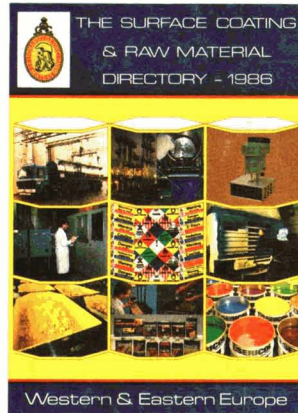


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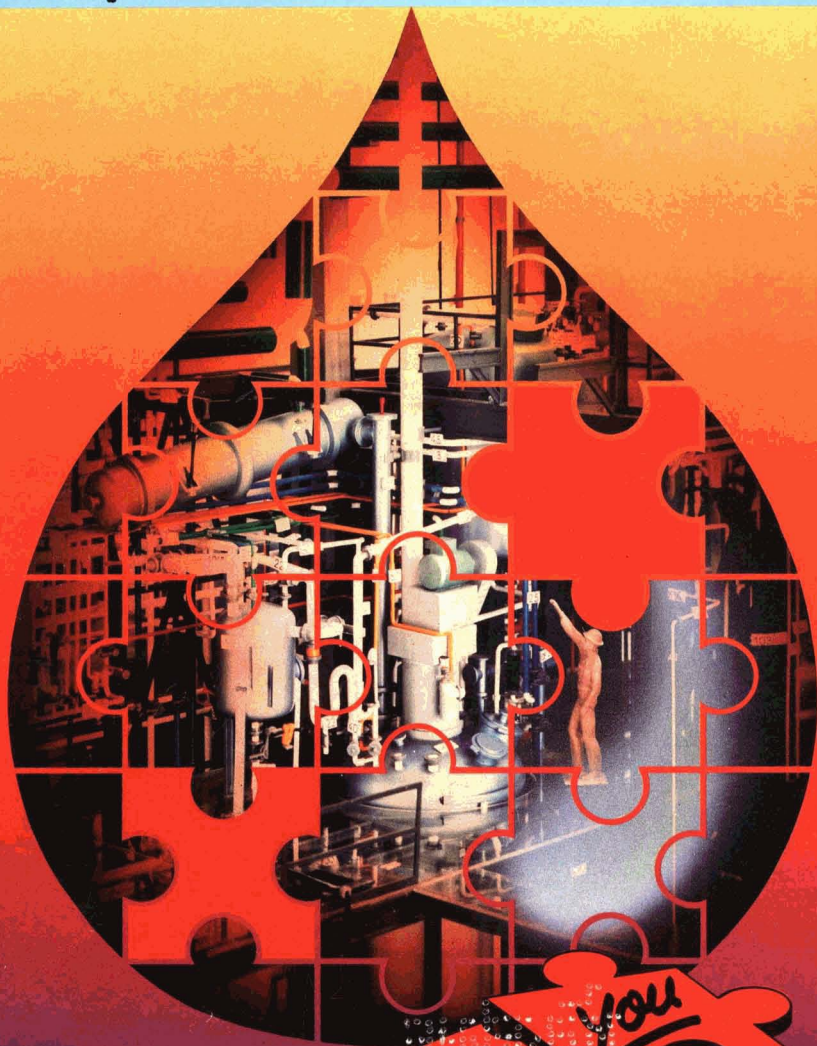
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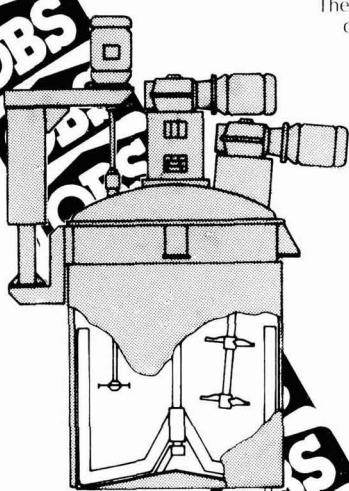
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Performance testing of exterior wood primers

M. L. Jansen

Building Research Association of New Zealand, Judgeford, New Zealand.

Summary

Five reference primers and four fail control primers were used in exposure trials and laboratory tests designed to assess various performance properties. Two separate finishing systems (alkyd and acrylic) were used in the study. The effects of different exposure periods on the primers outdoors (0, 6, 26 weeks) were studied. Some primers were clearly adversely affected after 26 weeks' exposure; two acrylic primers were apparently not seriously affected by this period of weathering prior to applying the finishing systems, and they clearly out-performed the other primers. There is a case for selecting more durable primers for those situations where finishing work cannot be carried out after priming within the few weeks usually recommended. Examination of the finished panels after weathering for one year and for three years confirmed the good performance of the all-acrylic paint systems.

Artificial weathering was also carried out but this test did not prove to be worthwhile. Laboratory tests were carried out for blocking, blistering, putty compatibility, tape pull-off adhesion, tensile adhesion strength, water permeability, extractive staining, flash and early rusting, and extensibility. Two laboratory tests which provided valuable information were for blistering and tensile adhesion strength (wet). Useful tests for blocking and flash and early rusting are generally applicable only to waterborne primers.

Introduction

The primary function of a wood primer is to bond finishing paints to the substrate. When this bond does not exist, or becomes critically weak, flaking and peeling of the paint will occur – often prematurely. A high proportion of all paint failures on exterior woodwork are due to this fault. An important secondary function of a wood primer is to seal the surface of the wood and to reduce the rate of change in moisture content, thereby protecting the timber surface during the construction stage. In New Zealand, the question of the durability of exposed primed surfaces has been raised on a number of occasions in the past, in relation to both oil-based primers (now little used) and to alkyd type primers. In the early stages of the project, industry surveys undertaken by the Building Research Association (BRANZ) confirmed that poor exterior wood priming methods constituted a significant problem in the building industry. Approximately 50 per cent of all houses in New Zealand are clad with timber. On the basis of the information obtained from the surveys, further work on the subject was considered to be justified and it is the results of that work which are presented in this paper.

While it is agreed that to delay undercoating is poor practice, there is little definitive information regarding the breakdown of primed timber surfaces due to weathering. Varied opinions exist concerning the effects of prolonged exposure of the primer before finishing coats are applied but a maximum period close to four weeks has been widely accepted as good practice. Because new types of primer and methods of application are now in use, this previous knowledge, experience and research may no longer be relevant. A requirement that primers withstand six months' exposure is accepted in the UK^{1,2}.

Experimental

Five reference primers were chosen on the basis of reputation or compliance to a standard, and were expected to perform well (the primers are denoted by a capital letter):

- A: Oil-alkyd, white and red lead primer based on the formulation in BS 5358:1976³.
- B: Oil-type primer, with zinc oxide/titanium dioxide pigments, complying with NZSS 1056:1952⁴.
- C: Waterborne acrylic primer based on acrylic resin MV23 (Rohm and Haas Ltd).
- D: Waterborne acrylic primer (Australia).
- E: Alkyd primer (Australia).

Fail control primers were included to assess the discriminating ability of the test methods. Each was expected to perform poorly by virtue of the various criteria used in choosing them:

- W: A specially formulated minimum cost solvent-borne exterior primer.
- X: Commercially available solvent-borne paint designed as a primer/undercoat for interior use.
- Y: Commercially available waterborne ceiling paint designed for interior use.
- Z: Alkyd reference primer E adulterated with 15 per cent raw linseed oil and 30 per cent turpentine.

Test panels were cut from kiln-dried flat-sawn, untreated *Pinus radiata* (moisture content 12 per cent). The dressed profile was rectangular, 150 × 20 mm, with all edges sharp. Each panel was 500 mm long and contained one finger-joint. Panels were primed in replicates of ten. The weight of primer applied was that necessary to achieve a dry film build of 30 microns on a non-absorbing surface.

The panels intended for weathering were mounted on exposure racks seven days after priming, in late January. The exposure site was at Judgeford, 20 km northeast of Wellington, approximate latitude 41° south. Panels were oriented at 45° facing north. The primed panels were exposed for either 0, 6 or 26 weeks before examination and application of the undercoat and topcoat. The six weeks' exposure period was divided between summer (three weeks) and winter (three weeks). Of the panels exposed for 26 weeks, five replicates of each primer were weighed at regular intervals (approximately each week) to determine weight changes due to moisture uptake or loss. At the completion of the exposure periods, the primed panels were brought indoors for examinations and tests.

After inspection of the weathered primed panels, eight replicate panels of each primer were undercoated: four with an oil/alkyd undercoat and four with a waterborne acrylic undercoat (for the formulations used see Appendix). On each panel all surfaces except the reverse surface were undercoated. The remaining replicates were held indoors as reference panels. The necessary weight of undercoat to be applied was based on a desired dry film thickness of 30 microns. After application of the undercoat the panels were

dried for seven days, cross-scribed and a tape pull-off adhesion test performed. This method, attributed to W. D. McMaster and described by Sward⁵, is very similar to that given in BS 5358³.

The panels with the oil-alkyd undercoat were then painted with a commercial alkyd enamel topcoat, and the panels with the acrylic undercoat were painted with an acrylic topcoat of the same composition as the undercoat. All surfaces previously undercoated were topcoated. The necessary weight of topcoat to be applied was based on a target dry film thickness of 25 microns. The topcoats were tinted teal-blue matching colour 7-077 of BS 2660:1955. After allowing the topcoat to dry indoors, the panels were exposed outdoors. Inspections were carried out after one year and three years' weathering.

The weathered primed panels and the weathered topcoated panels were examined for chalking, surface disfigurement, cracking and flaking to the appropriate ASTM test procedures⁶. In-house test procedures were used to evaluate the condition of the panel edges and the finger-joints.

In addition to the exposure tests, various laboratory tests were employed:

Water permeability measurements of primed quarter-sawn (slice cut) veneers of *Pinus radiata* were made using the wet-cup method described in ASTM E96-66⁷. Spiral applicator rods were used to apply a target dry film build thickness of 30 microns. The primer film thickness was later measured by examining sections of the coated veneers with a microscope having a calibrated field of view.

Blister resistance was assessed by using the method described by Gans⁸. In this method, painted timber panels are soaked by total immersion for seven days at room temperature and then transferred to an oven at 150°C for up to thirty minutes. The blistering assessments were made according to the ASTM method⁶.

The compatibility of primers with glazing putty was assessed using the method described in BS 5082:1974¹.

Resistance to flash and early rusting was determined by using a method in which nails, in sets of five, were driven into a board of *Pinus radiata* to simulate exposed nail-head fixings. These boards were then brush painted with the different primers. Any changes in the primers were noted as the primers dried over a period of 24 hours. They were then placed, painted surface down, on a condensing cabinet at 30° for 24 hours before reassessment.

Tensile strength adhesion tests were carried out by using circular aluminium studs, 20 mm in diameter, which were glued using epoxy cement on to sections of panels which had been exposed outdoors (the fourth replicates of the outdoor exposure tests); the panels chosen had been primed, exposed for 0 or 26 weeks, undercoated, topcoated and exposed for 35 weeks. The studs were then pulled off using a Dartec Universal Testing Machine at a cross-head speed of 5 mm/minute. A second group of tests was carried out in which the panels were soaked in water (20°C) before the studs were pulled off. The areas of failure were identified by visual examination.

Extractive staining resistance of primers was assessed by using specially prepared *Pinus radiata* panels, each treated

in two ways: one strip of the panel was painted with part A only of a resorcinol-formaldehyde glue thinned with a little water; the other strip was painted with a 3:2 creosote-turpentine mixture. The panels were then coated with a primer, dried for five days and painted with the solvent-borne undercoat and (over a separate area) with the acrylic-borne undercoat. After drying, the panels were inspected and then placed on a condensing cabinet, painted sides down, for 72 hours at 37°C (vapour temperature). Panels were then removed and inspected for degree and distribution of stain penetration through the paints.

A blocking test based on BS 5082:1974¹ was used. It was modified to use (quarter-sawn) *Pinus radiata* veneer instead of Kraft paper and a mass of 500g/25 × 25 mm area (8KPa) to press the primed veneer surfaces together. The water-borne primers were allowed to dry for two hours before testing; the other primers were dried for 24 hours. The tests were carried out in duplicate at 20±2°C and 65±5 per cent relative humidity. The simple pass-fail assessment in BS 5082 was extended by using a 1-10 rating scale.

Artificial weathering tests were performed on test pieces cut from the panels exposed outdoors (fourth replicates), which had already received 35 weeks' exposure of the topcoat. Each test piece was cut to 230 × 63 mm, and the bare timber edges sealed using a two-part epoxy paint. The 54 test panels (9 primers; exposed for 0, 6, 26 weeks before undercoating; solvent-borne and waterborne topcoat systems) were installed in an Atlas Ci 65 Xenon-arc Weather-o-meter. The test cycle used was the "alternate cycle" (Clause 4.5) set out in ASTM G26-77. After 1,000 hours' exposure, the test panels were evaluated.

The extensibility of primer films was measured using three films of each primer initially cast onto polyethylene sheet. The elongation measurements were based on the method of ASTM D2370-68⁹. A J. J. Lloyd Tensile Testing Machine, type T22K, was employed.

More detailed information about the test conditions and procedures used are given by Jansen and Whitney¹⁰.

Results and Discussion

Weight changes of primed panels during exposure

Measurements of panel weight indicated that over the 26 week period from January to July, the timber became progressively more damp, changing from the initial values of moisture content (close to 12 per cent) to about 18-20 per cent at the time of the last weight measurements. A statistical analysis was made of the data using the standard deviation (mean standard deviation of five replicate panels for each primer) of the absolute values of successive differences in percentage weight change over the 26 weeks. The analysis of variance of these mean values showed that only primer Y was significantly different from the other primers; and that among the other eight primers there were no significant differences.

On the assumption that all weight changes for the panels indicated a change in moisture content, percentage changes in moisture content of the panels were calculated (see Figure 1).

It is generally held that acrylic latex paints have greater permeability to water than oil-paints. For primers C and D,



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Table 1

Chalking, cracking and surface disfigurement ratings of primed panels exposed outdoors

Primer	Mean rating* for 10 replicate panels (front surfaces) after the exposure periods given (0, 6, 26 weeks)								Comment after 26 weeks
	Chalking			Cracking		Surface disfigurement			
	0	6	26	6	26	6	26		
A	10	10	9.8	10	9.0	10	9.3	Generally clean surface	
B	10	8.8	5.7	10	9.5	10	9.6	Mainly associated with timber cracks	
C	10	10	10	10	9.9	10	9.9	Fungi detected microscopically	
D	10	10	10	10	9.9	10	8.9	Fungi detected microscopically	
E	10	9.7	9.8	10	8.5	9.9	3.9	Fungi well advanced	
W	10	9.0	6.0	9.8	8.4	10	0.9	Fungi especially evident on eroded areas of primer	
X	10	9.6	9.9	9.1	8.0	10	5.0	Fungal growth	
Y	10	7.6	7.7	6.6	6.9	10	8.6		
Z	10	9.4	9.6	9.3	6.6	10	3.1	Fungal growth	

*10 = No defect, 0 = Severe failure

this generalisation is partly supported by the results of the wet-cup test (see Table 6) but not born out in Figure 1. It is suggested that for the first coat of paint applied to timber, the principal means of water transfer is via raised fibres, acting as wicks, and areas of timber covered by relatively thin paint. This argument applies to any paint type and explains why the commonly assumed superior water resistance to the passage of water for an oil-based paint is not illustrated in Figure 1. Holbrow et al¹¹ proposed the same idea to explain the results of laboratory water uptake tests on painted timber.

Chalking of primers

The results of the chalking tests are given in Table 1. Clearly, the greatest increase in chalking occurred with primers B and W. The chalking of primer B after 26 weeks' weathering contributed to the poor adhesion of the undercoat and the relatively poor performance of the total paint system after three years' weathering. The apparent chalking of primer Y is probably due more to the coarse texture and poor cohesive strength of this paint, than to chalking processes as usually understood.

Surface disfigurement

The results of surface disfigurement evaluations are given

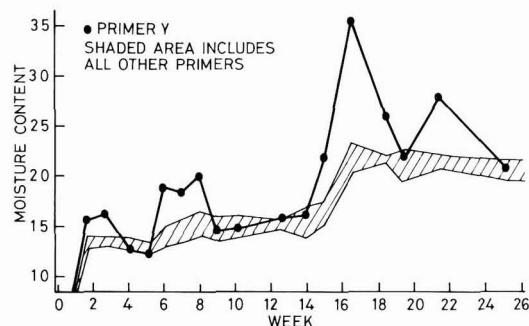


Figure 1. Percentage moisture content changes of primed panels exposed outdoors, based on measured weight changes.

in Table 1. The cause of the disfigurement was almost entirely due to fungal growth. After 26 weeks, which included some wet winter conditions, the disfigurement rating decreased markedly for five primers (E, W, X, Y, Z). This was not surprising for the four fail controls but it was not expected for primer E. It is likely that this Australian formulation was not designed for the damp conditions that often prevail in New Zealand.

The importance of this test relates to the surface damage produced, rather than to adverse aesthetic effects. Where fungus growth becomes established on a primed surface, later potential damage to the paint film may occur. If fungi (or other surface growth) do develop on a primed surface, it is necessary for the painter to carry out appropriate cleaning operations—usually at extra cost.

The unexpected appearance of fungal growth on primer E confirms the value of the surface disfigurement test. More than six weeks' exposure of the primed surface (including some periods of wet weather) was clearly necessary for adequate discrimination with this test.

Cracking

The results of the cracking evaluations are given in Table 1. "Cracking" refers to cracks visible on the primed surface and almost always indicates timber cracks beneath. The two areas of each panel separated by the fingerjoint were evaluated separately; any difference in the rating between these areas was generally one unit and less commonly two units.

The cracking was more severe on the front surface than on the reverse surface as expected from the greater temperature fluctuations experienced by the front surface. Cracking at panel ends generally occurred earlier than elsewhere. Moisture is readily lost or gained through the end grain and this draws attention to the need to seal the cut ends of timber. Reverse surface cracks developed with the very permeable primer Y even when the undercoat and topcoat were applied with no intervening weathering of the primed surface. This evidence does not support the view, once held in New Zealand, that weatherboards should be

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Table 2

Results of tape pull-off adhesion tests of undercoats applied to primed panels

Primer	Undercoat S or W†	Mean adhesions ratings‡ (for 4 replicates) of solvent-borne and waterborne undercoats to primed panels*. Undercoats applied after 0, 6 and 26 weeks		
		0	6	26
A	S	9	9	9
	W	7	8	7
B	S	8	8	7
	W	6	8	4
C	S	9	9	9
	W	10	10	10
D	S	9	9	9
	W	10	10	10
E	S	9	9	9
	W	8	9	9
W	S	7	8	9
	W	7	7	7
X	S	8	8	8
	W	8	8	9
Y	S	9	8	7
	W	5	3	2
Z	S	9	9	8
	W	8	8	9

* Where necessary, the calculated mean value was rounded to the nearest whole number. The standard deviation of replicate values was generally less than 1 unit.

†S = Solvent-borne undercoat, W = Waterborne undercoat
‡10 = Perfect, 0 = Severe adhesion failure

primed in such a way as to leave an unprimed "breathing" strip along the centre of the reverse surface.

Fingerjoints

Various minor degrees of fingerjoint visibility and minor glue-bleed through the primer were observed after weathering of the primer, but none were regarded as serious. After three years' weathering none of the fingerjoints revealed any significant problems.

Adhesion of undercoat

The results of the tape pull-off adhesion test for the undercoats applied to the primed panels are shown in Table 2. General points arising out of these data are: the excellent adhesion of the acrylic undercoat to the acrylic primers C and D (adhesion essentially unaffected by 26 weeks' weathering of these primers); the slightly poorer adhesion of the waterborne undercoat to oil or alkyd primers than of the solvent-borne undercoat; the decrease in adhesion of the acrylic undercoat after primers B and Y had been weathered (for B this is probably due to surface chalking, and for Y to the further embrittlement of this weak primer). The adhesion failure between primer and undercoat usually involved some cohesive failure of the primer as evidenced by the presence of small amounts of primer on the detached undercoat film.

Paint adhesion is of fundamental importance in defining the durability of a paint system. The ideal paint adhesion test which combines simplicity, accuracy and realism, especially for timber substrates, has yet to be devised. The tape pull-off method used in this study appeared to work

satisfactorily: it covered a wide range of adhesive strengths and was easy to carry out.

Performance after weathering fully painted panels for 1 year and 3 years

Both solvent and waterborne topcoats were in good condition after one year. The slight defects which were evident, generally reflected the defects which had previously been noticed on the primed surfaces. The waterborne and solvent-borne topcoats had lost some gloss and had undergone some chalking. On all panels fungus spores had settled and fungal hyphae were present over small areas indicating the early stages of colonisation.

After three years the main change in the topcoat itself was an increase in chalking with accompanying whitening of the topcoat from its initial blue colour.

The results of the cracking evaluations are given in Table 3. The one year ratings revealed slightly lower values for panels previously weathered for 26 weeks before undercoating and this was generally due to cracks which had developed before undercoating. The early development of severe cracking with primer Y is explained by the very permeable quality of the primer allowing rapid moisture content changes in the panels via the reverse (primed-only) side. With some panels a few timber cracks were bridged by

Table 3

Cracking ratings of finished panels after weathering for 1 year and 3 years

Primer	Undercoat Topcoat S or W†	Mean cracking ratings‡ for 3 replicates after exposure of topcoat for 1 year and 3 years* Undercoats and topcoats were applied after 0, 6 or 26 weeks exposure of primers					
		Primer weathered 0 weeks		Primer weathered 6 weeks		Primer weathered 26 weeks	
		1yr	3yrs	1yr	3yrs	1yr	3yrs
A	S	10	9	10	8.5	10 ^A	8.5
	W	10	10	10	9.5	10 ^A	8
B	S	10	8.5	10	8.5	9	7.5
	W	10	10	10	9.5	9	9.5
C	S	10	8.5	10	8.5	10 ^A	8.5
	W	10	10	10 ^A	9	9	10 ^A
D	S	10	9	10	9	9	8.5
	W	10	10 ^A	10 ^A	10 ^A	10 ^A	9
E	S	10 ^A	9.5	10	9	9	8.5
	W	10	10	10	10 ^A	10 ^A	9
W	S	10	9.5	10	9	9	7.5
	W	10	10	10	10	9	8.5
X	S	10	8.5	10	10 ^A	8	6.5
	W	10	10 ^A	10	8.5	9	7.5
Y	S	7	3	6	3	4	2.5
	W	10 ^A	8.5	8	6	5	5
Z	S	10	9	10	8.5	8	7.5
	W	10	10	10	10 ^A	8	7.5

* Where necessary the calculated mean value was rounded to the nearest half unit

^A One of the 3 replicates rated 9

† S = solvent-borne undercoat and solvent-borne topcoat

W = waterborne undercoat and waterborne topcoat

‡ 10 = No cracking, 0 = Severe cracking

Table 4

Flaking ratings of finished panels after weathering for 1 year and 3 years

Primer	Undercoat Topcoat S or W†	Mean flaking ratings‡ for 3 replicates after exposure of topcoat for 3 years*. Undercoats and topcoats were applied after 0, 6 or 26 weeks' exposure of primers. Unless indicated by a flaking rating value in parentheses, there was no flaking after exposure of top coat for 1 year.		
		0	6	26
A	S	9	8	8
	W	9	10 ^A	8
B	S	8	8	7
	W	9	9	9
C	S	10	10 ^A	10
	W	10	10	10
D	S	10	10	10
	W	10	10	10 ^A
E	S	9	9	8
	W	9	9	9
W	S	9	6	6
	W	9	8	8
X	S	8	9	(9)6
	W	9	9	7
Y	S	(9)3	(6)2	(4)0
	W	8	(8)6	(7)5
Z	S	10	9	7
	W	10	10	8

* Where necessary the calculated mean value was rounded to the nearest whole number

^A One of the 3 replicates rated 9

Pooled standard deviation for table = ± 0.5

† S = solvent-borne undercoat and solvent-borne topcoat

W = waterborne undercoat and waterborne topcoat

‡ 10 = No flaking, 0 = Severe flaking

the acrylic primers but not by the solvent-borne undercoat/topcoat which indicates the advantage of having extensible paints on timber.

After weathering for one year, significant flaking occurred only with primer Y caused by the poor cohesive strength of this primer (see Table 4). After weathering for three years, this table shows that in general, the waterborne topcoat system gave rise to less flaking than the solvent-borne topcoat system, with this difference being most marked for primer Y. The two acrylic primers appear to be superior to the others, with almost perfect flaking ratings. This is ascribed to the excellent adhesion of these primers to the timber and to their resistance to breakdown and embrittlement. It is also noteworthy that the solvent-borne undercoat and topcoat system performed well over these two acrylic primers. The alkyd primer E also performed well with the other two reference primers (A and B) slightly less satisfactory. As a group, the fail-control primers rated poor to moderate with respect to flaking, suggesting that this test is a very discriminating one.

Table 5 summarises the condition of panel edges after exposure for one year and three years. An important feature of this table is the apparently rapid deterioration from a perfect edge in only one year for most paint systems. This suggests that the edge condition is a very sensitive

discriminator of total paint system performance, although edge condition does not appear to sufficiently clearly indicate the effect of weathering the primer alone. The generally good performance of the acrylic primers is reflected by this assessment.

While the condition of paintwork over sharp edges is a useful early indicator of performance, it must be used carefully because sharp edges are most likely in practice to have insufficient or uneven paint coverage. In a controlled test this problem can be avoided by using a brushing technique which does not wipe paint away from such edges. It is emphasised that the use of sharp edges on external timber cladding and joinery is regarded as poor practice or design and should be corrected prior to painting.

Laboratory tests

Resistance to water movement: The results of the water vapour diffusion resistance measurements are shown in Table 6. Evidence of the variation in primer film thickness is also presented in Table 6. The veneer surfaces are much smoother than any timber surface one would expect to encounter in building practice and it emphasises the difficulty of regarding the primer as a "film" at all. It would be better to regard the primer as simply filling surface pores and becoming an integrated part of the timber surface.

The mean corrected water resistance data (R_w) show the slightly higher resistance to water of the non-waterborne primers. While the negligible water resistance of primer Y

Table 5

Conditions of panel edges after weathering for 1 year and 3 years

Primer	Undercoat Topcoat S or W†	Mean flaking ratings‡ for 3 replicates after exposure of top coat for 1 year and 3 years*. Undercoats and topcoats were applied after 0, 6 or 26 weeks' exposure of primer					
		0 weeks		6 weeks		26 weeks	
		1 yr	3 yrs	1 yr	3 yrs	1 yr	3 yrs
A	S	6	3.5	5.5	3	5.5	2
	W	7	5.5	6	4	5	2.5
B	S	4	2	5.5	2.5	5.5	1.5
	W	7	3.5	6.5	4	5	2
C	S	6.5	4	6.5	5	7	4
	W	8	5.5	6.5	5	7	4.5
D	S	8	4.5	7	4.5	7.5	4.5
	W	9	5	7.5	5.5	6.5	4.5
E	S	7	3	6	3	5	2
	W	7	3.5	6.5	3.5	5	3
W	S	8	2	7	0.5	6.5	1
	W	8	4	6	2	5	1.5
X	S	6	2	7	3	4.5	1
	W	7	3.5	6	3	6.5	1.5
Y	S	2.5	1	3.5	0.5	3	0
	W	3.5	1.5	2	1	2.5	0.5
Z	S	6.5	3	7	3	6	2
	W	8	4.5	6.5	3.5	6	2.5

* Where necessary the calculated mean value was rounded to the nearest half unit

† S = solvent-borne undercoat and solvent-borne topcoat

W = waterborne undercoat and waterborne topcoat

‡ 10 = No defects, 0 = Severe defects

Table 6

Water resistance of primers and film thickness measurements on quarter-sawn veneers

Primer	Upright wet cup results	Primer film thickness on veneers			
		Mean resistance† R _c (MN. s/g)*	Mean of 10 values (μ)	Range (μ)	Standard deviation (μ)
A		0.37	37	25-50	9
B		1.10	42	30-60	10
C		0.40	35	30-40	5
D		0.13	49	35-70	11
E		1.01	24	15-30	5
W		0.73	43	25-70	14
X		0.61	36	25-50	12
Y		0.00	33	25-50	8
Z		0.42	20	10-30	7

† Mean resistance of primer alone corrected to 30μ thickness

* The correction calculation was made on the assumption that film resistance is directly proportional to the measured film thickness

was expected, the water resistance of the waterborne primers C and D is somewhat higher than expected and in the case of primer C it is comparable with some of the oil or alkyd primers. These findings are consistent with the weight changes found for primed panels exposed outdoors.

Blistering: The results of the blister tests are given in Table 7. They indicate that blistering was worst for primer B with solvent-borne finishing coats only, primer W with either solvent or waterborne finishing coats and primer Y with solvent-borne finishing coats. Blistering for other primers A, E and Z was much less severe, and declined in apparent severity after the heating period.

Close examination of the blistered panels showed that without exception the zone of failure within which blisters formed involved the primer. Even for unblistered panels the wet paint layers possessed a zone of weakness at the primer-wood interface.

It is often assumed that paint blisters are caused by water (liquid or vapour) which enters timber from the reverse side. A valuable feature of the test used here is that it simulates another possible cause of blistering in practice, whereby water enters the paint system via the painted surface. The findings of Ulfvarson and Pattyranie¹² draw attention to the need to standardise blistering tests by using a reference primer and test panels from the same piece of timber. A blister resistance test is regarded by Kambanis and Chip¹³ as a valid wet adhesion test and the information gained in this work confirms that view. The good adhesion of some acrylic formulations is said to account for less blistering and grain cracking (Hopkins et al¹⁴).

Compatibility with putty: In the test designed to assess compatibility of primers with glazing putty no differences among any of the test pieces could be detected, and the discriminating ability of this test, as it stands, is seriously questioned.

Flash and early rusting: In the flash and early rusting test

the first signs of flash rusting appeared approximately one hour after painting with the waterborne primers D and Y over the flat head nails. After 24 hours, rusting was only slightly more developed. With primer D flat head nails showed small specks of rust (less than 0.5 mm diameter) over 20 per cent of the nailhead area. With primer Y flat head nails showed rust spots (about 1 mm diameter) over 10 per cent of the nailhead area.

After 24 hours' exposure on the condensing cabinet, the early signs of flash rusting with the waterborne primers D and Y were greatly magnified. With primer D on the flat head nails, rust had formed over approximately 70 per cent of the nailhead area. With primer Y on the flat head nails rust had formed over approximately 50 per cent of the nailhead area. None of the solvent-borne primers on the nailheads showed any sign of rusting other than slight surface stains which appear to have leached from rust formed on the unpainted metal surface in contact with the timber beneath. It is important to note that the waterborne primer C did not allow rusting to develop.

An evaluation of flash and early rusting is necessary only for waterborne primers. Grouke¹⁵ has reviewed the conditions which promote the flash and early rusting of latex paints and there are situations where these conditions will apply to waterborne wood primers. Clearly, a primer which actively promotes rusting when it is applied over steel building components, such as nails and hinges, is unsatisfactory but may be acceptable as a factory primer for timber, since steel components can be appropriately spot-primed on site.

Table 7

Blister resistance tests of primers using the method of water-soaking followed by oven heating of thick wood panels

Primer	Undercoat Topcoat	Blister formation ratings‡ after water-soaking for 8 days, before and after oven S or W† heating	
		Before heating	After heating
A	S	8 S	10
	W	6 MD	10
B	S	0 MD	0 D
	W	2 S	2 S
C	S	10*	10*
	W	10-	10*
D	S	10-	4 S
	W	10-	10-
E	S	8 S	10-
	W	10-	10-
W	S	8 F	10*
	W	0 D	0 D
X	S	8 F	10-
	W	10-	10-
Y	S	10-	0 S
	W	10-	0 M
Z	S	6 S	10-
	W	4 D	10-

* = Few small blisters along fingerjoint only

† S = solvent-borne undercoat and solvent-borne topcoat

W = waterborne undercoat and waterborne topcoat

‡ Size: 10 = No blistering, 0 = Severe blistering
Frequency: D = Dense, MD = Medium Dense, M = Medium, F = Few, S = Scattered

Tensile strength adhesion: Summaries of the results of the tensile strength adhesion tests are given in Figures 2 and 3. Unequivocal differentiation of failure between wood-primer interface and failure within the primer itself (cohesive failure) was generally difficult. Observations of wet wood-primer interface failure indicated that latewood bands held much less residual primer than earlywood bands, further complicating any attempt to distinguish between wood-primer and within-primer failure. The most obvious feature evident from these figures is the generally much reduced adhesion following soaking of the test pieces in water before testing. Wet paint adhesion failure most commonly occurred within the primer or between primer and wood. Primers particularly affected by soaking were B, W and Y. In some cases for these primers, soaking caused complete loss of adhesion. At the other extreme, soaking only reduced the adhesion to the degree that the wet-dry adhesion ratio was close to 40 per cent (45 per cent for primer X). In general the wet-dry adhesion ratio was within the range 10-30 per cent.

In some instances the dry paint adhesion was sufficiently strong to cause the wood beneath to break. If one regards the percentage wood failure to be a direct indicator of the overall strength of the paint system (dry), then the strongest paint systems would be those with waterborne primers C and D. However, it must be clearly understood that these results deal only with previously unweathered timber. As a matter of field experience and as confirmed by Underhaug, Lund and Kleive¹⁶ the weathering of timber surfaces can severely affect paint adhesion; latex paints in particular appear to be adversely affected by superficial wood fibre "chalking".

The tests were reasonably easy to carry out but reproducibility within a set of replicates was poor and this draws attention to the highly variable adhesive behaviour of paint on timber and to the variable bulk and surface qualities of timber. This is illustrated by the results obtained on dry panels with several well adhering primers and the separate results for the measured cohesive strength of the timber alone. Bootle¹⁷ has summarised the conflicting points of view concerning the differential adhesion of earlywood and latewood cells. Harris¹⁸ observed that the weakest region of a paint system on wood subjected to wetness is within the paint itself rather than at the surface of the wood. A comparison of the results obtained with the blister resistance and the wet panel tensile strength tests reveals that those primers most susceptible to blistering (B, W and Y) also possess the poorest wet strength adhesion.

Among the primers, data for wet adhesion is more discriminating than for dry adhesion, making the wet adhesion test the more useful one. In addition, wet adhesion is the more relevant of the two properties when one considers the frequent wetting and drying cycles experienced by painted timber and the way in which the exposed edges of a paint film will suffer if the wet adhesion is inadequate. The wet strength tensile measurements made by Emery¹⁹ of paint systems on southern pine plywood compare well with the results obtained here. Emery has suggested a set of "quality levels" based on the wet strength and also claims that the data show good correlation between the bond strength and the performance of the paint work in terms of flaking. He suggests that a wet adhesion strength of about 200 kPa could be used as a reliable screening level for poor paint systems. The present work appears to confirm the value of using a minimum

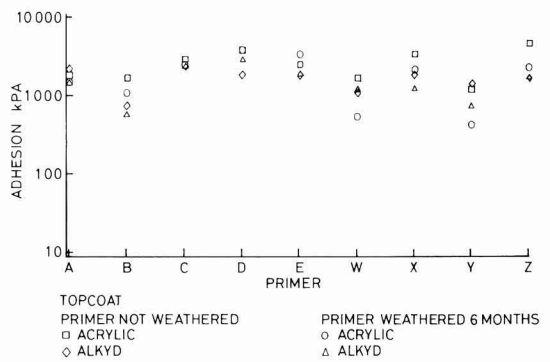


Figure 2. Dry tensile strength, adhesion of paint systems to *Pinus radiata*. Each point represents the mean of 5 replicate measurements. The dry adhesion of studs to unpainted timber of the same type is 3593 kPa (mean of 30 values), 1198 kPa (standard deviation) and 2131 - 5851 kPa (range).

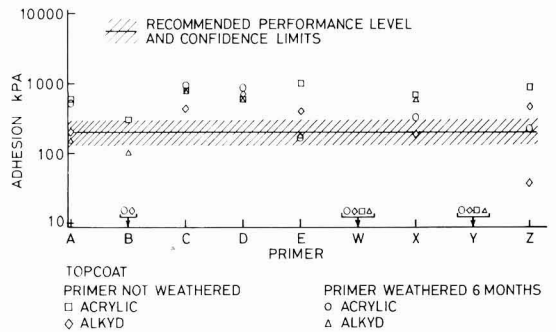


Figure 3. Wet tensile strength, adhesion of paint systems on *Pinus radiata*. Each point represents the mean of 6 replicate measurements.

performance level of about 200 kPa, with primers falling within the confidence limits shown being regarded as marginal.

Stain resistance: The extractive staining tests show that at the time of application of the primers, none was affected by the resorcinol or creosote treatments. However, on the creosote-treated areas, the waterborne undercoat underwent cissing as it was applied over the primers A, E, W, X, Z.

This observation is relevant to the painting of timber pre-treated in some way with a water repellent dip or dressing. It appears that the waterborne undercoat is affected by water repellent substances mobilised by these solvent-borne primers and brought to the top surface of the primer layer.

On the resorcinol-treated areas, all primers except C and D allowed small brown spots of resorcinol to come through. This effect was much more apparent on the waterborne undercoat and was slightly enhanced after exposure on the condensing cabinet. The effect was not apparent on the solvent-borne undercoat. For primer Z the effect was clearly enhanced over the early wood bands. A microscopic examination showed that resorcinol had penetrated

through extremely small pores in the paint film and had spread out over the pore area. Apart from this effect, none of the panels exhibited more than slight staining on either the waterborne or solvent-borne undercoat.

On the creosote-treated areas at least slight staining was visible on the solvent-borne undercoat for all primers, but no staining was visible on the waterborne undercoat or any of the primers. After exposure on the condensing cabinet, staining on these creosote-treated areas was moderately developed over the solvent-borne undercoat for primers B, C, D, E, Y and Z and severely developed for primer W; and moderately developed over the waterborne undercoat primers W and Z. The generally good resistance to resorcinol bleed and creosote staining by the acrylic primers C and D is worth noting. Acceleration of the test by using a condensing environment appeared to work well.

Blocking resistance: The results of the blocking tests using the veneer substrate are given in Table 8. In this test a rating of 4 is regarded as being a minimum performance level and is essentially equivalent to the criterion applied in BS 5082¹. The most serious failure was for primer C. As expected the greater contact pressures and longer contact times generally gave slightly lower ratings. The use of veneer substrates is considered to be more realistic than Kraft paper and is to be favoured in any testing programme.

Eight kPa represents the pressure at the bottom of a stack of timber approximately 1.3 metres high, assuming that the weight is uniformly distributed. This pressure is twice that used in BS 5082 but is below the least demanding blocking pressure used in ASTM D2739 (Class III, 35 ± 1.7 kPa). Enquiries made to factory priming specialists showed that a 1.5 m high stack of timber would be generally representative of the stacking heights of primed boards found in this industry. The primers likely to cause blocking problems are the thermoplastic waterborne acrylic primers; furthermore, blocking problems are likely to be of most relevance to the factory priming industry.

Artificial weathering: After 1,000 hours of artificial weathering the timber test panels showed no useful information concerning the performance of the primers, which was not otherwise evident after one year's natural weathering of the topcoat. It should be recalled that the small test panels installed in the weathering cabinet were totally sealed on all edges and this had the effect of eliminating any edge effects. Likewise, cracking originating from the end grain was effectively prevented. In this way the areas where early indications of failure are most likely to occur are unrealistically protected.

Extensibility: The primer film elongation measurements showed that the solvent-borne primers had percentage elongation values of about 10 per cent or less. Values for the two acrylic primers were approximately ten times this value. Primer Y was too brittle to handle (i.e. effectively 0 per cent elongation). The preliminary nature of the tests did not permit any more detailed conclusions to be drawn. The method of using detached films is obviously unrealistic but the biggest drawback to the test is the care and time required to obtain reliable results.

Whiteley and Rothwell²⁰ have drawn attention to the importance of the extensibility of the primers, although they recognise the problems of incorporating a test for this property into a standard specification for primers.

Table 8

Blocking tests of primers on wood veneers

Primer	Blocking ratings, for duplicates, of primers on wood veneers, using a primer-to-primer surface contact pressure of 8 kPa with contact periods of 2 and 24 hours	
	2 hour contact	24 hour contact
A	8, 10	8, 8
B	8, 8	8, 8
C	6, 6	6, 6
D	8, 8	6, 6
E	10, 10	10, 10
W	8, 8	6, 6
X	10, 10	10, 8
Y	10, 10	10, 10
Z	10, 10	8, 8

Barnes²¹ considered that gross dimensional changes of timber in exterior use could be up to 5.5 per cent ("a value which most coatings could not endure for many cycles"). The true picture is likely to be far more demanding than this estimate since the dimensional changes in timber are not always uniform.

Superimposed on a general dimensional change are local cracks in the substrate which may effectively concentrate the total dimensional change of the whole width of the board into one line. This line is of vanishingly small dimensions before cracking and opens to a finite size (e.g. 0.5 mm) as the crack develops. This may occur over a short period of time, as during a sudden drying spell. For a brittle coating the result is obvious. For an extensible coating the volume of the coating immediately above the line of the crack will more or less accommodate itself to the changing width of the substrate and the coating thickness will partly determine whether the crack will be bridged.

It is easily forgotten that the primer, once applied, must serve successive paint systems applied over it. Even if a primer was once flexible, it fails the paint system if it embrittles to a critical stage. At that stage, the integrity of the paint work depends on the strength and flexibility of the overlying coats. Clearly, the good extensibility of some acrylic formulations is a very desirable quality in an exterior timber coating.

Weathering period of primers

Current recommendations in New Zealand for maximum exposure before finishing coats are applied, are generally close to four weeks. A period of six weeks allows a small safety margin beyond this and it is suggested that this period (during summer months) be used as a minimum exposure period in any weathering trials of wood primers before finishing coats are applied. There may be some advantage in dividing this period between summer and winter as carried out in this study.

The research presented here showed that some primers are able to withstand prolonged weathering before finishing coats are applied. For such primers, the six months weathering period as used here, appears to work well. Furthermore, it corresponds to the delay in painting often found in construction schedules. However, it was noted

that chalking of primer B (and to a lesser degree the carbonation of primer A) was a problem in that this caused poor adhesion and apparently an inferior paint system in the long term. The performance of this type of primer no doubt accounts for the old rule of thumb that overcoating should be carried out within four weeks of priming.

A major cause of paint system failure is timber cracking and this can be initiated during the period of primer exposure before undercoating. Also, prolonged exposure of primed timber, especially during wet months, can enable surface fungi to become established. Thus, even for durable primers there are still strong reasons for limiting the length of exposure before final painting.

Summary of primer performance

Primer A performed well in laboratory tests with the exception of some blistering when a waterborne finishing system was used. After three years' outdoor exposure some flaking had developed, especially associated with panel edges. Otherwise it performed well.

Primer B was deficient with respect to adhesion (particularly wet adhesion) and this was consistent with its poor blistering resistance. It also showed early chalking. After three years' weathering, paint flaking was clearly evident – particularly, close to panel edges.

Primer C was susceptible to blocking. In addition, it allowed some end-grain timber cracking to develop over 26 weeks' exposure. After three years' outdoor exposure panels were virtually free of flaking with the edges in relatively sound condition.

Primer D was also susceptible to some blocking and it caused flash rusting of steel nailheads. Like primer C this primer performed well after three years' outdoor exposure with virtually no flaking and with the panel edges in relatively sound condition.

Primer E allowed some front surface timber cracking to develop over 26 weeks' exposure. Its major defect was the marked development of fungus growth on the primed surface after 26 weeks' exposure. After three years' outdoor exposure some paint flaking had begun, mainly close to panel edges. Panels were otherwise in good condition.

Primer W allowed timber cracking and surface disfigurement to develop. This primer also had poor wet adhesion and caused some blistering. Moderate flaking had developed after three years' exposure.

Primer X allowed timber cracking to develop even after six weeks' exposure. Surface disfigurement occurred after 26 weeks' exposure of the primed surface. Over this primer, paintwork exposed for one year showed some cracking and flaking and deteriorated further after three years' exposure.

Primer Y was clearly the least satisfactory primer with respect to all tests, except blocking and (front) surface disfigurement. The paint had almost no cohesive strength or water resistance.

Primer Z allowed front surface cracking, even after six weeks' exposure, and surface disfigurement after 26 weeks.

The first of these problems appeared to contribute to the failure of the paintwork after one year's exposure.

Acrylic primers

The two acrylic primers used in this study appeared to be almost as effective as any other primers in controlling fluctuations in the moisture content of timber and exhibited good adhesion; the all-acrylic paint systems were especially good in this latter respect.

The superior performance of two-coat acrylic latex paint systems compared with two-coat systems consisting of alkyd primer followed by acrylic latex paint has been reported by Feist²². Vorster²³ also found that an all emulsion-system could be more durable than conventional systems. More recent confirmation of the good performance of all-acrylic paint systems is given by Miller and Boxall²⁴. If the deficiencies of the waterborne acrylic primers C and D can be solved by paint manufacturers, this type of primer appears to have an extremely promising future for unweathered timber. This view is also supported by the study by Emery²⁵. In terms of two properties critical for the protection of wood (adhesion to the timber and to the undercoats; and extensibility) the acrylic primers selected performed very well. These primers are likely to be suitable for extended exposure prior to application of finishing paintwork.

Conclusions

The tests differentiated between the reference and fail control primers used in this study, and also highlighted shortcomings of some of the reference primers. The results of this study are currently being used to assist in an evaluation of commercial wood primers within New Zealand.

The exposure tests in the proposed test programme involve an exposure period of six weeks before topcoating, with an optional period of 26 weeks for primers which are thought to be suitable for extended exposure. The initial assessment of the exposure performance of primers is based on the condition of the primer after weathering. This study showed that an inspection of the topcoated primers after one year's exposure provided little information. However, the early indications of performance obtained from laboratory tests were confirmed by the condition of panels after three year's exposure. Artificial weathering was not found to be an effective means of assessing performance.

The soak/oven procedure to test blistering resistance proved successful in discriminating among primers which are more or less susceptible to blistering, and it is worthwhile including in a test programme. The tensile adhesion tests on wet samples gave useful information and correlated well with the blister resistance tests. Good wet adhesion is important for the long-term durability of a paint system, and is worthwhile assessing. The blocking and flash rusting tests highlighted shortcomings in the performance of some of the waterborne primers, and should be included for such primers. A practical test to evaluate extractive staining has been established should such a test be required in special cases. Extensibility measurements of detached films graphically showed the high extensibility of the acrylic primers used and it appears that this property strongly contributed to the good performance of these primers. Interpretation of extensibility data in practical terms is very difficult, and it is

not possible to recommend any performance levels at this stage. Further development of this technique would be well worthwhile.

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Appendix

Paint Formulations

1. Oil-alkyd, white and red lead primer.
In the formulation used, the linseed oil/glycerol resin specified in BS 5358 : 1976 was replaced with a linseed oil/pentaerythritol resin (Rhodene P2/70).
2. Solvent-borne oil alkyd undercoat:

	Weight %
Titanium dioxide	24.0
Barium sulphate	17.5
Hydrated aluminium silicate	7.5
Silicon dioxide	1.5
Long-oil alkyd	23.5
Linseed oil	1.8
Driers, thinners, additives	24.2
	100%
3. Solvent-borne alkyd topcoat: New Zealand commercial product.
4. Waterborne acrylic undercoat (also topcoat):

	Weight (g)
Pigment dispersion:	
Ethylene glycol	336.1
Tamol 731 5%	71.5
Nopco NXZ	4.8
Titanium dioxide R900	1320.5
Let-down:	
Water	240.0
Rhoplex AC-507	2625.2
Chisso CS-12	88.3
Super Ad-It premix	43.2
Nopco NXZ	4.8
Ethylene glycol	144.0
Ammonia	9.6
Acrysol G-110	48.0
Water premix	112.8
	5048.8g

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The use of pressurized differential thermal analysis to study the kinetics of curing of melamine resins

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Abstract

Pressurized differential thermal analysis has been used to study the kinetics of the cross-linking reaction between hexakismethoxymethyl-melamine (HMMM) and 2-hydroxyethylmethacrylate (2-HEMA).

The Borchardt-Daniels relationship shows that the reaction is first order. The simple equation can be applied to solid-state reactions with only a slight loss in accuracy of the results.

Introduction

Melamine resins are widely used as surface coatings in wood finishes, laminates, domestic appliances and motor cars. They provide hard scratch resistant surfaces in almost unlimited colours. There is, therefore, considerable interest in the mechanism of the curing of melamine resins. The characterisation of cross-linking reactions, however, presents considerable difficulties. One technique that has been found useful in such work is differential thermal analysis (DTA)^{1, 2}. One difficulty in the study by DTA of reactions that involve the evaporation of solvents is that the endotherm of evaporation obscures the cross-linking reaction. To overcome this problem the position of the endotherm may be removed from the temperature of cross-linking by performing the DTA under pressure³.

As the costs of energy continue to rise there is increasing interest in coatings that require less energy for cross-linking. The low bake automotive acrylic paint is an example of a resin medium chosen chiefly because it can be cross-linked at low temperatures. The determination of the minimum cross-linking temperature and the speed of curing of these coatings is of considerable economic importance.

DTA was shown by Borchardt and Daniels to be a suitable technique for the study of the kinetics of the decomposition of benzene diazonium chloride provided that a number of stringent criteria are met⁴. In technological work it is rarely possible to meet all these criteria but useful information may still be obtained⁵.

Experimental

Apparatus

Du Pont 900 Thermal Analyser with High Pressure DSC Head Attachment. Sinclair Spectrum 48K Computer.

Materials

Both the HMMM and 2-HEMA were pure commercial materials.

Method: A 10 to 20 mg sample of the HMMM/2-HEMA

resin was run in a Du Pont 900 pressure DSC head pressurized with nitrogen at approximately 7 MPa (1,000 psig), with an expanded temperature scale of 10°C/in, a heating rate of 1°C/min and a sensitivity of 0.5°C/in.

Data Analysis

The analysis relies on the relationship that the heat of the reaction H is proportional to the area under a DTA curve for that reaction, i.e.

$$H = DA$$

where D is the cell constant, determined by using a standard material with a known heat of fusion as a calibrating medium.

A heat balance on the cell leads to a general equation, which can be simplified to

$$k = \frac{\beta (C_p(d\Delta T/dT) + D\Delta T)}{D(A-a) - C_p \Delta T}$$

for first order kinetics. The equation given is a variation put forward by Manley and Clark for use with temperature based graphs, such as those produced by the Du Pont 900. Of the terms used, k is the reaction rate constant (min^{-1}), C_p is the heat capacity of the sample (JK^{-1}), D the cell constant (JK^{-2}), ΔT is the height of the curve at a given temperature, $d\Delta T/dT$ the gradient at that temperature and a the partial area under the curve up to that point, with A being the total area under the peak, β is the heating rate in Kmin^{-1} and is the new term necessary for use of the B & D equation for temperature based recordings⁶.

Some of the terms in the equation are small enough to be negligible thus a simplified equation may be obtained

$$k = \frac{\Delta T \beta}{(A - a)}$$

The DTA graphs were converted to digital form by means of a BITPAD digitiser linked to a Commodore PET microcomputer. The digital information was then fed into a Spectrum computer. The Spectrum programme utilised the Simpson's Rule equation for calculating the area under the curve and both the simple and complex form of the B & D relationship for calculating the reaction rate for first order kinetics.

Results and Discussion

The actual values for ΔT are given in Table 1 and refer to Figure 1. The calculated values for the log (reaction rate)

Table 1

Digitized form of the pressurized DTA trace for the HMMM/2-HEMA reaction

Temperature	ΔT	Temperature	ΔT
410	0	420.5	.516
410.5	.004	421	.46
411	.01	421.5	.408
411.5	.012	422	.37
412	.014	422.5	.342
412.5	.018	423	.314
413	.022	423.5	.292
413.5	.024	424	.27
414	.040	424.5	.248
414.5	.062	425	.23
415	.102	425.5	.216
415.5	.14	426	.194
416	.226	426.5	.18
416.5	.302	427	.166
417	.412	427.5	.152
417.5	.876	428	.132
418	1.176	428.5	.124
418.5	1.526	429	.112
419	1.636	429.5	.106
419.5	1.650	430	.102
420	0.624		

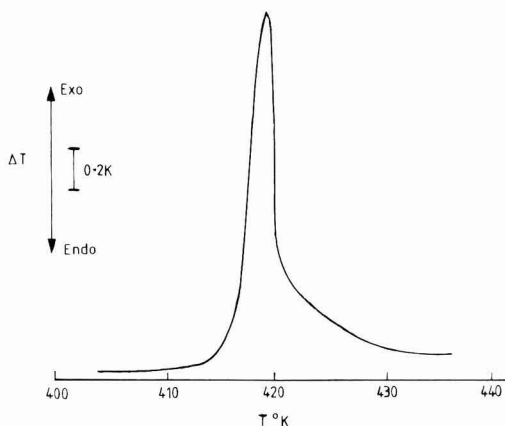


Figure 1. DTA curve of HMMM/2-HEMA mol. ratio 1:6 in nitrogen at 7 MPa. Sample wt 19 mg, heat rate 1 Kmin⁻¹.

determine whether the reaction rate is first order, then it is quite acceptable to use the simple form of the relationship.

Conclusion

The cross-linking reaction for a HMMM/2-HEMA mixture has first order kinetics, with an activation energy of 1430 kJ/mole. The Borchardt and Daniels relationship is a suitable method for studying microsample DSC solid-state reactions, with the complex form being the preferable equation to apply.

Acknowledgement

We thank Berger Industrial Coatings for the supply of materials.

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variable are given in Table 2. The difference between the values calculated by the simple and complex equations is small. Plotting these values against the inverse of the temperature variable gives an Arrhenius plot from which the activation energy of the reaction can be calculated. The value for the simple equation was 1472.8 kJ/mole and for the complex equation 1430.0 kJ/mole, a difference of only 3 per cent. Thus if a study of the kinetics of a reaction is being made it is recommended that the complex equation is used in order to obtain the highest precision possible in the results. However, if a test is being made merely to

Table 2

Calculated values for log of the reaction rate using the simple and complex equation

Temperature	Log Reaction Rate Simple Equation	Log Reaction Rate Complex Equation
413	-6.1662	-6.1299
414	-5.3813	-5.2215
415	-4.2408	-4.1263
416	-3.3389	-3.2335
417	-2.6302	-2.4361
418	-1.3125	-1.1994
419	-0.5134	-0.4162

next month's issue

The Honorary Editor has accepted the following papers for publication in the June issue:

Atomization. A new concept in producing zinc dust for the paint industry by M. Leclercq, Veille-Montagne, Belgium

Moisture and painted wood by B. Lindberg, Scandinavian Paint and Printing Ink Research Institute, Denmark

Midlands Section

Nickel chromium antimony titanate pigments

The fourth technical meeting of the 1985/6 session of the Midlands Section was held on the 20 February 1986 at the Clarendon Suite, Stirling Road, Edgbaston, Birmingham.

Members and guests heard Mr G. Streatfield of *Blythe Colours Limited* give a talk on "Nickel chromium antimony titanate pigments".

Mr Streatfield said that the pigments were based on the mixed metal oxides of titanium, nickel and chromium and antimony or niobium. Nickel is used to give yellow shades and chromium the orange ones. In the titanium dioxide rutile molecule, some of the titanium is replaced by the transition metal giving rise to a lattice distortion and hence the colour. The pigments consist of approximately 85 per cent titanium dioxide and particle size variation gives the hue variation. No new derivatives are possible only better quality. Different pigments may be produced from a new family combination, the best other possibilities are more expensive and duller.

The pigments are produced by mixing the metal oxides then calcining at over 1000°C. Sintered aggregates may be formed during the process and must be removed otherwise grinding difficulties may occur in paint mills. The pigments are then crushed, ground and clarified and it is in this area that most advances have been made in recent years.

The colour intensity of the pigment is due to the amount of nickel or chromium present and the particle size. For the highest gloss a narrow particle size range is necessary, in fact all the properties of the pigments are dependent on the particle size though a compromise has to be made. They have excellent heat stability up to 300°C with very good lightfastness and durability.

The speaker said that on the question of toxicity depending on the test conditions and the limits set, it is doubtful if they would meet the new toy regulations.

With regard to the future Mr Streatfield said that better particle size distribution for better properties, but there is little scope for improvement. It may be possible to modify for gloss and dispersability, but at extra cost. Pigments that are made by co-precipitation methods have little advantage.

B. E. Myatt

Midlands Section— Trent Valley Branch

Exterior wood stains

The Trent Valley Branch of the Midlands Section of OCCA held its meeting as usual, in the British Rail School of Transport, London Road, Derby, on the night of Thursday, 27 February. To an enthusiastic gathering, Mr John Bridle who is the Technical Service Manager of *Cray Valley*

Products Ltd delivered his paper based on the results of extensive investigation into the formulation and performance of exterior, varnish stains. The importance of transparent iron oxide pigments as the key component for UV protection and durability, was fully illustrated with slides and exposure panels.

The role of suspending agents to ensure good shelf life and can appearance was linked with special reference to *Super Gelkyds*.

The contribution of waxes to give water repellency and gloss control, the use of silica, choice of resin and preservations were all discussed with reference to the large series of exposure panels on display, which also formed the main body of evidence on the durability aspects of formulation. *Synolac 6005w* the new flexible alkyd was also introduced as being potentially far superior to conventional alkyds for both varnishes and varnish stains.

Refreshments were provided and a vote of thanks was proposed by Mr M. Hannah.

J. R. Kitchen

Ontario Section

Titanates and zirconates in printing inks

The Ontario Section of the Oil and Colour Chemists' Association met on Wednesday, 26 February 1986, at the Cambridge Motor Hotel, with 26 members and guests in attendance. Mr James Johnston of *Kay-Fryes Inc* (a Division of *Dynamit Nobel Chemicals*) spoke on "Titanates and zirconates in printing inks".

Mr Johnston began by noting that titanate and zirconate esters are used as catalysts, dopants for ceramics, and oil viscosity modifiers, in addition to their applications in printing inks. In inks, they are useful in improving water and heat resistance, and in assisting the wetting and dispersion of inorganic pigments.

The speaker started with a description of the chemistry of these materials, and then went on to show how they react with various types of resins (particularly nitrocellulose and polyamide). The esters are very reactive towards water, and the use of chelate derivatives which overcome this problem was discussed in some detail. Finally, Mr Johnston reviewed the factors leading to the increased use of aqueous flexo, and indicated that some new zirconates currently under development might soon be available to assist the ink formulator in this area as well.

A lively question and answer period followed, and the speaker was thanked by the chairman, Mr Purnell, and by the audience.

The influence of rheology and formulation on small media mill performance

The Ontario Section of the Oil and Colour Chemists' Association met on Wednesday, 19 March 1986, at the Cambridge Motor Hotel with over 40 members and guests present, to hear Mr Leo Dombrowski of *Chicago Boiler*

Company talk about "The influence of rheology and formulation on small media mill performance".

Mr Dombrowski's talk covered the history of the development of media mills, from the first sand mills developed by *DuPont* in 1956 which employed Ottawa sand (from Illinois) as the grinding media, up to the present day where we see a variety of sophisticated vertical and horizontal media mills being used.

His talk described the importance of various parameters in optimizing mill performance and emphasized the importance of proper formulation to maximize mill efficiency. Among the many parameters controlling milling efficiency were: rheology of the paste being dispersed, mill speed, media size, specific gravity, and the ratio of media volume to mill base volume.

A lively discussion thus ensued after which the vote of thanks was given by Mr Tom Crooks.

P. Marr

Thames Valley Section

Avon Cosmetics visit

A visit by members of the Thames Valley Section to *Avon Cosmetics*, Northampton, took place on February 13 1986.

The meeting began with an excellent buffet supplied by our hosts. Then followed a comprehensive tour of the site which included the production plant, raw material stores and filling lines.

Later in the evening Mr Alan Moss gave an interesting talk which included the history, manufacture and raw material requirements of the perfumery industry.

The talk covered other aspects of perfumery which are not immediately identified with this industry, one of which is a scheme to assist in the education of blind children using the method of association of a fragrance and an unseen object.

J. A. Gant

Hull Section

Titanium dioxide optimisation

The fourth technical lecture of the session was presented by Mr Tim Edwards, a Regional Technical Service Manager of *SCM Chemicals Limited*, at the Duke of Cumberland Hotel, Cottingham on 6 January 1986. Speaking on the subject of "Titanium dioxide optimisation", Mr Edwards began by discussing how the number of specialist grades available had contracted over the years, to be replaced by the new generation of multi-purpose pigments. In consequence, there has been a steady move towards 'single' grade usage and bulk handling either in one tonne bags or tankers for major consumers.

Ease of dispersion is essential for multi-purpose designs and can significantly influence manufacturing costs with respect to energy requirements during processing. The

speaker described one particular pigment grade, *Tiona 535*, as having excellent wetting properties and ease of dispersion. This claim was supported by experiments carried out in SCM laboratories over seven years and involved measuring the current requirement of a high speed mixer when dispersing TiO_2 at a constant shear rate, in a long oil alkyd resin. Experiments had been conducted under controlled, cooled conditions and the current drawn by the electric motor was plotted by a chart recorder. Fifteen commercially available pigment grades were screened in this way and results indicated *Tiona 535* to have outstanding dispersion properties, giving a high mill loading, short processing time and reduced energy costs in manufacture.

After a demanding question time Mr J. Wenham proposed a vote of thanks to which the audience warmly responded.

P. A. Bentley

Bristol Section

The Section has had an excellent selection of lectures held initially at the George and Dragon, High Street, Winterbourne, and later due to the retirement of the manager further lectures at this venue were not possible and the meetings had to be held at the Compass Inn, Tormarton, Badminton, Avon.

The lectures were given under the chairmanship of Maurice Prigmore and were generally well-attended especially those having buffets.

Fluorescent pigments

The first lecture on 24 September 1985, was given by Mr P. Ryan of *Swada (London) Ltd*, on "Fluorescent pigments". The lecturer gave examples of the value of these pigments and the most suitable type of resinous media necessary to give prolonged service and maximum fluorescence. The use of these pigments for printing on such cartons as those used for washing powders and their impact on the eye of the customer was illustrated. It was stated that a poster printed with fluorescent pigment colours was seen 24 per cent sooner than a non-fluorescent type. On average, fluorescent posters attracted 60 per cent more attention.

The work of Long Aston Research Station

The second lecture on 29 October 1985, was given by Dr R. K. Atkin of the Long Aston Research Station. This was selected as the Ladies' Evening Lecture and a most interesting talk on the initial work of the station and the changes in the type of work now to be undertaken was given. In the early days the station was mostly devoted to apples and cider preparation. This industry is still studied to a limited degree at the present time. Their present day work is on cereal crops and, as such, horticulture in place of trees. The growing of new crops which are economic on impoverished land such as willows for use over marginal land is studied. Subjects such as the use of weedkillers and their degrading of the green portion of the plant were explained. There were many questions asked by the

audience, including the chemistry of the addition of such adulterants as antifreeze to wines.

The evening concluded with a buffet.

Corrosion—the vulture of metallurgy

The third lecture on 26 November 1985, was given by Mr Clarke of The Sir John Cass Institute on “Corrosion—the vulture of metallurgy”. The meeting was well-attended and the lecturer presented the subject in his well-known manner. The design of structures which encouraged corrosion was clearly demonstrated by slides of corroding bridges and other buildings.

The lecturer answered many questions on his talk.

Ethoxypropanols a substitute for ethyl glycol ethers

The second session on 28 January 1986, commenced with a lecture in the new venue of the Compass Inn at Tormarton and was given by Dr Zain Dawoodii of *BP Chemicals Ltd*. This lecture on “Ethoxypropanols a substitute for ethyl glycol ethers” was very informative. The possible need for changes in formulations containing ethylene glycol derivatives of these solvents due to the present belief that the latter solvents may cause bone marrow damage, testicular atrophy and tetrogenity damage was described. The properties of the propyl derivatives of the solvents now being introduced were clearly demonstrated by a series of excellent slides including their effect on volatility and solvent power in paint formulations. Information sheets were made available to those present. The lecture was well-attended despite the snow fall. *BP Chemicals Ltd* are to be thanked for providing an excellent buffet.

Inorganic pigments for anticorrosive finishes

The last lecture in the session on 18 March 1986, was on “Inorganic pigments for anticorrosive finishes” by Dr W. Schleusser of *Bayer AG*. Again the lecture was well attended with over 30 people present. The lecture covered the whole range of inorganic pigments manufactured by his company. The pigments discussed included lead chromates, iron oxide and yellow iron oxide types, black iron oxide, brown oxides and cadmium colours and titanium dioxide. Inorganic anticorrosive pigments of the zinc ferrite types and experimental modifications of some of their range were also mentioned.

A vote of thanks was proposed by Mr D. Newton. A buffet was provided by *Bayer AG* to which thanks are due.

J. R. Taylor

Newcastle Section

Design and use of the flocculation gradient monitor

The fifth meeting of the 1985/6 session was held on 6 February 1986, at the Central Laboratories of *Tioxide UK Ltd*, when 31 members heard a paper by Mr D. J. Rutherford of *Tioxide UK* on the “Design and use of the flocculation gradient monitor”.

Flocculation occurs when stabilizing forces are too weak to maintain dispersion. Mr Rutherford discussed paint defects caused by flocculation e.g. low hiding power, poor colour stability and reduced weatherability. Previous methods to measure flocculation have been time-consuming, inaccurate and highly suspect. The flocculation monitor was developed by *Tioxide* personnel to provide a quick, simple method of assessing dispersion efficiency, and is now in general use in *Tioxide* laboratories. An instrument manufacturer is now marketing a compact model for use as a general/Q. A. instrument by the surface coatings industry.

The flocculation monitor measures the IR reflectance (back-scatter) of wet or dry pigmented films at 2.5 μm wavelength. Reflectance varies directly with particle size and, at 2.5 μm incident wavelength, well dispersed paints give low back-scatter, whereas highly flocculated paints give high values. By plotting back-scatter at varying film thickness a straight-line graph is produced, the gradient of which indicates the degree of flocculation—lowest gradient, best dispersion.

Mr Rutherford demonstrated the use of the original instrumental arrangement, which included a large spectrophotometer, and the smaller instrument designed and developed by *Tioxide*. A series of gloss paints at 17.5 per cent PVC, containing varying amounts of flocculating agent, was used to illustrate the method. Graphs of difference properties were plotted against flocculation gradient—contrast ratio, gloss, colour strength, weight loss on weathering etc. These clearly showed the potential of the technique in optimising formulations and controlling production batches of paint.

In the question period Mr Rutherford discussed the testing of mill bases before let-down, the variability of flocculation gradient values due to normal composition variation in production batches, reproducibility of values, dilatancy, standardization of let-down procedures and the advantages of the technique over the simple fineness of grind measurements.

The vote of thanks to the speaker for an interesting lecture and to *Tioxide UK* for their hospitality was given by the Section Chairman, Mr R. G. Carr.

Non-automotive applications of paint electrodeposition

The sixth meeting of the 1985/6 session was held on 6 March 1986 when 35 members heard a talk by Mr Peter Hope of *LVH Coatings* of “Non-automotive applications of paint electrodeposition”.

Mr Hope began by reviewing the history of ED coatings from the original 1930's *Crosse & Blackwell* beeswax-based interior can linings, through the 1940's phenolic-based wire coatings to the applications by *Ford Motor Co* and others in the 1950's/1960's, when many of the previously unsolved ED problems were overcome in the race to overcome box-section corrosion first.

He showed how the reactions at the electrodes during

ED cause coagulation of emulsified coatings at either the anode or cathode, depending on the type of resin systems used; anodic or cathodic. In practice, the article to be coated is made the anode or cathode and the coating suspension forms the bath in which it hangs: on passage of current the coating liquid locally coagulates on the article surface in 2-3 minutes. The coagulation electrically insulates the area on which it deposits, shifting deposition elsewhere—this “throwing power” results in an even coating of 15-25 μm over intricate shapes and in shielded areas.

With anodically deposited coatings on steel, anode acidity causes dissolution of iron which can discolour pale coatings: aluminium substrates do not give this problem. Cathodically deposited (CED) coatings do not discolour on steel and give excellent performance on brass. Mr Hope showed slides illustrating the use of CED coatings for efficient coating of complicated shapes—plug sockets, door locks, lipstick holders, bath handles; window stays form a very big market for tinted CED coatings. Further slides showed jewellery and decorative metal currently protected by acrylic melamine and polyurethane ED coatings. Finally, anodised aluminium extrusions for patio doors were shown being coated at 20-25 μm thickness: some 7 million square metres are coated annually with acrylics. Polyurethane ED coatings are now available which, at 40 μm , equal the performance of much thicker powder coating films.

Mr Hope reviewed other areas of non-automotive applications currently supplied by ED coatings e.g. central heating radiators (same total area as car bodies!), air-conditioning equipment, scaffolding etc. More recently, electronic parts are being ED coated. Newer coating types include materials such as PVF₂ and silicone polyesters.

During an extended question time, Mr Hope discussed ED coating of double glazing, powder suspension coating, problems of ED bath control (solids/stability, ultra-filtration), toxicity of co-solvents and coating defects due to electrode contact with jigs.

The Chairman, Mr R. G. Carr, thanked Mr Hope for a most entertaining and highly informative presentation.

J. Bravey

Manchester Section

Silicone copolymer resins—established and newer types

Forty-six members and guests attended the sponsored lecture on “Silicone resins”, presented to the Manchester Section by *Croda Resins*, at the Pack Horse Hotel, Bolton, on Monday, 3 February 1986. The lecture was presented by Tony Cheeld aided by Charles Muscuin, John Martin and Fred Page.

The lecturer initially outlined the basic history and diversity of *Croda International*, who have a trading base in 17 countries and manufacturing facilities in 14.

Next, the basic types of silicone resins currently available were described, these being divided into three main types:

- Silicone Oils
- Silicone Resins
- Silicone Copolymers

Croda are specialists in silicone copolymers, in which silicone intermediates are reacted with other organic components, the aim being to improve heat resistance, and weathering properties, with only a moderate increase in cost.

The lecture continued by outlining the properties of established silicone copolymer systems. Silicone alkyds have double the exterior durability of conventional alkyds, therefore, since most of the cost of painting is in surface preparation, scaffolding, and application, the higher cost of silicone based materials has only a marginal effect on overall cost, and by extending coating life, is in effect much cheaper to use. Silicone Polyesters are available which contain between 20 and 60 per cent silicone modification, primarily, their advantage lies in much higher heat resistance in service.

Two newer products were outlined in detail. A silicone/urethane had been developed, initially for British Rail rolling stock. The product was required to air dry quickly (1 hour) and be white spirit soluble. The other product described was a silicone polyester based on silicone intermediates with a higher silicone content, so that cost reductions can be made without reducing silicone content or performance.

Other new fields in which silicone copolymers are being introduced were briefly outlined, these were:

- Release coatings for the baking industry
- Silicone Polyesters for powder coatings
- UV Curing
- De-inking resins

Future trends and developments will progress from requests by end users and paint manufacturers for coatings which match their particular requirements.

Regarding health and safety, silicone copolymers are toxicologically safe and there are no handling problems, in fact they are as easy to use as other coating systems.

After a question and answer period, a vote of thanks to Tony Cheeld and his associates was proposed by Mike Langdon.

Chips with everything

One-hundred-and-thirty members and guests attended the sponsored lecture on “The manufacture and use of pigment chips”, presented to the Manchester Section by Fred Morpeth (Section Vice-Chairman) of *Foscolour Ltd*, and held on Monday, 17 February 1986, at the Silver Birch in the Birchwood Centre, near Warrington.

The lecturer outlined briefly the history of the industry

occa meetings

which dates back to about 1930 and employs manufacturing techniques based on the rubber milling industry.

Pigment chips are concentrated dispersions of pigment, in solid resin, produced under high shear, in the moulten or high viscosity solution state, on twin-roll mills. The two techniques are wet milling and dry milling. *Foscolour* use only the dry milling technique, in which the components are fed directly into the nip between the two rollers. Wet milling (where the product is pre-wetted into a paste) is less hazardous for the production of nitrocellulose chips, but dry milling, by using higher viscosities, gives greater efficiency, better dispersion, shorter and more flexible processes, with greater cost.

In the formulation of pigment chips, the customer requires superior gloss, transparency, colour strength, ease of solubility and maximum pigmentation. The manufacturer has to compromise to some extent on these factors, in order to balance the four pigment and resin properties as outlined, which influence chip manufacture.

More difficult	dispersion	easier
Hard	pigment texture	soft
Low	oil absorption	high
Low	resin melt viscosity	high
Poor	resin wetting properties	good

Judicious use of wetting agents and plasticiser is possible, but these are best omitted, and at worst minimised, to avoid unwanted side effects.

In comparison with other forms of colourants, pigment chips have the advantages that they can be produced from almost any resin and pigment, dissolved on simple equipment, and yield a standard of gloss, colour, transparency and colour development not generally attained by more conventional systems. Although not cheap due to the slow labour intensive process involved, this can be compensated for in many cases, because of increased throughput and colour strength.

Pigment chips can be used instead of raw pigment for any surface coating application. The traditional market is liquid printing inks, and automotive re-finishing paints. They are increasingly being used in wood finishes and powder coatings.

After an interesting and lively question and answer period, a vote of thanks was proposed by the Section Secretary Stewart Heyes.

Confessions of a small paint maker

On Monday, 3 March 1986, ninety members and guests of Manchester Section met at the Manchester Club for a dinner lecture entitled "Confessions of a small paint maker" by David Penrice of *Newtown Industrial Paints*.

This highly amusing talk on the various facets of a small paint company was illustrated with a series of slides, which much to the audience's enjoyment, appeared to be primarily concerned with the merits of a scantily clad

member of the fair sex, rather than the equipment which was kept well into the background.

After a short period for questions primarily aimed at obtaining the model's name, address and telephone number, a vote of thanks was proposed by Bill Borrell and warmly approved by all present.

Quality control of organic pigments for paint and printing inks

On Monday, 17 March 1986, eighty-nine members and guests of Manchester Section attended a sponsored buffet lecture at the Pack Horse Hotel, Bolton. The lecture entitled "Quality control of organic pigments for paint and printing inks", was presented by Dr S. G. Lawrence of *Ciba-Geigy Pigments Division*, Paisley, and Scottish Section Vice-Chairman.

Dr Lawrence initially outlined the problems associated with a batch of pigment which was not within specification, these being:

1. Lost plant time
2. Raw material used up
3. Customer supply problems
4. Demotivated work force
5. Interdepartmental friction

Dr Lawrence then went on to emphasize that process control is the first step in quality control, and that controlling the manufacturing process ensures the material has the best chance of being within specification.

Taking Pigment Yellow No 3 as a basis, Dr Lawrence outlined how controlling flow of reactants, temperature, pH and rate of stirring, can be used to control the quality of the product. In this particular process, large quantities of sodium chloride are produced, therefore by monitoring this it is easy to control the washing stage. Filtering is a simple standard process, however, as too much heat degrades the pigment, drying has to be controlled, and this is carried out using heat sensors.

In order to ensure the product is suitable for sale, it is tested against a standard sample. Normally 200 to 300 kilos of standard product is retained, which is stored in a special room, to which there is only limited access.

The properties investigated are:

- Colour strength
- Gloss
- Opacity/Transparency
- Flow
- Shade
- Level of dispersion

The test methods used have to be of accurate reproducibility and the product will be tested essentially in the type of system it will normally be used.

To conclude the lecture, Dr Lawrence briefly outlined the various manufacturing and test methods employed for

quality control, and the pros and cons of each of the methods described.

To summarise, requirements for quality control are:

- Process control
- Product control in comparison with a standard sample

The lecture was followed by an extensive and lively question time, and the vote of thanks was proposed by Mr David Clayton.

M. G. Langdon

reviews

Aromatic Diazo Compounds

by **K. H. Saunders and R. L. M. Allen**
Edward Arnold Ltd, London, 1985 (third edition),
pb899, £90 hardback, ISBN 0-7131-3499-2

Aromatic diazo compounds form the largest class of intermediates used in making colouring matters; they also undergo many diazo-exchange and -coupling reactions to give a wide range of chemicals often inaccessible by other methods. Such applications in chemical synthesis are still increasing.

First published in 1936 Saunderson's "Diazo Compounds and their Technical Applications" rapidly became a classic. Mr Saunders died in 1975 before completing a projected third edition; fortunately his long-time colleague at ICI Organics Division Dr R. L. M. Allen took on the task of completing the review of recent work and writing this third edition, largely within the framework envisaged by Mr Saunders. The end result is an excellent book providing a comprehensive account of diazo chemistry and conveying the high enthusiasm of both authors for their subject. It is an essential source book both for those having a serious interest in colour chemistry and for practising organic chemists in general. For the latter it provides many practical details for experimentalists as well as sources of stimulation for those seeking new routes to particular compounds or new applications for recently developed materials.

Chapter 1 reviews the six most important methods for diazotisation with illustrative examples. The following two chapters discuss the mechanism of diazotisation, the constitution of diazonium ions, their (in)stability and methods for their stabilisation and safe isolation in the solid state (p 151 lists twenty of the commercially available stabilised diazonium salts).

Chapters 4 to 16 deal systematically with the reactions of diazo compounds, beginning with further substitution of the arenediazonium nucleus (chap 4), oxidation and reduction of the diazonium group (chap 4), co-ordination of arenediazonium ions with hydroxyl, cyanide, sulphite and sulphanyl anions (chap 5).

The next two chapters review intermolecular coupling reactions of arenediazonium compounds—with phenols, naphthols, thionaphthols, arylamines, etc (chap 6), and

with amines to give linear triazens and pentazens and with hydrazines to get tetrazens, tetrazoles and hexazens. (chap 7).

Intramolecular coupling of diazonium compounds provides a route to indazoles, cinnolines, benzo-1, 2, 3-triazoles, benzo-1, 2, 3-triazens, benzotetrazines, benzo-1-thia-2, 3-diazoles and benzothiadiazine derivatives (chap 8).

Chapters 9 and 11 review the decomposition of diazonium ions to give reactive species for intermolecular arylation—of (substituted) aromatic hydrocarbons to give biaryl compounds (Gomberg Reaction)—of activated olefins (Meerwein Reaction)—of aliphatic oximes, followed by hydrolysis to secure araldehydes or alkyl aryl ketones (Beech's Reaction).

Chapter 12 discusses many examples of intramolecular arylation (through elimination of the diazo group) to secure 4, 5 and 6 membered rings e.g. fluorene, carbazole, dibenzofuran, dibenzothiophene, phenanthrene and phenanthridine derivatives.

Four chapters cover the well-known, and many lesser known diazo replacement reactions; replacement by hydrogen (in chapter 10), by NO₂ (in chapter 13), by phosphorus, arsenic, antimony, bismuth and metal linkages (chapter 14) by oxygen, sulphur, selenium and tellurium substituents (in chapter 15) and by halogens (chapter 16).

The concluding chapter 17 reviews the photochemical decomposition reactions of diazo compounds and their application in one of the earliest of office photocopying methods.

Despite its enormous and authoritative coverage the book is eminently readable—if not cover to cover at least selectively. Even its efficient index is "browsable" disclosing for example that full or indicative details on the diazotisation of about one hundred amines are provided also that diazo compounds are involved in thirty of the Name Reactions of organic chemistry involving fifteen letters of the alphabet.

Even in these inflationary times the price of the book seems rather high which will unfortunately inhibit many practising chemists who might otherwise like to add it to their personal bookshelves.

G. de W. Anderson

Elcometer factory opening

A new factory built for *Elcometer Instruments Ltd* of Manchester was recently opened by HRH The Duke of Kent, Vice-Chairman of the Board of Overseas Trade. *Elcometer* specialise in producing measuring instrumentation for the surface coatings industry and the new factory will be used for printed circuit board electronic component assembly.



HRH The Duke of Kent opening Elcometer's new factory with Managing Director Mr I. C. Sellars (left).

New milling test facility

Glen Creston Ltd of Stanmore, the UK suppliers of mills has completed installation of their new milling test facility in London NW9. The building houses laboratory, pilot and production mills. Production dry mills on show include pinned-disc, swing hammer, blast and stud/peg mills.

Jodrell Bank telescope refurbishment

Manchester University's 250 ft diameter radio telescope at Jodrell Bank has been refurbished using Ferrozinc. This compound is a rust converter produced by *H Marcel Guest Paints Ltd* of Manchester.

Health and Safety new arsenic controls

The Health and Safety Commission has stated that the present recommended exposure limit (set to 0.2 mgm⁻³) should become a control limit on 1 January 1987. Inorganic arsenic compounds are used to make copper chrome arsenate (CCA) wood preservatives.

Sheen on the move

Sheen Instruments Ltd have moved from Richmond, Surrey, to larger premises at 8 Waldegrave Road, Teddington, Middlesex. The new factory and offices are situated in the grounds of the Paint Research Association.

Norplex acquisition in Singapore

Norplex (a unit of the *US Group Allied Signal Inc*) has acquired the laminate business *Bakelite South East Asia* based at Gul Circle, Jurong from *BP Singapore Pte Ltd*.

News in brief

Degussa AG of Frankfurt am Main, W Germany has acquired *Phillips Petroleum's* carbon-black plants in Europe whose total production is 330,000 tons per year.

Quality Rubber Products Inc of Santa Cruz, USA will be US distributor of *John Chubb Instrumentation* (Gloucester) electrostatic instruments.

Penarth Research Laboratories Ltd of Eastleigh has been formed to investigate building materials.

Buckingham Coatings Ltd has commenced paint production in Buckingham at a new £7 m factory jointly financed by *C H Industrials* and *Petrofina Ltd*.

Glaserit Valentine of West Drayton has become suppliers of refinishing products for Vauxhall-Opel cars.

Air Products Ltd of Walton-on-Thames are to supply *Eli Lilly* the French chemical company with solvent resistant containers.

DSET Laboratories of New River, Arizona, USA, has formed a new research division called The Research and New Business Development Group.

products

Anti-skid surface

Mebon plc of Nottingham has introduced *Epok Tread*, a new anti-skid surfacing system designed for under-foot safety in industrial environments. The system is produced in both screed and tile form without the need for grit blasting. Pedestrian walkways can be made on oily, damp and rusty steel surfaces such as to be found in offshore oil and process industries, shipdecks and aircraft loading areas.

Reader Enquiry Service No. 30

Airless handgun

Ransburg-Gema UK Ltd has available the new *Ransburg Electrostatic Mix* (REM) gun which combines the principles of air and airless atomization with cascade style integrated power supply. Transfer efficiencies are stated to be ninety per cent.

Reader Enquiry Service No. 31

Bolt-on-Sims system

VG Scientific Ltd of East Grinstead has introduced a secondary ion mass spectrometer (SIMS) for surface analysis. The technique uses a beam of low energy ions to erode atoms from the sample surface into the vacuum where they are analysed by a mass spectrometer. Detailed chemical information is provided in the characteristic fragmentation patterns obtained in the mass spectra.

Reader Enquiry Service No. 32

Glass coating process

Vapocure Ltd of New South Wales, Australia, has announced a new glass coating process. This process enables the manufacturer to produce a clear flint glass container to which the appropriate coloured coating is applied. One of the useful properties of the coating is the containment of glass fragments on dropping as shown below.

Reader Enquiry Service No. 33



Vapocure structural coating

Fine impact mills

Alpine Process Technology Ltd of Runcorn has available a new range of fine impact mills called the 100 and 160 *UPZ*. These mills designed for laboratory/pilot production have interchangeable grinding media.

Reader Enquiry Service No. 34

Rectangular solvent containers

Air Products Ltd of Walton-on-Thames has now available 1 litre size solvent resistant polyethylene containers with a new rectangular cross-section.

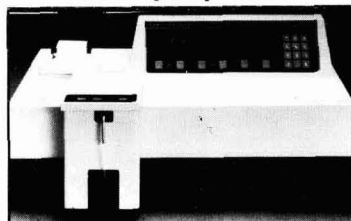
Reader Enquiry Service No. 35

New analytical spectrophotometer

Philips Analytical, Pye Unicam of Cambridge (UK) has announced a new type of single beam spectrophotometer. The UV/VIS/NIR PU 8620 succeeds the PU 8600. One of the instrument features is its large wavelength range from 195-1,100 nm. Other features include solid state, diode detector, fast operation, non-volatile method storage and automatic self test.

Reader Enquiry Service No. 36

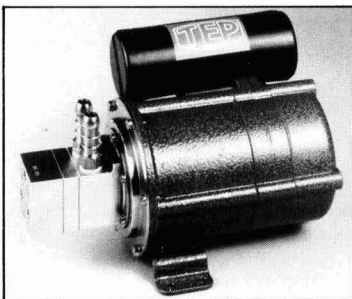
PU 8620 Spectrophotometer



Gear pump

Totton Pumps Ltd of Southampton has available a new gear pump (PPG) designed to handle water-based dyes, acids, lacquers, ether compounds and aggressive fluids. The pump is designed for high pressure, low flow applications (max press 70 psi, max flow 1.8 litres/minute). The use of magnetic couplings ensure a leak-free operation.

Reader Enquiry Service No. 37



Magnetically driven gear pump

Filling system

Beltron Corporation of Red Bank, New Jersey, USA, has developed a new automatic filling system called the *Spectrum 1*. This system uses an ultrasonic probe to control fill height and accommodates containers from ¼ pint cans to 55 gallon drums.

Reader Enquiry Service No. 38

Plastic paint cans

Metal Box PLC of Reading has now available 1 litre *Polycans*, made of polypropylene with an anti-static additive for water-based products. A patented anti-slop feature assists easy filling and provides a surface for paint brush wiping.

Reader Enquiry Service No. 39



1 litre Polycans

Box oven

Mindon Engineering of Nottingham has developed a new gas fire batch type stoving oven (M2000) for industrial finishing. Heat

(2 therms) is provided by a rear-sited burner assembly and circulated by a vertically mounted fan. Its back panel has a built-in explosion relief and a 6" diameter duct for fume extraction.

Reader Enquiry Service No. 40

Matting agents

Crosfield Chemicals of Warrington (a member of the Unilever Group) has introduced the HP200 silica based matting agents. They combine high pore volume with precise control of particle size distribution and can be used in finishes for wood, metal and fabric.

Reader Enquiry Service No. 41

Conductive inks

Hart Coating Technology of West Midlands has available a new range of Novamet particulate metallic products as an alternative to the expensive pure silver used in polymer thick film systems. Uncoated *Novamet* nickel conductive spheres are available in two size ranges, ten and sixty microns.

Reader Enquiry Service No. 42

literature

Additive guide

Byk-Chemie GmbH has produced a pocket-sized Byk-Additive Guide for paint and laboratory technicians. Additives for various types of binder are outlined. The guide is available in German, English and French from: Byk-Chemie GmbH, Abelstrasse 14, D-4230 Wesel, W Germany.

Chemicals catalogue

Johnson Matthey Chemicals Ltd has available a new catalogue on its full product range. Copies obtained from: Johnson Matthey Chemicals Ltd, Orchard Road, Royston, Herts SG8 5HE.

Tankstore leaflet

Felixstowe Tank Developments has available a six-page leaflet on its range of tank storage services available at the port for minerals, plastics, chemicals and petroleum. Copies can be obtained from: Mr R Hopkins, Felixstowe Tank Developments Ltd, FTD House, The Dock, Felixstowe, Suffolk, IP11 8RY.

Analytical reagents catalogue

The 1985/6 edition of *Dojindo Laboratories catalogue* of chemicals and biochemicals is available from: Ubichem Ltd, 281 Hithermoor Road, Stanwell Moor, Staines, Middlesex TW19 6AZ.

Timber finish colour card

A 4 × A4 colour card showing the full range of *Butinox* wood finishes including the new *Butidekk* (water based acrylic wood finish) is available from: Mike Todd, *Butinox* Timber Finishes Ltd, Monzie, Crieff, Perthshire PH7 4HE.

Wood protection brochure

Glasureit Beck (a member of the BASF Group) has produced a new colour brochure on Lasutect, its wood protection system. This is available from: Glasureit Beck Ltd, Slinfold, nr Horsham, West Sussex RH13 7SH.

meetings

Maintenance painting conference

The international conference of the Steel Structures Painting Council (SSPC) of America on "Industrial Maintenance Painting" will be held at the Post House Hotel, Heathrow from 20-22 May 1986. Further information: Conference Organiser, ITI Anti-Corrosion, ITI House, 177 Hagden Lane, Watford, Herts WD1 8LN. Tel: 0923 47311.

Concrete protection conference

Thames Valley Section of OCCA are organising a one-day conference on "Reactive Surface Treatments for Concrete" to be held at Brunel University on Friday, 4 July 1986. Further details and registration form from: Hon Secretary, Brian Gregory, Tioxide UK Ltd, 10 Stratton Street, London W1A 4XP.

Adhesion and polymeric coatings courses

The Continuing Education Institute of Europe will be presenting two short courses. The first on "Adhesion and adhesive joints for the automotive and aircraft industry" will occur on 16-20 June, 1986, at the Munkebjerg Hotel, Vejle, Denmark. The second on "Polymeric Coatings: Binders, Pigments and Paints" will occur on 6-10 October, 1986, at the Mercury Hotel, Nieuwegein by Utrecht, The Netherlands. For further information contact: CEI-Europe, Rörstorpsvägen 5, S-612 00 Finspang, Sweden.

BPVLC symposium

The Birmingham Paint, Varnish and Lacquer Club, will be holding a symposium on "Management and investment required to achieve coatings laboratory efficiency-miracle". This will be held at the Strathallan Hotel, Hagley Road, Birmingham, on Thursday, 22 May 1986, commencing at 10 am. The charge, including luncheon, to members of either BPVLC Club or OCCA will be £28 each;

non-members will be charged at £35 each. Further details are obtainable from John Hitchin, c/o W Canning Materials Ltd, Great Hampton Street, Birmingham B18 6AS.

FATIPEC congress

XVIII FATIPEC Congress will be held in Venice from 21-26 September 1986, on "The scientific developments in the coatings and printing ink industries on the doorway of the 21st century". The Association has a number of registration forms available on request from Priory House. Applications in writing or telex 922670 (OCCA G).

Radiation curing symposium

A symposium on "Radiation Curing of Polymers" organised by the Royal Society of Chemistry Industrial Division will be held at Lancaster University on 18-19 September 1986. Further details from: Dr D R Randell, Ciba-Geigy Industrial Chemicals, Tenax Road, Trafford Park, Manchester M17 1WT.

people

John L MacMillan has been named president of Toronto-based *PPG Canada Inc*, a wholly-owned subsidiary of PPG Industries which operates flat glass, architectural metals, coatings, chemicals and potash production facilities in Canada.

Brian Davies has been appointed Group Managing Director of *Berger, Jenson & Nicholson*.

John Mabforth has been appointed as European General Manager for *Airopak Containers, Air Products*.

Brian Scott has been appointed General Manager of *AMF Cuno-Europe*, Division Filtration Industrielle of Levallois-Perret (France).

Ray Parkinson has been appointed Installation Manager for *Binks-Bullows Ltd*.

Peter Burns, Chairman of *Crown Paints* has been appointed to the board of *Reed International PLC* as Chief Executive of Paint & DIY operating group of Reed International which comprises, Crown Paints, Polycell UK, Europe and USA, General Paints in Vancouver and Parker Paints and Frazee Industries in the USA.



Peter Burns

OCCA news

Annual General Meeting 1986

The 1986 Annual General Meeting of the Association will take place on Wednesday, 18 June, at the Unicorn Hotel, Prince Street, Bristol, and will be preceded by a Reunion Luncheon to which Past Presidents, Past Honorary Officers and Honorary Members of the Association are invited as the Association's guests.

Following the Luncheon an illustrated talk will be given by a speaker from the *SS Great Britain Project* which will deal with the work of restoration and the problems of corrosion involved in this important project.

This talk has been arranged by the Bristol Section of the Association and it is felt that members of the Association will be most interested in the talk on this project, and those visiting Bristol for the AGM may like to take this opportunity to go and see the *SS Great Britain* on the same day.

The Unicorn Hotel has agreed on a special rate for any member attending the AGM wishing to stay overnight either on Tuesday 17 or Wednesday 18 and those wishing to avail themselves of this facility should write to the Unicorn Hotel, stating that they are attending the Association's

Luncheon Lecture in order to obtain the preferential rate.

Forms of application for the Luncheon will be sent to members with the 1985 Annual Report in this issue.

Provided there are sufficient members wishing to participate it may be possible to arrange a guided tour of the *SS Great Britain* at 10.00 am on the morning of the

AGM (18 June 1986) and applications for the visit should be made at the same time as application for luncheon tickets.

Ontario Section

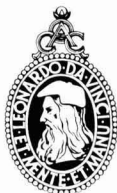
Tenth Annual Dinner Dance

The Ontario Section marked another milestone on 15 February 1986, the



Ontario Section Committee members at the tenth Annual Dinner Dance: from left to right, Peter Birrell, Frans Grootveld, Bob Purnell, Shirish Patel, John Ambury, Doug Pratt, Mike Hazen and Alan Gray.

OIL & COLOUR CHEMISTS' ASSOCIATION



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by J. W. Nicholson, BSc, PhD, CChem, MRSC, Laboratory of the Government Chemist.

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Basic principles of water-borne coatings — the nature of water — principles of solubility/dispersability in water — emulsions and dispersions — electrodeposition — principles of electrodeposition — polymers for electrodeposition — the change from anodic to cathodic electrodeposition — pigmentation of paints for electrodeposition — emulsion paints — film formation by emulsion paints — polymers for emulsion paints — formulation of emulsion paints — latex paints for corrosion protection — gloss emulsion paints — recent developments in water-borne coatings — developments in water-soluble resins — developments in cross-linking reactions — flash-rusting inhibitors — aqueous powder coatings.

To Oil & Colour Chemists' Association, Priory House, 967 Harrow Road, Wembley, Middlesex, HA0 2SF.

Please send . . . copies of Monograph 2, **Water-borne Coatings** at £7.50 each (surface mail) (US \$18.00)

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occasion being the tenth Annual Dinner Dance.

Although there were many new faces, and an encouraging number of young ones, some celebrants were present for the tenth consecutive year. The attendance again broke the previous record. (The 1985 calendar year, just finished, was also a record: the first year in which the Section's membership was over 100.)

It becomes difficult to describe this event in successive years without being repetitive. The Old Mill setting was perfect, the meal was excellent, the dance music was delightful, the prizes were generous and imaginatively selected (with thanks to Mr and Mrs Brian Haick), and the company was cheerful and stimulating.

A highlight of the evening was the presentation of the Section's very first "Commendation Award", which is to be bestowed at the discretion of the committee "with deepest gratitude for outstanding meritorious service in the promotion of the aims and objectives of the Ontario Section". This year's recipient, a unanimous choice, was Mr Peter Birrell, FTSC. Mr Birrell is considered to be the principal founding member of the Ontario Branch and Section. He was its first Honorary Chairman, and remains active in the office of Representative on Council and as a senior member of the Professional Grade Committee.

Mr Bob Purnell, Chairman and master of ceremonies, presented Mr Birrell with a framed certificate bearing the signatures of all the current executive and committee members, and with an engraved silver tray. Mr Birrell accepted the award in his usual gracious manner, reviewing briefly the accomplishments of the Section and its members, and paying special tribute to Mr Herbert Worsdall for his encouragement and assistance.

J. F. Ambury



At the Newcastle Section Annual Ladies' night. Front row (left to right): Mrs Fuller, Mrs Fell, Mrs Redman, Mrs Carr, Mrs Arbuckle, Mrs Smith and Mrs Wright. Back row (left to right): Mr H. Fuller (Social Secretary), Mr J. G. N. Smith (Honorary Treasurer), Mr A. W. Fell (Chairman, Thames Valley Section), Mr F. B. Redman (President), Mr R. G. Carr (Chairman, Newcastle Section), Mr K. H. Arbuckle (Chairman, London Section), Mr T. Wright (Chairman, West Riding Section).

Newcastle Section

Annual Ladies' Night

The Annual Ladies' Night was held once again at the Five Bridges Hotel, Gateshead. This year the dance was on Friday, 14 February 1986 and so it was, in effect a Valentine's Ball. As well as the Ladies' Gift, which happened to be a hand-crafted trumpet vase, all the Ladies had a red rose presented at the table which was very much appreciated.

The function was attended by 203 people, the principal guests being the President and Section Chairmen from the West Riding, Thames Valley and London Sections with their Ladies.

Following an excellent meal the Newcastle Section Chairman, Mr R. G. Carr, proposed a toast to the Ladies and Guests which was followed by the President of the Association, Mr Frank Redman proposing a toast to the Newcastle Section.

Mr R. G. Carr then presented to Mr H. Fuller, Social Secretary and Mr J. G. N. Smith, Treasurer, engraved tankards in recognition of the many years' service they had given to the Newcastle Section, both of whom having indicated they would be retiring from office at the next Annual General Meeting.

Formalities over, dancing got underway to the George Rowell Orchestra until the early hours of the morning.

H. Fuller

Obituaries

A. R. H. Tawn FRSC FIP FTSC

Hon. Editor 1965-69
Hon. Research and Development Officer
1969-75

Mr A. T. S. Rudram writes:

Alec Tawn died on 27 February 1986. Like the private person he was, he died at home and alone. He was sixty-three and retired.

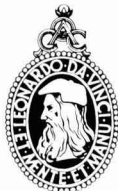
Born and brought up in modest surroundings in the East Riding of

Yorkshire, he served in the Army during the war. He soon realised that regional accents and attitudes cut very little ice with authorities and the pragmatic Alec Tawn we came to know showed himself when he neutralised the accent and restrained the more pugnacious elements of his Yorkshire background. Indeed, in later years, no doubt due to his commitment to the London Section, he was often wrongly associated with the Home Counties. That is not to say that he could not and did not express himself in very determined fashion when he felt it to be necessary and many an OCCA Committee and Council has come to appreciate the directness and sense of his contributions.

He quickly made progress in the Army

and was a commissioned officer carrying out the things he was best at—teaching and explaining. Later he became a Fellow of the Royal Institute of Chemistry (now the Royal Society of Chemistry) by examination—a rare distinction. His reputation was spreading and in the early 50's I had the pleasure of inviting him to give a paper to OCCA and that remains a major contribution to our Journal. He took a great interest in the affairs of the London Section and made a considerable mark in his work as Programmes Officer—the experience he gained at this made his period as Honorary Research and Development Officer a notable one. He had already experienced Honorary Office as Editor and the Journal profited in reputation as a result.

OIL & COLOUR CHEMISTS' ASSOCIATION



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by E. V. Schmid, Protective Coatings Consultant, St Gallen, Switzerland

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Protection of steel by zinc coatings — zinc coating processes — hot dip galvanizing — electroplating — metal spraying with zinc — overcoating with zinc rich primer — reactions of zinc metal — reactions of the metallic zinc surface — loss of adhesion by osmosis — reactions of zinc with fatty acids — cleaning and surface preparation (pretreatments) — cleaning the surfaces — pretreatment by chemical conversion coatings — wash primer — general views on organic coatings on zinc surfaces — alkali resistant binders and pigments — low water vapour permeability — passivating pigments — practical experiences with coating systems — one coat systems — multi-coat systems — stoved systems — underwater systems.

To Oil & Colour Chemists' Association, Priory House, 967 Harrow Road, Wembley, Middlesex, HA0 2SF.

Please send . . . copies of Monograph 3, **Painting on Zinc Surfaces and Zinc Containing Anti-corrosive Primers** at £7.50 each (surface mail) (US \$18.00)

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He was much in demand as a speaker at Conferences and Seminars. His capacity for debate and discussion was insatiable. Talking to an ex-colleague of mine he recalled a discussion we had at one conference after the programme had ended for the day. It was, he suggested, most "intellectually stimulating" and went on into the small hours. Next morning at 9.30 am Alec gave a meticulous lecture on an abstruse area of technology and, seemingly, had no notes.

He was always ready to spread information and lectured at the Polytechnic of the South Bank, the London College of Printing and was a member for many years of the Technical Training Board of the Printing Industry. Many of today's technologists have cause to thank him, including many in our Professional Grade who came before a "viva" panel of which he was a member.

A genial host he chose food and wine with great love and care. He was a good chef. Meals with Alec and June were memorable.

A lover of good wood and a dedicated woodworker, his home bears testimony to his skills.

I have not listed his offices and services—these are appended. I have tried to talk of the man I knew and not his successes nor yet his disappointments—yes, he had them and sometimes thought he was by-passed by lesser men.

He is survived by two daughters and his delightful wife, June. I shall miss him and, I have no doubt, so will many others.

Mr J F J Rule

Mr W G Topham writes:

The death occurred recently of Mr J. F. J. (Fred) Rule, former chief chemist of the Industrial Division of Goodlass Wall and Co Ltd, at Liverpool.

After obtaining his BSc Hons degree at London University, Fred Rule worked in the laboratories of Jenson and Nicholson, London, and immediately prior to the second World War joined Goodlass Wall at the then new factory at Speke, Liverpool, as Chief Chemist of the Cellulose and Industrial Division. His initial duties here involved the implementation of information gained through a licence agreement with the Valspar Corporation of America and until his retirement in 1969, he maintained responsibility for formulating and controlling the varied and changing range of products demanded by industrial users of surface coatings.

After his official retirement, Fred continued to work for a period of ten years as part-time technical librarian, where, until ill-health forced him to give up his duties, he again made a valuable contribution.

Fred Rule must also have been one of the longest-serving members of the Oil and Colour Chemists' Association, being elected in 1927 and not relinquishing membership until 1984. For most of this period he regularly attended technical meetings, conferences and other events and on at least two occasions he served on the committee of the Manchester Section of OCCA.

Fred was a founder member of the Goodlass Social and Athletic Club and, always a music lover, was a member of the Goodlass Music Society and of the local Opera Circle.

He will be remembered by his very many ex-colleagues and by his friends, both as a dedicated and conscientious worker and someone to whom one could always turn for help and advice.

To his widow, Dorothy, the Association extends its heartfelt sympathy.

Jordan Award

The Jordan Award Committee now invites applications for the ninth award of £100. The rules of the Award are:

1. The Award will be made for the best contribution to the science or technology of surface coatings by a member of the Association of any nationality working in either the academic or industrial fields who is under the age of 35 at the date of the application.

2. The final date for submission of applications will on this occasion be 31 December 1986 and it is hoped to present the award at the Association's Conference in the following year.

3. The selection of the recipient of the Award will be made by the Jordan Award Committee under the chairmanship of the Association's Hon. Research and Development Officer.

4. There will be two methods of application. First, by submission of a paper describing original work by the candidate which is offered for publication in the *Journal* or has been so published during application. The alternative method will be by recommendation of a superior for work which for reasons of commercial secrecy cannot be published; in this case the candi-

date will be expected to submit a dissertation on a topic relating to his work and demonstrating his superior knowledge of the principles thereof. The Award is for individual merit and clear evidence of the candidate's own contribution will be required if a paper is offered under joint authorship.

5. Applications should be addressed to the Director & Secretary at the Association's offices.

News of Members

S. Kofi Asubonteng, ATSC a member attached to the General Overseas Section and Managing Director of Two Worlds Manufacturing Co Ltd of Accra, Ghana, West Africa, has been elected to serve as first President of the newly formed Paintmakers Association of Ghana.

new members

The sections to which new members are attached are shown in italics together with the country, where applicable.

Ordinary members

Aspinall, D (*West Riding*)
 Baron, D I, BSc (*Manchester*)
 Bilyk, A M (*Manchester*)
 Brook, K (*West Riding*)
 Conway, K A (*Natal*)
 Costello, B A, MSc (*London*)
 Crosby, K (*Bristol*)
 Deering, M R (*Manchester*)
 Dewar, A, BSc (*Transvaal*)
 Du Plessis, D, BSc (*Transvaal*)
 Fyne, P J, MA, DPhil (*London*)
 Gabriel, P (*Manchester*)
 Gill, T G, BA (*London*)
 Hewitt, W G, BSc (*Transvaal*)
 Howell, A (*Manchester*)
 Johnson, C D (*West Riding*)
 Kennedy, S (*Thames Valley*)
 Lesniak, M C (*Auckland*)
 Mathew, C M, MSc (*Bristol*)
 Patel, V, BSc (*Midlands*)
 Prior, P, BSc (*Irish*)
 Reehal, J S, PhD (*Thames Valley*)
 Riseley, M T, BSc (*Ontario*)
 Robinson, H L, PhD (*Thames Valley*)
 Rudman, B, BSc (*Transvaal*)
 Siddiqui, F H, MSc (*General Overseas—Saudi Arabia*)
 Whitehead, J J (*Manchester*)
 Woods, W (*Newcastle*)

Associate members

Bower, M J (*Auckland*)
 Ehlers, K (*Transvaal*)
 Lack, F R (*Auckland*)
 Molloy, J (*Auckland*)
 Ritchie, B (*Transvaal*)
 Sutulic, A (*West Riding*)

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And the Microsplit and the Unit Air Separator — self-contained units for classifying dry powders with a product ranging from around 6 to 300 microns.

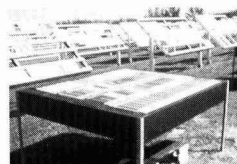
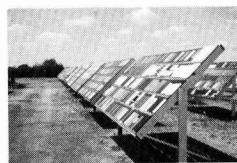
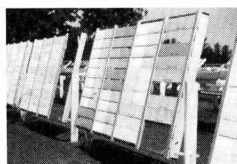
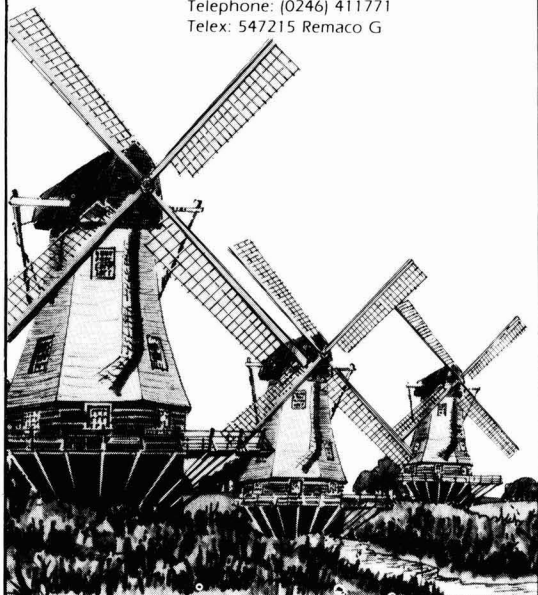
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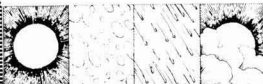
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Sandoz is a major multi-national Company founded 100 years ago providing speciality chemicals, colours and pharmaceuticals to a wide variety of industries.

Due to internal promotion we are seeking a specialist in Paint Technology for our modern laboratories based in North West Leeds.

Reporting to the Technical Manager of the Company's Pigments and Additives Industry Line the successful applicant will supervise a small team providing technical service and development work.

Suitable applicants will have a degree or equivalent in Chemistry or related subject, have worked for a number of years in a Surface Coatings laboratory and have experience in:-

- General paint formulation
- Pigment dispersion on a production scale using modern milling equipment

As Sandoz offers a computerised colour matching service some experience of using computer colour matching equipment would be advantageous. Salary is negotiable within sufficient limits to properly reimburse individual abilities. Attractive Staff Benefits include Contributory Pension Scheme, Permanent Health Insurance, 24 days annual plus service linked holidays, and good sports, social and canteen facilities.

Generous assistance with re-location expenses is available if required. Telephone in the first instance for an

Application Form to:



Personnel Department,
SANDOZ PRODUCTS LIMITED,
Calverley Lane, Leeds LS18 4RP.
Tel. (0532) 584646,
Ext. 2202/2203.

SCOTT BADER**PROJECT LEADER RESIN DEVELOPMENT**

Scott Bader is a successful independent Company supplying polymers and resins to a range of industries including the Glass Reinforced Plastics and the Surface Coatings Industry.

Due to an expansion in our Development activities a vacancy has arisen for a person to lead a section in our laboratories, based at Wollaston within the Development and Marketing Department.

The position exists as a focus for resin development targeted at the range of industries served by the Company, but especially at the Surface Coatings Industry.

We are seeking a person of at least Graduate standard with a sound knowledge of, and wide experience in, solvent and solid based resin technologies, with five to ten years practical experience preferably in a product development/formulation environment. The preferred age range is 30 to 35 years.

The position will appeal to someone seeking to expand their leadership role and make use of their innovative skills with enthusiasm and self discipline in an unfettered environment.

A Central Marketing function within the Department is set up to ensure a high degree of market orientation, and there is a significant interaction with this and with Sales, Technical Service and Production functions.

The salary for this position is on a scale rising to £16,000 pa and the point of entry is negotiable dependent on experience and ability.

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Application forms are available from:

Personnel Department,
Scott Bader Company Limited,
Wollaston, Wellingborough,
Northants NN9 7RL
Telephone: 0933 663100, ext 214.

**POLYMER CHEMIST/
MATERIALS SCIENTIST**

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These include development of surface coating systems for use on highly flexible substrates and the investigation of cross-linking in natural and synthetic polymers.

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Applications to: The Director, British Leather Confederation, Kings Park Road, Moulton Park, Northampton NN3 1JD.

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Contact: Box No. 560.

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