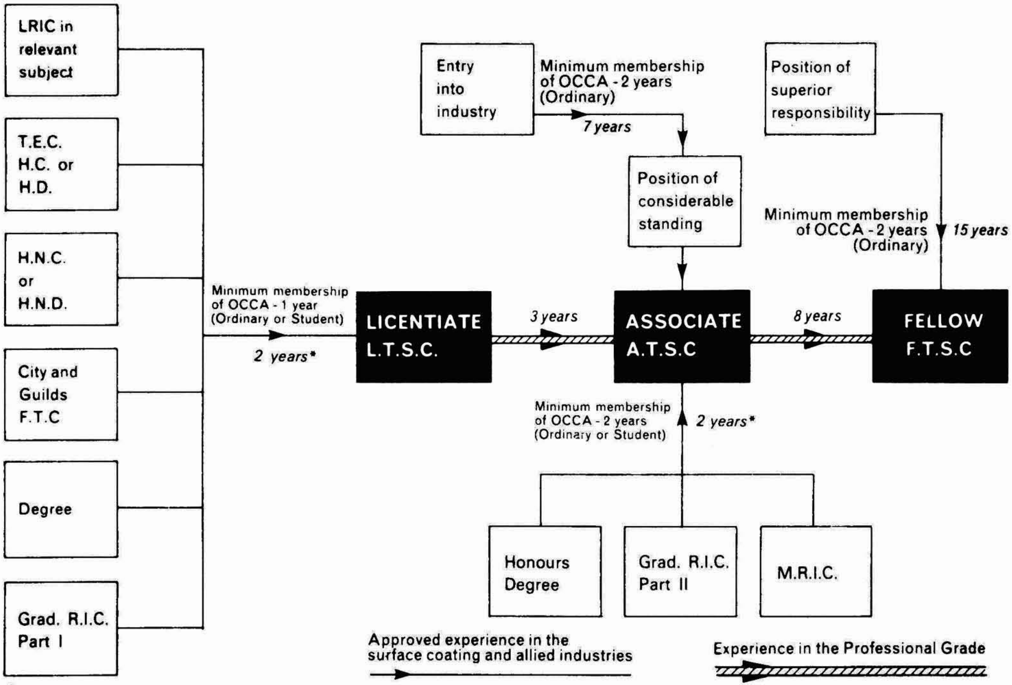
LEWIS, GARY NORMAN, St. Catherin's College, Oxford OX1 3UJ *(Thames Valley)*

MCLEOD, KEITH, St Edmund Hall, Oxford OX1 4AR *(Thames Valley)*

Optional Professional Grade for Ordinary Members

Routes to the Professional Grades

The innovation of the Professional Grade has proved to be most successful, as evidenced by the impressive list of names in the December issue of the *Journal*. For the convenience of potential applicants, a chart indicating different routes to the various grades is shown below.



*Not necessarily after qualification – see regulations.

Note: At present there is no restriction on Students up to 21; between 21 and 25 a certificate from the employer or college confirming the course being taken is required.

Regulations for admission to the Professional Grade – Amended February 1981

A. Licentiate

1. Shall be an Ordinary Member of the Association and have been an Ordinary Member or Registered Student of the Association for not less than one year.

2. Shall have attained the age of 22.

3. (a) Shall be a Licentiate of the Royal Society of Chemistry in Coatings Technology or another relevant subject, such as advanced analytical chemistry, colour chemistry or polymer science.

OR (b) Shall have passed the Higher Certificate or Higher Diploma of the Technician Education Council in Coatings Technology or other relevant subjects (or equivalent SCOTEC qualification).

OR (c) Shall have passed Higher National Certificate or Higher National Diploma in a relevant subject (or equivalent SCOTEC qualification).

OR (d) Shall hold the Full Technological Certificate of the City and Guilds of London Institute in a relevant subject.

OR (e) Shall be a graduate in a relevant subject.

OR (f) Shall have passed Part I of the examination for the Graduateship of the Royal Society of Chemistry or Council of Physics.

OR (g) Shall have passed such other qualifications as approved by the Professional Grade Commitee from time to time.

4. Shall have attained approved experience in the science or technology of coatings. It is not expected that sufficient experience would be gained in a period of less than two years in the industry. Approved experience may be gained before, during or after the qualifications in paragraph (3) above have been attained.

5. Shall be required to satisfy the Professional Grade Committee, or some other body approved by the Professional Grade Committee in a *viva voce* examination and submit a dissertation on a subject directly associated with the science and technology of Surface Coatings or allied materials previously approved by the Professional Grade Committee.

6. Shall normally be sponsored by three Ordinary Members of the Association in the Professional Grade (either Associate or Fellow at least one of whom is a Fellow). A sponsor will usually be a person who has knowledge of the career of the applicant. The candidate shall be in a position to furnish the name of a referee acceptable to the Committee, who can be contacted in confidence, if required. The referee will have a full knowledge of the candidate's technical and scientific achievements to date and could be the applicants employer.

7. Shall have paid the fee stipulated by the Council and have paid the current subscription payable by an Ordinary Member.

B. Associate, being already a Licentiate

1. Shall, since his election to the Licentiateship, have practised the science or technology of coatings for not less than three years.

Note: For the sake of simplicity, reference is made only to UK examinations etc., but equivalent qualifications overseas will naturally be accepted.

2. Shall provide evidence acceptable to the Professional Grade Committee of his increased professional skill and maturity since his election as a Licentiate.

3. Shall have published work which, in the opinion of the Professional Grade Committee, is of a sufficiently high standard OR may be required to submit a thesis or dissertation on a topic previously approved by the Professional Grade Committee OR shall hold the City & Guilds of London Institute Insignia Award.

4. MAY be required to satisfy the Professional Grade Committee or some other body as approved by the Professional Grade Committee in a *viva voce* examination.

   The nomination of a referee for a *viva voce* examination will normally be for those whose work could be of a highly confidential nature or for overseas candidates.

5. Shall normally be sponsored by three Ordinary Members of the Association in the professional grade (either Associate or Fellow) at least one of whom must be a Fellow.

   A sponsor will usually be a person who has knowledge of the career of the candidate. The candidate should be in a position to furnish the name of a referee acceptable to the Committee, who can be contacted in confidence if required. The referee will have a full knowledge of the candidate's technical and scientific achievements to date and could be the applicant's employer.

6. Shall have paid the fee stipulated by Council and have paid the current subscription payable by an Ordinary Member.

C. Associate, not already a Licentiate

EITHER

1. Shall be not less than 24 years of age.

2. Shall be an Ordinary Member of the Association and have been an Ordinary Member or Registered Student of the Association for not less than two years.

3. Shall hold the Graduateship of the Royal Society of Chemistry or Council of Physics or a University or Council of National Academic Awards degree recognised by the Royal Society of Chemistry or Institute of Physics as giving full exemption from the Graduateship examination.

4. Shall have attained approved experience in the science or technology of coatings. It is not expected that sufficient experience would be gained in a period of less than two years in the industry. Approved experience may be gained before, during or after the qualifications in paragraph (3) above have been attained.

5. Shall normally be required to satisfy the Professional Grade Committee or some other body approved by the Professional Grade Committee in a *viva voce* examination.

   The nomination of a referee for the *viva voce* examination will normally be for those whose work may be of a highly confidential nature or for overseas candidates.

6. Shall normally be sponsored by three Ordinary Members of the Association in the Professional Grade (either Associate or Fellow) at least one of whom must be a Fellow.

   A sponsor will usually be a person who has knowledge of the career of the candidate. The candidate must be in a position to furnish the name of a referee acceptable to the Committee, who can be contacted in confidence if required. The referee will have full knowledge of the candidates technical and scientific achievements and could be the applicant's employer.

7. Shall have paid the fee stipulated by Council and have paid the current subscription payable by an Ordinary Member.

OR

8. Shall be not less than 30 years of age.

9. Shall be an Ordinary Member of the Association and have been an Ordinary Member of the Association for not less than two years.

10. Shall have been engaged in practising the science or technology of coatings for not less than seven years and shall have attained a position of considerable standing in the industry, with appropriate responsibility for technical and scientific matters within the company.

    It would be helpful if he had contributed to the knowledge and understanding of surface coatings technology by lecturing or by the publication of articles. He will also have shown himself to take a keen interest in the work of the Association by being an active member of his Section and by attendance at lectures etc., whenever and wherever possible.

11. Shall normally be required to satisfy the Professional Grade Committee in *viva voce* examination of his professional competence and also be required to submit a dissertation on a subject agreed by the Committee. In cases where the subject is of a highly confidential nature the use of a referee agreeable to the Committee may be asked to examine the dissertation.

12. Shall normally be sponsored by three Ordinary Members of the Association in the Professional Grade (either Associate or Fellow) at least one of whom must be a Fellow.

    A sponsor will usually be a person who has knowledge of the career of the candidate. The candidate must also be in a position to furnish the name of a referee acceptable to the Committee who can be contacted in confidence, if required. The referee will have a full knowledge of the candidate's technical and scientific achievement and could be the candidate's employer.

13. Shall have paid the fee stipulated by the Council and have paid the current subscription payable by an Ordinary Member.

D. Fellow

Note: This is the senior award of the professional grade. The Professional Grade Committee will require substantial evidence of professional maturity in the science or technology of coatings although commercial experience will be taken into account in assessing the merits of candidates.

1. Shall be not less than 33 years of age.

2. Shall have been an Ordinary Member of the Association for not less than ten years.

3. Shall have made outstanding contributions to the science and technology of coatings or reached a position of eminence in the industry **through the practice thereof.**

4. EITHER (a) shall have been an Associate of the Professional Grade for at least eight years and shown continued development.

   OR (b) shall have not less than fifteen years' experience in the science and technology of coatings in a position of superior responsibility.

5. Shall submit, with the application, an account of experience, with due reference to scientific and technological interests, achievements and publications.

6. Shall normally be sponsored by three Ordinary Members of the Association in the professional grade, all of whom must be Fellows, (who should submit a supporting commentary to the Professional Grade Committee).

7. It would be helpful if he had contributed to the knowledge and understanding of surface coatings technology by lecturing or by the publication of articles. He will also have shown himself to take a keen interest in the work of the Association by being an active member of his Section and by attendance at lectures etc., whenever and wherever possible.

8. Shall have paid the fee stipulated by the Council and have paid the current subscription payable by an Ordinary Member.

The fees payable with the application are as follows:

Fellow–£10.00 Associate–£6.00
Licentiate–£3.00
(Plus VAT at standard rate).

Application

Completed application forms should be returned, together with the appropriate remittance, to the Director & Secretary at the Association's offices (except in the case of those Members attached to the Cape, Natal, Transvaal, Wellington, Auckland and Ontario Sections, who should address their forms to their Section Hon. Secretaries).

The Committee wishes it to be known that members rejoining the Association after a period in other industries may include length of service as an Ordinary Member before their resignation as part of the qualifying periods for entry into the Grade.

Students wishing to apply for entry into the Professional Grade must first make application in writing for upgrading to Ordinary Membership, giving the reasons for their eligibility for such regrading. Applications, together with the appropriate remittance, should be addressed as for application for admission to the Professional Grade.

Potential applicants are recommended to give the fullest possible details of their appointments, including the number and type of staff under their control, and indicating to whom the applicant is responsible, as this aids the committee considerably in its deliberations.

PAINT TECHNOLOGISTS

Johnstone's Paints, one of the country's fastest growing independent decorative and semi-industrial paint manufacturers, are looking for experienced Paint Technologists to develop and enhance existing product lines.

The successful applicants will ideally have:

A high level of attainment in Paint Chemistry.

A minimum qualification of HNC in Chemistry or equivalent.

A working knowledge of DEF standards applicable to the Paint Industry.

Considerable experience in paint formulation.

The position which will involve working at Head Office and Factory carries a negotiable salary commensurate with experience and other benefits associated with a company of our standing.

Apply in writing along with detailed CV to:

step up with JOHNSTONE'S PAINTS

Managing Director,
Johnstone's Paints PLC,
Stonebridge House,
Edge Lane,
DROYLSDEN,
Manchester.
M35 6BX.

TECHNICAL MANAGER

Runnymede Dispersions Limited, a company in the forefront of pigment dispersions, require a Technical Manager to lead them into the next phase of their expansion programme.

Reporting to the General Manager, the incumbent would assume product management and all technical functions associated with the manufacture of pigment chips and industrial dispersions. The successful applicant will be well versed in surface coatings technology and a printing ink background is preferred but not essential.

Customer and technical service support will be a major priority and is well supported by an efficient sales force.

We are situated in attractive rural surroundings but with easy access to nearby towns and the motorway network.

Salary negotiable, car and other benefits provided including assistance with relocation where appropriate.

Please apply with curriculum vitae to:

Runnymede Dispersions Limited
Ruspidge Works,
Cinderford,
Gloucestershire GL14 3AS
For the attention of T. M. Lougher, General Manager

Technical/Production Director Designate

London C £13000 + profit percentage + car

Tor Coatings is a fast growing group of paint manufacturers. Their London based company will shortly be moving into a new 10,000 sq. ft. factory in Southwark.

This new appointment is an unusual opportunity for a highly motivated, practical paint chemist/technologist seeking a new challenge with excellent career prospects.

Responsibility will be to Tor Southern Managing Director. Candidates 27-46 should have an extensive knowledge of building paints including formulation and works practice. Minimum qualifications are HNC and/or City and Guilds Paint Technology. Contribution to removal expenses if necessary.

Please write, in confidence, giving full details to:

Gordon Carr,
Group Technical Director,
Tor Coatings Limited,
9 Portobello Industrial Estate,
Birtley, Co. Durham

TOR
COATINGS GROUP
PAINTMAKERS

WE ARE
one of the major agency companies supplying materials to the surface coatings and plastics industries in the UK.

WE SEEK
an experienced person to join our sales team, suitably qualified in these fields, as a **TECHNICAL/SALES REPRESENTATIVE.**

WE OFFER
an attractive salary, plus a profit sharing bonus; Pension Scheme, membership of PPP and a company car with unrestricted private use.

WE INVITE
applicants to write initially, with brief personal details to:

Miss J. Harwood,
Cornelius Chemical Co. Ltd.,
Ibex House,
Minories,
London EC3.

CLASSIFIED ADVERTISEMENTS

APPOINTMENTS

Colour Technologist

c.£9,500

Vinatex, a member of the international Norsk Hydro Group, is a major manufacturer of high quality PVC polymers and compounds. We have an immediate need for a capable, experienced Colour Technologist to join us here at Havant.

Reporting to the Technical Manager, this key appointment involves advising on the most effective use of instrumental techniques and the most suitable colourants for particular applications. Additional responsibilities will include carrying out weathering evaluation tests, the compilation of a weathering library and generally monitoring the colourants market to ensure that Vinatex keeps abreast of new developments and maintains its high standards in this area.

The man or woman we seek is probably aged over 28 with degree qualifications in Chemistry or a related subject. Considerable experience in the use of colourants in thermoplastic materials (ideally PVC and/or ABS) and in modern instrumental measuring techniques is called for. Knowledge of plastisol or paint systems would be an additional advantage.

In return a salary of around £9,500 will be offered together with a generous range of personal benefits including assistance with relocation to this attractive corner of Hampshire.

If you are interested please telephone or write for an application form to

Olivia Hughes,
Vinatex Limited, New Lane,
Havant, Hampshire.
Tel: Havant 486350.

VINATEX

MISCELLANEOUS

TECHNICAL ADVICE SOUGHT

Technical advice sought by foreign company for organic and inorganic pigments.

Replies in confidence to
Box No. 512

AGENCY OFFERED

An Italian company is interested in representing UK manufacturers of various raw materials for the surface coatings industries.

Replies in confidence to **Box No. 513**

Books on Offer

Varnish Constituents – Chatfield (1944 edition)
Synthetic Resins Chemistry – Martin (1947)
Varnish Manufacture and Plant – Chatfield (1957)
Ink Manual – SBPIM (1961)
Handbook of Adhesives – Skeist (1962)

Anyone interested in obtaining the above volumes should contact:

Mr W. F. Daggett, 3 Barn Close, Littlehampton, West Sussex, BN17 6JU.

Back issues of JOCCA 1957 – 1980

Tel 01-428 4381
(after 6.00 p.m.)

BACK ISSUES ON OFFER

Journal Back-issues on Offer

A complete set of *JOCCA* dating from 1965, a number of *Science News* issued by *Penguine Book Co*, New Scientists, and a "Lecture Series" issued by the *Royal Institute of Chemistry* are offered to anyone who may be interested. *Please contact:*

Mrs Y. Wiseman
61 Casimir Road
London E5 9NU

SITUATIONS WANTED

Permanent or Temporary Employment sought

Due to early retirement, member with 27 years experience of pigment evaluation is available for temporary or permanent employment.

Replies in confidence to Box No. 509

SITUATIONS WANTED

Member with wide experience seeks challenging position

Member of OCCA (in the Professional Grade) with extensive experience in the surface coatings industry: R & D, technical service, market R & D, marketing and sales, advertising and PR. Also, experienced technical writer, general lecturer, book contributor and author of many papers. Seeks an executive sales/marketing or technical appointment; positions in general management, admin., PR, teaching or scientific journalism would be eagerly considered.

Replies in strictest confidence to Box No. 511.

Part-time Consultancy

Recently retired CBE, PhD with wide experience in the UK and abroad in company management and selling seeks part-time consultancy.

Replies in confidence to Box No. 510

JOCCA

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Please also send information on the following items relating to the above:

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Name . . . .

Job Title . . . .

Company . . . .

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Photocopy or cut out this form and send 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
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INDEX TO ADVERTISERS

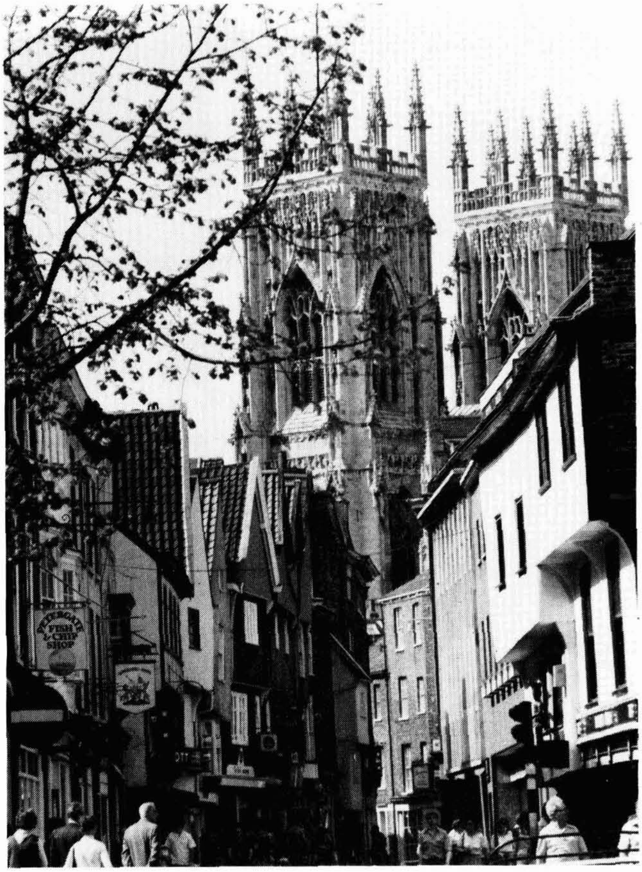
Further information on any of the products advertised in this *Journal* may be obtained by circling the appropriate number on the *Reader Enquiry Service (RES)* form. The numbers are shown in brackets below. Enquiries will be forwarded to the organisations concerned.

OCCA CONFERENCE 1983

YORK

15-18 JUNE
1983

CALL FOR
PAPERS



THE EFFICIENT USE OF SURFACE COATINGS

The next OCCA Biennial Conference will be held at the Viking hotel, York from 15-18 June 1983 with the theme "The efficient use of surface coatings".

There will be four technical sessions under the headings:

(I) Formulation including manufacturing etc.

(II) The efficient use of coatings application

(III) The use of computers in surface coatings

(IV) Maintenance of quality and prediction of performance

Following the innovation at the 1981 Conference there will be a discourse session included in the fourth technical session.

The Hon. Research & Development Officer now invites offers of papers for presentation at this Conference. Anyone wishing to submit a paper for consideration should notify his intention as soon as possible to: **The Director & Secretary, Oil & Colour Chemists' Association, Priory House, 967 Harrow Road, Wembley, Middlesex HA0 2SF, England (Tel: 01-908 1086; Telex: 922670 OCCA G).**

Reader Enquiry Service No. 199

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