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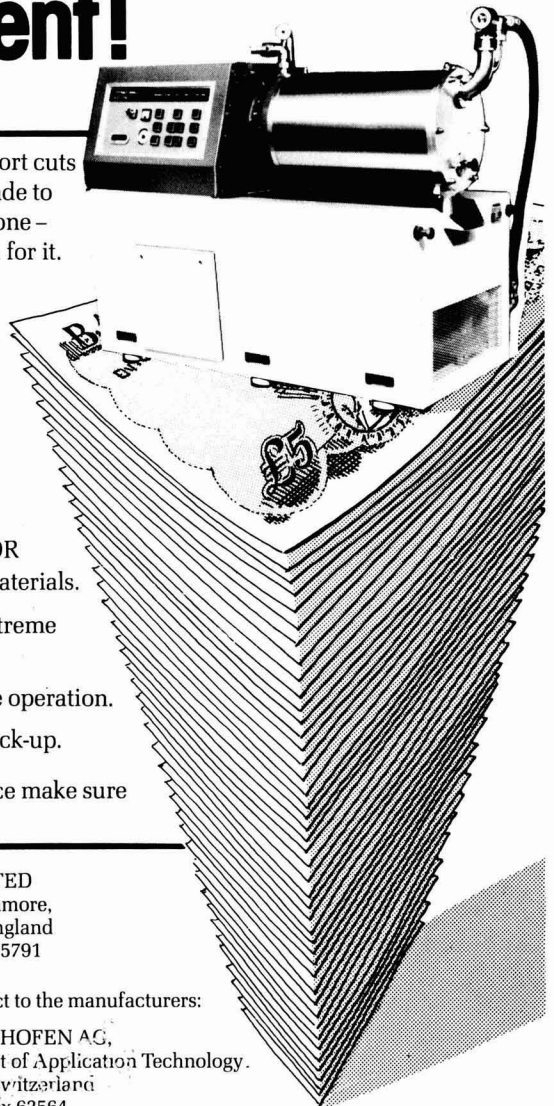
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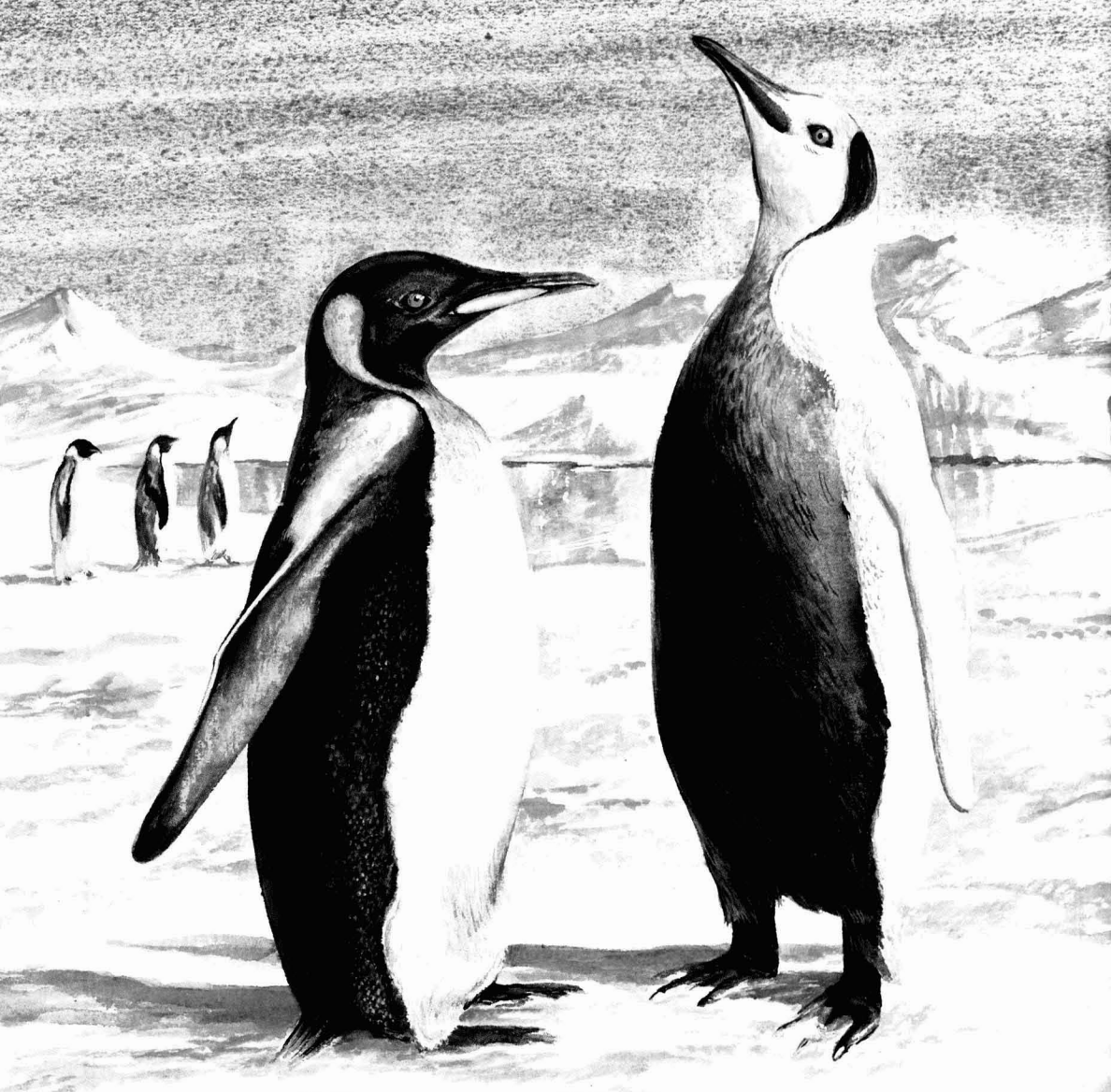
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## Programmed environmental testing – a pet theory\*

J. L. Scott

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### Summary

The primary reason for conducting most accelerated durability tests is to obtain results from which one may confidently predict, within reasonable limits, the in-service life of a material. In view of the overwhelming, and somewhat discouraging, evidence that we may not expect repeatable exposure results even when duplicate materials are tested at the same location but at different times, perhaps we are asking too much from any accelerated testing device when we insist on perfect correlation. Our major concern should be whether the relative performance of several materials in an accelerated testing apparatus correlates with their general performance in the field.

### Introduction

It has been said that the best way to present an idea is to state the basic principle right up front with all discussion to follow. Therefore, Programmed Environmental Testing is the concept of conducting accelerated laboratory weathering tests based on specific geographical outdoor exposure parameters.

The assumed hypothesis for the sake of discussion is: if one conducts a test using any of the Weather-Ometers currently on the market with the intent of correlating the results with those obtained by exposing duplicate specimens outdoors, the probability of achieving success should be greatly enhanced if the appropriate factors of the average climate for the geographical area in which the outdoor exposure is being made are programmed into the Weather-Ometer. Prior to discussing this theory, I should warn the reader that the following is more in the nature of an "editorial" and not necessarily intended as an article of technical merit.

### Outdoor exposures

The pace of modern technological change is making it increasingly impractical to determine the in-service life expectancy of a material by conventional outdoor exposure tests. The pressure applied by marketing or sales departments in response to projected consumer demands does not allow the time required for outdoor durability tests. Or, by the time useful data are available from long-term testing, the product formula may have changed several times or become completely obsolete. Also, Kamal<sup>1</sup> states "...every outdoor exposure is an artificial weathering test and may be no more representative of performance in actual service than are exposures carried out in a controlled laboratory environment."

The unpredictable nature of weather and the constant variation of its many elements does not lend itself to repeatable testing. Even if this were not the case, no single geographical location may be considered as representative

of all the world's various climatic regions. However, Florida exposures have been correlated to parts of Europe.

Helemn and Hess<sup>2</sup> have stated that "one year outdoor exposure in Basel is equivalent to approximately 6 months in Florida." Koch<sup>3</sup> has indicated that normally one year in Florida is equivalent to two years in central Europe. However, when the acceleration factor due to 45° south exposure is considered, one year in Florida is equal to four years in central Europe at 90° south.

After investigating 13 sites representing a wide variety of global climates, Boers<sup>4</sup> reports that on average, coatings deteriorated fastest in tropical climates, slowest in Europe, with sub-tropical regions intermediate. He found that the degradation rate for the coatings tested were dependent on the climate, and that reversals in ranking could occur depending on the formulation. From personal experience I know this to be true – that reversals can and do occur when one compares test results obtained by exposing duplicate specimens in the hot, humid climate of Miami to those from the desert in Arizona. You can bet different sites will provide some differences in test results.

To overcome this "deficiency" of nature, many companies now operate in-house exposure sites liberally scattered throughout the world. This may eliminate the surprise of reversals in material performance, but still leaves the "time factor". Thus we are faced with the ever present and as yet unresolved dilemma of using the time consuming conventional outdoor exposures and risking the material becoming obsolete before usable data are obtained, or relying on accelerated test results as a basis for marketing new products.

### Accelerated testing

Accelerated testing devices have been in constant use since the carbon-arc Fade-Ometer was introduced in 1918 up to the current state of the art. Some of these new, highly complex and sophisticated devices provide a light source nearly duplicating the spectral distribution of natural sunlight, with the added advantage of controlled irradiance and the capability of precisely programming many of the climatological variables encountered in outdoor testing. With these types of equipment available, we should be able to expect accelerated testing results which compare favourably with outdoor exposures. In the author's opinion, the fact that this correlation has not been reported on a regular basis is the product of operating procedures and not the fault of the accelerated testing device used.

With few exceptions, the literature indicates that when a programme is conducted with the intent of comparing

\*the-o-ry 5 a: a hypothesis assumed for the sake of argument or investigation (Webster's New Collegiate Dictionary).

*Table 1*  
*Climatological comparisons*

Location	Mean temp. (C°)	Precipitation (mm)	Sunshine (h)	Mean yearly irradiation kJ/cm <sup>2</sup>
Australia				
Cloncurry – 21°S,141E rural, hot-dry desert	27	270	3500	
Innesfail – 18°S,145°E cleared area in tropical rain forest	22	3500	2500	680
Melbourne – 38°S,145°E suburban, sub-tropical	15	780	2200	430
Townsville – tropical	24			710
Denmark				
Leirje – 56°N,13°E rural, urban	8	550	1800	
England				
Hurstcastle – 51°N,2°W seashore	11	800	1800	
Teddington – 51°N,0°W suburb SW London	10	550	1400	
Germany				
Stuttgart – 49°N,9°E outskirts industrial town	10	700	1800	400
Holland				
Denffelder – 53°N,4°E seashore, navy harbour	9	700	1600	390
Delft – 52°N,4°E outskirts industrial town	9	750	1500	370
Brazil				
Sao Paulo – 23°34'S,46°44'W urban, some pollution, sub-tropical	19		3000	627
Sweden				
Bohus-Malmon – 58°N,11°E small island, rural	6	450	1900	
Switzerland				
Clavade/Davos – 47°N,10°E 1700 metres altitude	3	1000	1600	
Dubendorf – 47°N,9°E near Zurich, suburban		1200	1700	
United States				
Albuquerque – 35°03'N,106°37'W rural, semi-desert	13	412	3468	756
Brownsville – 25°54'N,97°26'W gulf coast, industrial	23	730	2766	661
East Lansing – 42°42'N,84°28'W suburban, near industry	8	2172	2381	508
Los Angeles – 34°03'N,118°14'W large urban, heavy pollution	17	330	3149	693
Miami – 25°48'N,80°16'W hot, humid, sub-tropical	23	1437	3000	625
Phoenix – 33°48'N,112°32'W hot, dry, desert	21	278	3900	709
Portland – 43°39'N,70°19'W north-east sea coast, rural	7	3047	2459	514
Salt Lake – 40°42'N,111°55'W semi-rural, light pollution	11	2277	3164	639

accelerated testing devices with Florida exposures, little (if any) consideration is given to including climatological data in the test criteria used in the accelerated testing apparatus. Usually, historical test parameters such as those recommended in ASTM Standard Practices G-23 (carbon-arc) and G-26 (xenon-arc) are used, even though failure to achieve hoped for correlation using the

established criteria has been reported frequently. More often than not, the old standby of 102 minutes of light followed by 18 minutes of light plus water spray with a  $63 \pm 5^\circ\text{C}$  black panel operating temperature and a  $50 \pm 5$  per cent relative humidity or the dew cycle is used.

The National Coil Coaters Association (NCCA)



Table 2  
Total energy below 400 nm in  
laboratory accelerated testing devices

Light source	J/cm <sup>2</sup> h
Sunshine carbon-arc	48.5
Single enclosed carbon-arc	18.2
Twin enclosed carbon-arc	36.4
2,500W xenon-arc	35.6
6,000W or 6,500W xenon-arc	26.1

Note: Above data based on borosilicate inner and outer filters.

exposed 47 coatings in a 6,000 W xenon, 6,500 W xenon, dew cycle Weather-Ometer and QUV Cyclic Ultraviolet Weathering Tester. Replicates were exposed at 5°, 45° and 90° south in Florida. What could have been an excellent opportunity to establish usable data relating accelerated testing to Florida exposures resulted only in limited success due to the test procedures used for the accelerated weathering<sup>5</sup>. If we accept the common assumption that it is primarily the synergistic effect of light, temperature and moisture which is the major cause of material degradation, then by comparing the test conditions used in the NCCA programme, we may surmise that good correlation should not have been achieved. It is logical that the wide divergencies between the programmed and the natural climatological conditions would prevent good correlation.

Berger<sup>6</sup> reports more satisfactory results in his comparison of time to the same degree of yellowing in polyvinyl chloride exposed in a Weather-Ometer using the 102/18 cycle and at 45° south in Arizona. This should be expected since the Weather-Ometer test parameters used had a closer relationship to the climatological data of Arizona.

It appears that the majority of programmes which have been conducted to compare accelerated with outdoor exposures have not broadened their test parameters beyond what has always been done. There are exceptions, of course, and as far back as 1965 Fullard<sup>7</sup> reported on 20 years of laboratory accelerated weathering, experimenting with several cycles. In spite of nine years of experience with a 68-12 cycle selected for use as their standard weathering cycle based on the correlation work of Hill, Cook and Moyer<sup>8</sup>, the South African Bureau of Standards decided to revert to the 102-18 cycle in the interest of international standardisation. They did state: "We were most disappointed later to find that the valuable work of this US Research Laboratory had never been followed up nor to our knowledge had it been reported on by any other research organisation or laboratory."

Yamasaki and Blaga<sup>9</sup> report an experimental cycle in a 6,000 W xenon Weather-Ometer which resulted in surface deterioration with characteristics similar to those occurring from exposure at 0° horizontal in Ottawa and at an acceleration rate of 5-30.

Emery<sup>10</sup> exposed 36 trade-sales finishes applied to veneer-flakeboard composite panels at 45° south in Tacoma, Washington; Miami, Florida; and Phoenix, Arizona; and in a 6,500 W xenon machine with borosilicate inner and outer filters. An experimental cycle was used and the xenon machine was modified to provide very low relative humidity during a drying period. Emery

states "Excellent correlations were obtained between the outdoor and laboratory data for erosion, flaking, crack and face checking. ... The laboratory weathering method provides an effective short-term test for identifying those finishes with poor marginal durability, and it also provides data which can be used to estimate the durability of better finishes."

In view of the last three references, it seems as if there may be a light on the horizon – if we approach accelerated testing logically and make full use of the laboratory devices' capabilities and the knowledge of an area's climatology.

### Programmed environmental testing

In each of the cited references where better correlation data were obtained, consideration was given to the actual climatological elements to which the materials would be subjected in actual field applications. Or, by design or by chance, the laboratory results were compared with outdoor exposures conducted in a geographic area more closely related in weather to the test parameters selected for the accelerating apparatus, as in the case of Berger.

What I find puzzling is the fact that, with very few known exceptions, the concept of programmed environmental testing is not being pursued. The knowledge is available and current machines manufactured by Atlas have the capability to make use of climatological data. By using the programmability of these instruments to control irradiance and irradiation, and to simulate as closely as possible the elements of the weather in the geographical area of interest, the actual clock hours required to equal outdoor exposures may be significantly reduced (saving time, energy and money), and better correlation may be obtained. I admit that due to day to day variations, "average" weather does not exist. But I believe that with accurate climatological data the weather profile which may be expected during a test year can be predicted at any geographical location selected for outdoor durability exposure, thus making possible the development of a workable "standard weathering year".

For example, if we are attempting to determine the performance characteristics of a material intended for use on the north-east coast of America, we should consider designing into the accelerated testing programme, cycles which include soaking (especially important for wood and wood substances), freeze/thaw, salt spray and for some areas contaminants. Additionally, the operating temperature and relative humidity should be in line with the area.

It appears inconceivable that the same laboratory test conditions should be used in a test for materials intended for off-shore platforms, ocean going vessels, a Boeing 747 flying at 11,000 metres, clapboard sidings for Finland or waterproof coatings for Malaysia. Yet that is what is happening in laboratories all over the world. These are instances where additional laboratory devices such as a salt spray or salt soak cabinet and freezer should be used to supplement the Weather-Ometer test cycle.

To illustrate the problem using more typical examples, let us look at the climatological data for several locations as presented in Table 1, and the energy below 400 nm for laboratory accelerating devices as shown in Table 2.

Important areas of information are missing from Table 1 – relative humidity, black panel or specimen temperature and total time of wetness. These data are available for

many geographical areas but if not they can be estimated within acceptable limits. Even though these data may be incomplete or outdated in some instances, they do illustrate that not all weather is the same. By comparing the information in Table 1 with the operating cycle already discussed and the radiant energy below 400 nm provided by the laboratory devices' light sources presented in Table 2, it becomes obvious that more planning must go into accelerated testing programmes if better correlation is to be achieved with outdoor exposure.

One of the major problems in correlating accelerated testing with outdoor exposures is that we simply do not know what is happening in natural sunlight. We know more or less what is occurring in the laboratory devices, but cannot relate these tests realistically to outdoor results. Programmes to monitor solar irradiance at selected wavelengths are currently under way at South Florida Test Service of Miami, Florida. They are using the LM3A developed by Atlas Electric Devices Company of Chicago, and by Zerlaut<sup>11</sup> at DSET Laboratories Inc. of Phoenix, Arizona, with a spectroradiometer developed by that company. Preliminary results indicate that both of these programmes may be successful, and the LM3A may provide an inexpensive system which can be used throughout the world. If so, this significant step forward will provide the basis for conducting more reliable accelerated tests which should correlate well with real-time testing. In the meantime we must rely on existing information for calculating the amounts of ultraviolet light, which is one of the important keys in conducting accelerated tests.

A laboratory test programme incorporating the climatological data for Miami is already in use. The Weather-Ometer test parameters selected are based on ten year averages of measurements made in the immediate test area, and are now included in ASTM E-765 Standard Practice for Evaluation of Cover Materials for Flat Plate Solar Collectors. SFTS is planning a comprehensive project to compare results from direct exposures in Arizona and Florida with various artificial light sources and programmed environmental testing cycles. Results

from this project will be made available as they are realised.

While radiant energy, wet time, temperature and relative humidity are usually controlled factors in laboratory exposure apparatus, it is difficult to project whether or not samples exposed in one of these devices will exhibit changes that will occur during outdoor exposure. For this reason, clients are encouraged to either expose the same materials to direct weathering for comparative purposes, or at least to make sure that each set of specimens for laboratory accelerated testing contains a control until confidence in the apparatus, test criteria and results is achieved.

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# Fractional precipitation of lac. Part 2: characterisation\*

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## Summary

In this paper, the various fractions of lac have been characterised for their acid values, melting points, colour constants, hard resin contents and molecular weights. Besides this, the distribution of each property has been dealt with separately, and reasons put forward for apparently random results.

## Introduction

Since the properties of a polymer are recorded only as average values, there remains the possibility of chemical as well as molecular weight distribution.

As a matter of fact, the poor distribution of functional

groups produces molecules with little or no crosslinking potential<sup>1</sup>, whereas the presence of branched chains results in decreased crystallinity, a lower softening point and reduced tensile strength. The functional group distribution is also an important factor in governing the reactions of high polymers.

This stimulated a detailed study of the physical and chemical properties of the isolated fractions of lac, the results of which are contained in this paper.

## Experimental

The fractions, isolated by means of precipitation with a non-solvent as described in the previous paper<sup>2</sup>, were

\*Part 1 appeared in *JOCCA*, 1983, **66**(4), 111.

Table 1  
Characterisation data

Solution/ non-solvent	AV (mg KOH/g)	Melting point (°C)	Colour constant (-k)	Hard resin content (%)	Soft resin content (%)	M	Log <sub>10</sub> M	v/b	b	Number of moles
100:30	71.50	106	- 9.96	79.54	20.46	1299	3.11	18.07	1.66	0.028
100:40	74.22	99	-10.00	76.18	23.82	1228	3.09	24.54	1.63	0.053
100:50	70.16	102	- 9.77	78.03	21.97	1267	3.10	31.45	1.59	0.053
100:75	72.85	90	-10.06	72.88	27.12	1167	3.07	49.34	1.52	0.073
100:100	75.54	94	- 9.84	70.64	29.36	1127	3.05	65.79	1.52	0.075
100:200	75.54	95	- 9.91	65.79	34.21	1051	3.02	140.84	1.42	0.090
100:300	75.53	90	-10.01	68.45	31.55	1092	3.04	204.08	1.47	0.086
Seed lac	82.50	85	- 8.23	61.50	38.50					

characterised for their physical and chemical properties, such as acid value, melting point, colour constant, hard resin content and molecular weight.

#### Acid value

The acid values were determined by the modified Weinberger-Gardner method as outlined below:

One gram of the sample was dissolved in 50 ml of methylated spirit (b.p. 76°C) and titrated with 0.5 N alcoholic KOH solution using thymol blue (0.04 per cent in 95 per cent alcohol) as an external indicator. The point where one drop of solution imparted the first temporary deep blue colour reaction to the indicator was taken as the end point. The results are recorded in Table 1.

#### Melting point

On account of the resinous character of lac, there is no precise method for the determination of melting point. Moreover, the melting point of lac is dependent on the particle size and moisture content. Prior to use the fractions were ground and finally passed through a 40 mesh sieve and dried in the usual manner. Melting point was determined by the mercury surface method<sup>3</sup>. The dried sample, which was sprinkled over the mercury surface, was viewed constantly through an eyepiece. The melting point was noted as the temperature at which the molten particles just coalesced and spread like transparent streaks<sup>3</sup>. The data are included in Table 1.

#### Colour constant

There are several methods for the determination of the colour constants of lac fractions. The most common method is based on a colour comparison between dilute solutions of fractions and a standard solution of iodine, however this method is not very precise. Nowadays the use of tintometers, colorimeters and spectrophotometers<sup>4</sup> is quite common. A Lovibond Comparator has in fact been employed to determine the colour index of lac<sup>5</sup>.

In the present investigation the colour was measured with the aid of a Klett Summerson photoelectric colorimeter. The procedure that was followed is detailed below.

First of all the instrument was standardised with respect to the solvent (viz. methylated spirit, b.p. 76°C) and then the cell was charged with a 2 per cent solution of the fraction. Readings were taken on the colorimetric scale and the relevant results are given in Table 1.

#### Hard resin content

Hard resin is by far the most desirable constituent of lac and as such an attempt was made to assess the amount of hard resin present in each fraction.

For this purpose the Palit method<sup>6</sup> was adopted; the experimental details are as follows. About 0.1g of sample was treated with 20 ml of an ethyl acetate/benzene mixture (1:1) in a 100 ml Pyrex beaker. This was then allowed to stand for two hours (with occasional shaking) inside a bell jar saturated with the solvent vapour. Thereafter, the insolubles were filtered and weighed after drying. The results are recorded in Table 1. The reproducibility of the method remains to be ascertained.

#### Results and discussion

From Table 1 it is obvious that the physical and chemical properties of the fractions vary in a random manner. In the absence of definite evidence it is difficult to explain the anomalous behaviour.

#### Distribution of acid value

The actions of the acid groups are well-known. The low acid number favours the isomerisation of the double bonds<sup>7</sup>, whereas the carboxyl groups on the branched chains possess the potential of opening the epoxide and isocyanate groups to form larger molecules. In addition, the acid groups that act as the internal catalyst in the polymerisation of the thermoplastic resins also take part in the crosslinking reaction of the thermosetting resins. The acid groups also have a marked influence on the film properties. In coating compositions, a polymer with low acid group content is preferred so as to minimise the possibility of reactions with other polymers or the pigments. In the case of a styrene/ethyl acrylate/acrylic acid polymer, it has been claimed that the spraying characteristics will be good<sup>7</sup> when the acid content is not less than 6 per cent. These facts necessitated a detailed study of the distribution of the acid groups in a wide spectrum of the fractions and the results of the investigation are contained in Table 1.

As can be seen, the changes in acid value are not regular. This implies a complex mode of incorporation of the acid groups into the precipitates. The complete elucidation of this effect awaits further work. However, the cumulative polygon<sup>8</sup> for the acid value is presented in Figure 1 and the plot of weight average acid values against the number of fractions used<sup>9</sup> is shown in Figure 2. These

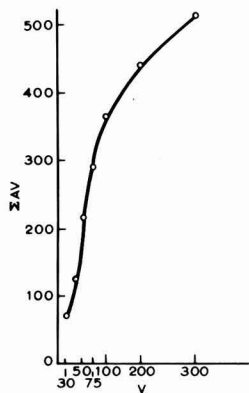


Figure 1. Cumulative polygon for acid value

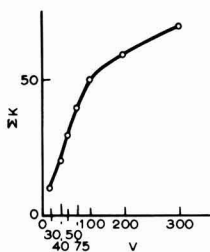


Figure 5. Cumulative polygon for colour constant

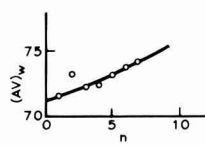


Figure 2.

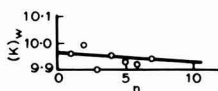


Figure 6.

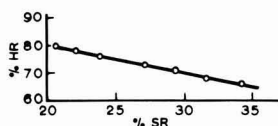


Figure 7. Relation between hard and soft resin contents

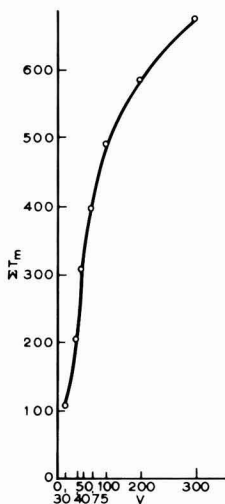


Figure 3. Cumulative polygon for melting point

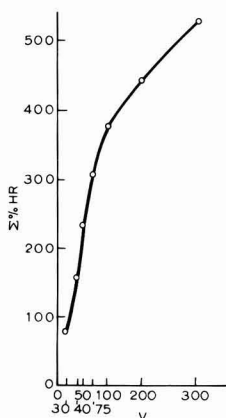


Figure 8. Cumulative polygon for hard resin

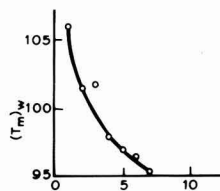


Figure 4.

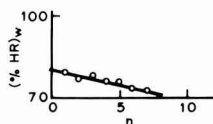


Figure 9.

plots undoubtedly affirm the accuracy of the experimental data.

Since there is no increase in the acid value after the addition of 100 per cent precipitant, it can be inferred that the acids are completely precipitated when the solution/non-solvent ratio is 1:1.

### Distribution of melting point

Polymers generally melt over a range of temperatures and the melting point is taken as the temperature at which all crystallinity vanishes<sup>10</sup>; this is because melting is characterised by an abrupt change in the degree of order of the system as the temperature is raised<sup>11</sup>. The measurement of any of the properties such as specific volume, heat capacity, transparency etc. may be used to detect the crystalline melting temperature.

Thermodynamically the melting point,  $T_m$ , is given by the equation<sup>12</sup>

$$T_m = \Delta H / \Delta S$$

Where  $\Delta H$  is the heat of fusion and  $\Delta S$  is the entropy of fusion.

The melting point ( $T_m$ ) is also connected with the cohesion energy<sup>13</sup>,  $E$ , defined as<sup>14</sup>

$$E = L - RT$$

Where  $L$  represents the molecular heat of evaporation. This rule is not applicable to the high polymers.

Further, the melting points of the members of a homogenous series are related to their molecular weights<sup>15</sup>, but there is no general relationship between molecular structure and melting point. It is a well-known fact that polar and symmetrical molecules melt at higher temperatures<sup>15</sup> whereas isomeric compounds have large differences in their melting points. Besides this, phenyl and bulky side groups increase melting points<sup>16</sup> whereas double bonds show the reverse effect. The series of normal alkanes and fatty acids show an alternation of increase in melting points<sup>15</sup>, most probably due to the presence of the opaque forms<sup>17</sup>. According to recent theory, the alternation is caused by the random distribution of even and odd numbers of carbon atoms amongst the members of the homogenous series<sup>18</sup>.

Taking these factors into account makes the interpretation of the melting point data difficult. However, the cumulative polygon for melting point is shown in Figure 3 and the plot of the weight average melting point against the number of fractions used is shown in Figure 4. From the gradient of the graph, it is apparent that there exists an exponential relationship between the weight average melting point and the number of fractions used.

### Distribution of colour constant

According to Hatchett<sup>19</sup>, seed lac contains about 2.5 per cent dye-stuff, but John<sup>20</sup> has claimed about 3.75 per cent dye-stuff. Lac resin, in fact, contains two dyes - laccic acid and erythrolaccin. Laccic acid is a mixture of closely related anthraquinone derivatives containing a small percentage of nitrogen<sup>21</sup>, whereas erythrolaccin is a yellow pigment present at levels of about 1.0 per cent. Erythrolaccin has been represented as 1,2,5,7-tetrahydroxy-4-methyl anthraquinone<sup>22(a and b)</sup>.

It is apparent that an appraisal of colour will give an idea of the combined amount of erythrolaccin and laccic acid present in each fraction.

From Beer's law it is known that<sup>19</sup>

$$I = I_0 10^{-kcd}$$

Where  $I_0$  is the initial intensity of light and  $I$  is the intensity of light after passing through  $d$  cm of solution having a concentration  $c$ . The above equation can be recast as

$$I/I_0 = 10^{-kcd}$$

or

$$-k = \text{Log}_{10} I/I_0/cd$$

In the following treatment the term  $-k$  has been defined as the colour constant.

The cumulative polygon for colour constant is shown in Figure 5 and the plot of the weight average colour constant against the number of the fractions used is shown in Figure 6. These graphical tests tend to support the experimental data.

Further, it may be added that the colour constant of each fraction is much less than that of seed lac ( $-8.23$ ).

#### Distribution of hard resin

As is known, lac contains about 70 per cent hard resin is a mixture of aliphatic and terpenic acids<sup>24</sup> whereas soft resin is a mixture of acids (aliphatic and terpenic), dye (erythrolaccin) and "odoriferous principle".

The relation between the hard resin and soft resin contents is shown in Figure 7. Further, the cumulative polygon for the hard resin content is shown in Figure 8 and the plot of the weight average hard resin content against the number of fractions used is shown in Figure 9. These plots demonstrate the plausibility of the experimental results.

#### Molecular weight

It is a well-known fact that the film properties of a surface coating<sup>7</sup> improve as molecular weight or molecular complexity increase. This necessitated the determination of the molecular weights of the fractions. It should be pointed out that the molecular weights were calculated from the percentages of soft resin and hard resin and their molecular weights<sup>25,26</sup> (2,000 and 550). The results are recorded in Table 1. It was noted that

$$R = A + B \text{Log}_{10}M$$

Where  $R$  represents the resin content. The linear plots of  $R$  against  $\text{Log}_{10}M$  are shown in Figure 10. It is evident that the greater the hard resin content (or the lesser the soft resin content), the higher the molecular weight.

#### Distribution of molecular weight

It is expected that each fraction will be a composite mixture of several constituents and its molecular weight will represent an average value.

It has been claimed that an absolutely homogeneous substance gives a vertical line at certain  $M$  values, whereas a

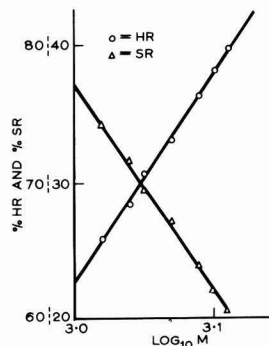


Figure 10.

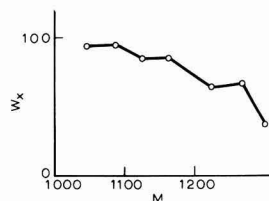


Figure 11.

strongly in-homogeneous mixture exhibits flat curves and maxima<sup>27</sup>.

The plot of  $W_x$  against  $M$  is shown in Figure 11. This profile is an actual graphical expression of in-homogeneity.

Figure 11 clearly manifests the in-homogeneous character of the fractions, which may be responsible for the fluctuation of the properties.

The cumulative polygon for molecular weight is shown in Figure 12 and the plot of weight average molecular weight against the number of fractions used is shown in Figure 13. These graphs substantiate the molecular weight data.

#### Correlation of data

As can be seen, no correlation exists between the physical and chemical properties and the amount of the precipitant added or the material precipitated. However, an effort has been made to correlate basicity with the percentage of precipitant added.

The basicity,  $b$ , was calculated from the equation<sup>28</sup>

$$b = M \times AV/56000$$

The values of  $b$  are listed in Table 1. It is evident from Figure 14 that the ratio  $V/b$  is a linear function of  $V$ . The intercept and slope of the straight line are  $-2$  and  $2/3$  respectively.

It is thus evident that the basicity influences the precipitation process to a great extent. In fact, the solubility and ease of precipitation of a macromolecular mixture that contains ionogenic functional groups are greatly affected by the dissociation of such groups<sup>27</sup>.

Further, the plot of basicity ( $b$ ) against  $n$ , the number of

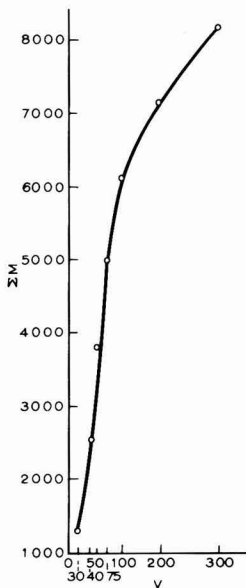


Figure 12. Cumulative polygon for molecular weight

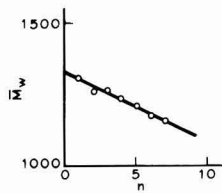


Figure 13.

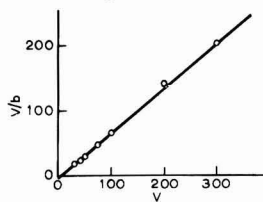


Figure 14.

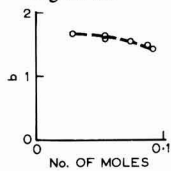


Figure 15.

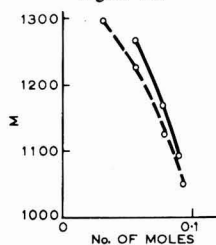


Figure 16.

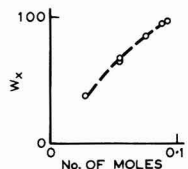


Figure 17.

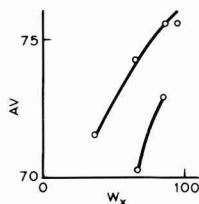


Figure 18.

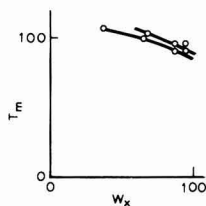


Figure 19.

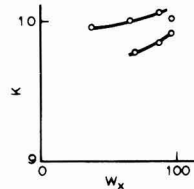


Figure 20.

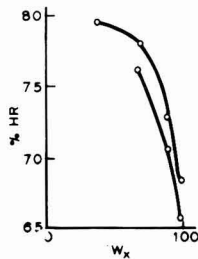


Figure 21.

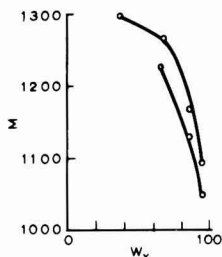


Figure 22.

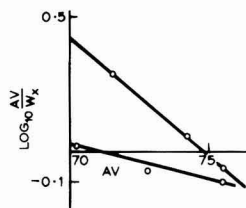


Figure 23.

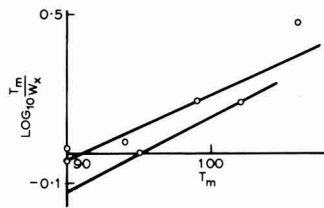


Figure 24.

moles obtained from the weight fraction and molecular weight, is shown in Figure 15. The plots of  $M$  and  $W_x$  against  $n$  are shown also in figures 16 and 17.

### Explanation for alternation

As it is understood, the fractions exhibit alternation in their properties. The compounds, which are highly polar, form an alternating series wherein the zig-zag chains are tilted with respect to the terminal plane<sup>29</sup>. The tilt actually depends on the nature of the polar groups.

When the polar groups are strongly associated, the tilted forms are stable, and exhibit alternation. In weakly associated compounds, the vertical chains that possess the longest crystal spacing are stable, resulting in non-alternating series.

The alternation appears in many of the properties of the fatty acids. The plots of the physico-chemical properties against the carbon content invariably result in two curves corresponding to the members containing either even or odd numbers of carbon atoms. In order to ascertain alternation of this sort, the acid values, melting points, colour constants, hard resin contents and molecular weights were plotted against their weight fractions as shown in figures 18 to 22. As can be seen, the experimental points tend to fall upon two curves, lending support to the alternation theory as explained above.

Besides these, the linear plots of  $\log_{10} P/W_x$  against  $P$  are shown in figures 23 to 27.

### Acknowledgements

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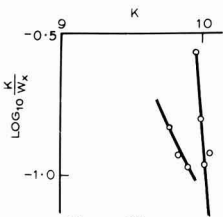


Figure 25.

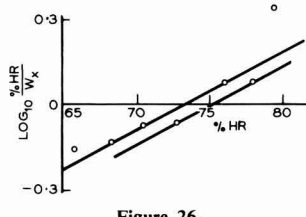


Figure 26.

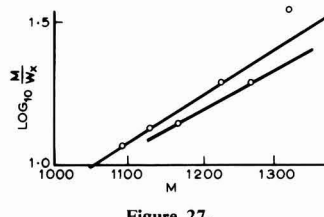


Figure 27.

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## Wood preservation and its adjacent partners\*

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### Introduction

This paper is intended primarily to demonstrate where wood preservation has an interface with the surface coatings industry. However, it is useful to go over the reasons why preservative treatment of the timber that is used today in the building industry is necessary.

In fact the need for wood preservation was recognised a long time ago since the author of Genesis must have known something about timber decay and its prevention because of references to "resinous" wood being used for the ark.

Presumably also the architects who designed King Solomon's temple knew about timber decay and moisture migration because according to I Kings VI, they rested the cedar roof beams on pillars built out from the external walls, thus the beams were not inserted into the walls themselves and so were removed from any possibility of becoming wetted as a consequence of moisture migration across the walls. Regrettably such wisdom concerning the desirability to keep timber dry became lost with the passage of time, and the builders of both York Minster and Winchester Cathedral used timber as a structural component in foundations. Decay inevitably ensued.

Clearly, therefore, timber decay is not a new problem, it appears however to be much more prevalent today than it

was earlier this century, and it is not difficult to identify reasons for this. Before World War II, most timber used for building in this country was fairly slow grown and had a high percentage of heartwood which is very often resistant to attack by wood destroying fungi. However, since the War, faster grown plantation produced timber has been used and the proportion of heartwood present in this is lower. Consequently modern building timbers contain a higher proportion of sapwood which is invariably vulnerable to decay.

Nevertheless, even unpreserved sapwood can last for many years in buildings provided it is kept dry, i.e. with its moisture content below 20 per cent. In this context, good design is obviously important; properly installed joinery having no ledges or crevices in which water can collect is obviously unlikely to become permanently wet and thus is unlikely to decay. Only when the moisture content of the timber rises above 25 per cent can fungal decay start. However, following the great upsurge in building in the 1950s it became evident that a problem existed regarding decay in external joinery. Changes in the quality of timber supplies, changes in joinery manufacture and changes in building practice all combined to produce high uptakes of moisture and consequent fungal decay, which became very widespread.

As a result, during the 1950s serious thought was given to the preservative treatment of external joinery, and since

\*Paper presented to the London Section on 21 October 1982.

such timbers must be machined before treatment it was obvious that non-swelling organic solvent preservatives were to be preferred. Publication of the Building Research Establishment (BRE) Technical Note 24 "Preservation treatments for external joinery timbers" in 1967 provided certain criteria for treatment based on North American experience. This resulted in much wider treatment of joinery with organic solvent preservatives and when the National Housebuilders Registration Council, as it was known then, included this treatment in their requirements in 1969, the widespread application of joinery preservation was firmly established.

The timber used for external joinery in the UK is mainly redwood (*Pinus sylvestris*). For treatment with organic solvent preservatives the recommendations given by the BRE Technical Note 24 are that joinery components should be immersed for three minutes or treated by double vacuum. The preservative is required to contain 5 per cent pentachlorophenol (PCP) or 1 per cent tributyltin oxide (TBTO), or it should be proved to be equivalent to 5 per cent PCP when tested against certain standard strains of fungi in the laboratory.

However, these preservative types mentioned in the TN Note 24 are recommended only on the basis of fungicidal requirements. It was very clear to us that when the NHBC introduced their preservative requirements, a radical change was necessary in the preservation industry. From simple immersion systems for treating joinery to double vacuum pressure plant required considerable development and many problems have had to be resolved. Some of the more important factors involved were as follows:

- Formulation
- Uptake and distribution
- Biocidal activity
- Water repellency
- Compatibility with paints/glues

### Formulation

When formulating a wood preservative for the treatment of joinery it is important to bear in mind the functions required of the solution. It must penetrate the timber to a suitable depth carrying with it effective biocides. Water repellents may be required to add to the efficiency of the preservative. The treated timber must be able to be glued and painted within a reasonable time after treatment.

To function efficiently it is necessary to select the right solvent. It must be capable of dissolving all the necessary ingredients with minimum heat and auxiliary solvents, and of holding them in solution even at low temperatures. It must be sufficiently volatile so that preserved wood can be painted within 48 hours of treatment, but it must not be so volatile that the biocides are brought to the surface of the wood during evaporation. Finally, the flash point must not be less than 40°C.

To assist in the assessment of the suitability of solvents, the solubility of PCP is determined. In addition the evaporation rates of the solvents are assessed. Solvents normally used in the UK are within the boiling range 140°C to 270°C. Although the distillation range gives an indication of evaporation rate, it does not always give a true guide due to the nature of the higher boiling fractions of the solvent. The rate of evaporation of candidate solvents are compared with that of white spirit using filter papers. Weighed filter papers are saturated with a known amount of solvent and suspended to allow free evaporation. Papers similarly saturated with white spirit

are included as a reference. The papers are re-weighed every five minutes and the loss of solvent is calculated in milligrams per minute over one hour. In order to compare solvents tested at different times when small variations in air movement and temperature may occur, the evaporation rate of a solvent is presented as a factor of the evaporation rate of white spirit obtained at the same time.

### Examples

Evaporation rate		Factor
Solvent A	15.0 mg/min	= 0.64
White spirit	23.6 mg/min	
Solvent C	8.6 mg/min	= 0.39
White spirit	22.0 mg/min	

### Selection of solvents

Table 1

Solvents	TBP (°C)	90% distilled (°C)	PCP dissolved (%)	Evaporation factor
White Spirit	140	188	2.3	1.00
A	140	210	1.2	0.64
B	145	210	3.8	0.61
C	144	225	1.4	0.39
D	146	225	1.6	0.46
E	156	225	1.2	0.38
F	158	214	1.1	0.44
G	164	212	2.2	0.54
H	180	224	1.1	0.14

Although the factors obtained in this manner cannot be used directly to assess evaporation from treated wood, they give guidance to the amount of higher boiling fractions present. As can be seen from the above Table, this may not be judged entirely from the distillation figures. The solubility of pentachlorophenol can also vary between solvents.

Together with the biocides, resins are normally included in preservatives to render them more permanent and also to improve the overpainting properties of the treated wood. Water repellency additives are also included in some formulations. All these extra solids in the solution increase its viscosity, which in turn impairs the penetrating ability of the solution. The effect of a hydrocarbon resin on the penetration of white spirit into redwood sapwood is shown.

Table 2  
Effect of an aliphatic hydrocarbon resin on penetration in redwood

Resin solution in white spirit (%)	5	10	15	20	25
Penetration as % of xylene	86	75	61	52	45

The amount of solids present in an organic solvent preservative must be limited since their effect on viscosity can retard penetration into wood.



The fungicides currently used for joinery treatment in the UK are PCP, TBTO or a mixture of these.

However, where joinery is to be used in buildings which are to be situated in places such as the Middle East, where the hazard is not decay by fungi but termite attack, an insecticide, either  $\gamma$  HCH or Dieldrin, is included in the preservative.

Termites are found in tropical and sub-tropical regions. There are hundreds of species of termites and many of these may attack building timbers, voraciously eating away wood from within and doing enormous amounts of damage. Some solitary termites spend their entire lives within a piece of timber, while others live in often very highly organised nests from which they go on forays for food.

### Application of preservatives

No matter what the hazard, the degree of protection given to timber is related to the method of application.

In British Standard 5589 (1978), recommendations for the pretreatment of wood are given according to specified end-uses and include treatment for external woodwork in buildings, out of contact with the ground. The application of acceptable organic solvent preservatives is defined by giving immersion times and by specified double vacuum treatment cycles.

Table 3  
Double vacuum treatment cycles

Timber	Hazard	Initial vacuum (bar)	Hold time (min.)	Pressure (bar)	Hold time (min.)	Final vacuum (bar)	Hold time
Redwood	low/med	0.33	3	0	3	0.67	20(A)
Redwood	high	0.33	5	1	5	0.67	20(B)
White-wood	all	0.83	10	1	60*	0.67	20(C)

\*By increasing the pressure, the hold time can be reduced.

The above treatment cycles are now regarded as "standard", but other treatment cycles may be developed to accommodate different timbers or different hazards.

The treatment cycle A is most commonly used for joinery timbers in the UK. However, in BS 5589 the desired service life of treated timber has been quantified and for redwood external joinery timbers, treatment cycle A (or three minutes immersion) is recommended for a desired service life of 30 years. For 60 years service, treatment cycle A (or 60 minutes immersion) is accepted for redwood less than 20 mm thick. For larger section redwood, treatment cycle B is required. It should be noted that these treatments are restricted to woodwork in which the weathered surface will be painted or given some other protective finish which will be maintained in service.

In practice the three minute immersion treatment is now mainly used for low hazard areas such as internal timbers not exposed to damp conditions.

The average amount of preservative taken up during treatment (from records provided by two joinery manufacturers for the months of January to May 1979) are shown below. For comparison, figures are also given for rough sawn redwood, treated in a timber yard during that period by time controlled immersion (TCI) and by treatment cycle A.

Joinery manufacturers – planed redwood joinery components

Cycle A	1207 m <sup>3</sup>	(303 loads) average uptake 20.5 l/m <sup>3</sup>
Cycle A	2051 m <sup>3</sup>	(324 loads) average uptake 21.0 l/m <sup>3</sup>
Cycle B	16 m <sup>3</sup>	(4 loads) average uptake 33.0 l/m <sup>3</sup>

Timber yard – rough sawn redwood

TCI (3 mins)	62 m <sup>3</sup>	(21 loads) average uptake 20.0 l/m <sup>3</sup>
Cycle A	326 m <sup>3</sup>	(118 loads) average uptake 27.0 l/m <sup>3</sup>

Since commercial loads of redwood contain a high proportion of heartwood – and the bulk of the preservative is absorbed by the sapwood – the amount of preservative present in the sapwood is greater than the figures shown above. The expected uptake of preservative in planed redwood sapwood is as follows:

Treatment cycles	3 mins TCI	Cycle A	Cycle B
Sapwood penetration	4 – 8 mm	10-15 mm	complete
% w/w preservative in outer 3 mm	6 – 10	15-20	25-30
% w/w preservative in outer 10 mm		6-8	10-15

(10% w/w preservative = approximately 50 Kg/m<sup>3</sup>)

### Water repellency

It is well known that if timber is kept dry then decay will not occur, thus if the moisture content of joinery could be maintained below 20 per cent no preservation would be required. However, building practice in the UK is such that this ideal situation is not achieved. The moisture content of joinery timber is usually satisfactory before treatment and when the primer is applied in the factory, i.e. the windows, doors etc. are in good condition. On delivery to the building site even if they are stored off the ground and under cover as recommended, they are then built into houses by laying bricks around them and are in direct contact with the wet bricks and mortar. Thus all surfaces are exposed to wet conditions until the roof of the building is constructed, and this often takes some time. The final painting of undercoat and top coat will not take place until the building is near completion and this may be as much as six to nine months after the joinery was first built into the house. Ideally, houses should be built with formers providing the spaces for windows and doors and the joinery inserted at a later date when the bricks and mortar have dried out and the roof is in place.

It is difficult if not impossible to change current British building practice since economy takes first place. Thus the inclusion of a water repellent additive can do much to alleviate the problem of uptake of water during the building process. The most vulnerable area is the end grain where water can penetrate ten times faster than through lateral surfaces. The consequent swelling of the wood leads to opening of joints resulting in further access by water. The single layer of primer paint does little to prevent moisture penetration since wood fibres penetrating the film act as wicks. The final paint system will provide a water-proof layer provided that joints are intact; the addition of water repellents to standard preservatives is primarily intended to provide protection to the joinery during the building process.

**Table 4**  
*Performance of adhesives with water repellent wood preservative*

Adhesive tested (brand)	Number of paired samples	Water immersion before pulling	Mean failing load (lb ft)	Type of failure
R/F (A)	8	6h @ 100°C	518	wood
untreated	6	6h @ 100°C	563	4 – wood 2 – wood/glue
R/F (B)	10	6h @ 100°C	528	wood
untreated	6	6h @ 100°C	473	wood
U/F + hardener (C-1)	9	3h @ 67°C	342	5 – wood 3 – wood/glue 1 – glue
untreated	6	3h @ 67°C	370	4 – wood 2 – glue
U/F + hardener (C-2)	9	3h @ 67°C	163	glue
untreated	6	3h @ 67°C	184	glue
U/F (D)	10	3h @ 67°C	78	glue
untreated	6	3h @ 67°C	243	glue
PVA (E)	10	3h @ 67°C	150	glue
untreated	3	3h @ 67°C	282	glue

Required minimum failing loads (BS 1204): R/F – 325 lb f, U/F and PVA – 300 lb f

The most common water repellent used is paraffin wax, with a maximum concentration of 0.5 per cent since painting problems can occur at higher concentrations. However, field trials with L joints at PRL have shown that a water repellent preservative containing 0.5 per cent paraffin wax applied by double vacuum can maintain painted pine sapwood below a moisture content of 22 per cent for four to five years. (Purslow and Williams)

#### Compatibility with paints

The majority of joinery manufacturers in the UK apply acrylic primers by dipping or by electrostatic spraying in the factory. In order to obtain satisfactory paint adhesion, the bulk of the preservative solvent must have evaporated before priming. The time interval required depends on the amount of preservative absorbed by the timber, the drying characteristics of the solvent and the amount of ventilation (an airflow of 10 metres/minute or greater is recommended). Overpainting tests on treated timber have been carried out with over 100 different commercially available primers (including aluminium, oleoresinous, alkyd and acrylic types). Panels of pine sapwood, 13 mm × 50 mm × 150 mm, were treated and allowed a drying time of 24 hours before painting. Tests included drying time, tackiness compared with untreated wood and adhesion testing.

Similar tests have also been undertaken by the larger paint manufacturers. It has been shown that after double vacuum treatment, as long as the recommended ventilation is provided, priming can be carried out 24 to 48 hours later. In fact it is advisable not to delay painting with acrylic primer beyond 48 hours after treatment with water repellent containing formulations to avoid surface build up of waxes.

It must be remembered that timber is a natural product and on occasion contains "over absorbent areas", which has led to overpainting problems due to high quantities of residual solvent.

#### Adhesives

Double vacuum treatment of assembled windows or doors presents no problems as far as compatibility is concerned, because cured glues are not affected by organic solvents. It should be emphasised, however, that glues for external joinery must be suitable to withstand damp conditions without loss of adhesion. In addition any wooden dowels used should be treated before assembly.

Since fungal decay is most often initiated in the region of the joints, the end grain surfaces of joinery components need to be well treated. It is therefore more desirable to treat the components before assembly when the end grain surfaces are freely available to the preservative solution. For subsequent gluing it is essential that the adhesive used is suitable for the purpose and is compatible with the treated wood.

Laidlaw and Paxton (1974) of BRE have shown that neither PCP nor TBTO markedly affect glue bonding but that the wax used in water repellent preservatives can affect urea formaldehyde and casein glues. The following tests of glue bond strength have been carried out according to BS 1204 using redwood strips instead of beech and omitting sanding of the ends to be glued. The strips were glued 24 hours after treatment with water repellent preservative. Because external joinery must withstand damp conditions, the glued strips were then immersed in water in accordance with the type of glue tested as required in BS 1204. The adhesives used included resorcinol formaldehyde (R/F), urea formaldehyde (U/F) and polyvinyl acetate (PVA). All came from different manufacturers except the two U/F + hardener (C1 and 2), which are different products from one manufacturer.

From the results shown in Table 4 it can be seen that the R/F adhesives tested gave good performance. The U/F adhesive C-1, which gave a satisfactory performance in damp conditions, is specifically manufactured for use with water repellent joinery preservatives. The other U/F



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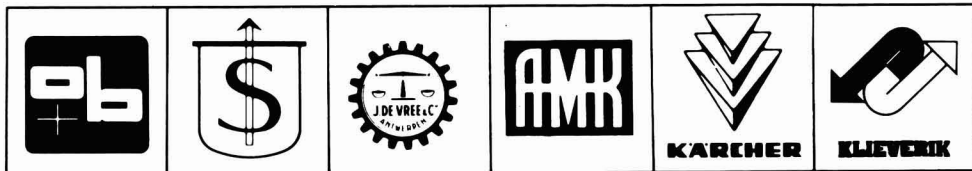
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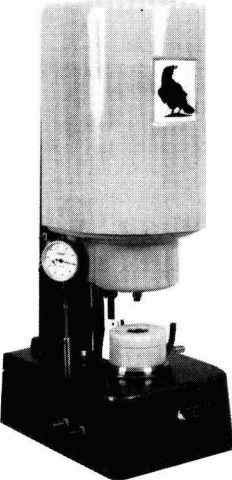
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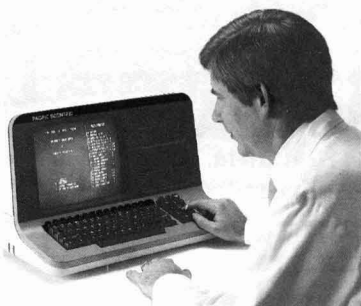
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adhesives and the PVA adhesive tested gave poor results with treated wood, but also did not come up to the requirements of BS 1204 with untreated wood, after immersion in water for three hours at 67°C.

Since the performance of adhesives used in conjunction with water repellent preservatives varies not only with the type of preservative but also within the type according to the individual product, the adhesive manufacturer should

be consulted regarding a suitable product for joinery manufacture.

In conclusion, this paper has shown where the interface is between the surface coatings industry and the wood preservation industry, but also that the preservation industry is aware of the problems that can be encountered and is able to deal with them accordingly.

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# The adhesive property of shellac on wood to wood surfaces

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## Summary

The adhesive properties of shellac in the presence or absence of adhesion promoters, pigments and extenders has been studied on teak wood surfaces. It was found that the incorporation of 10 per cent hydrolysed lac (on the weight of shellac) led to an increase in bond strength from 0.083 ton/sq inch to 0.22 ton/sq inch.

## Introduction

The adhesive properties of shellac on different metallic surfaces such as brass, copper and steel in the presence or absence of adhesion promoters, and the effect of changing various parameters such as temperature, pressure and time has already been reported<sup>1,2</sup>. It was reported that dewaxed shellac when bonded at 150°C and 2,000 lb/sq inch pressure for one hour gave a maximum bond strength of 0.183 ton/sq inch on a steel surface. With the addition of maleic acid (4 per cent) as promoter under the same conditions the bond strength increased to 0.3 ton/sq inch. Recent<sup>3</sup> studies have shown that an aqueous alkaline solution of shellac/seed lac and hydrolysed lac composition performed satisfactorily as glue for pasting paper to paper and paper to other surfaces. So far the actual adhesive strength of shellac has not been studied on wooden surfaces, though a patented composition comprising shellac, hydrolysed lac and polyethylene glycol for bonding wood, paper and leather has been published<sup>4</sup>. Hence, a systematic study of the adhesive properties of shellac in spirit solution on wooden surfaces would seem to be of interest.

## Experimental

Dewaxed lemon shellac solutions in spirit in different proportions were prepared. A solution was applied to a teak wood panel (1 inch × 6 inches) over an area of one square inch with the aid of a glass rod and then immediately a second panel of the same size was positioned over this area in the opposite direction and the composite clamped at room temperature for 24 hours.

The clamp was then removed and the sample allowed to age for seven days at room temperature. The bond strengths of different concentrations of shellac were determined using a Hounsfield Tensometer (Table 1). For each sample, five readings were taken and the average value reported. A 40 parts shellac/60 parts spirit composition was found to be optimal (Table 1). Hence,

further experiments involving the incorporation of adhesion promoters, pigments and extenders were studied using this composition.

## Results and discussion

With the variation in concentration of shellac there was variation in adhesive strength. From Table 1 it is evident that the 40:60 shellac/spirit composition was optimum and the bond strength was found to be 0.083 ton/sq inch. The addition of 4, 5 and 10 per cent maleic acid<sup>2</sup>, urea<sup>3</sup> and hydrolysed lac as adhesion promoters (on the weight of shellac) to the optimum composition resulted in an increase in bond strength to 0.12, 0.14 and 0.22 ton/sq inch respectively. The increase is about three

Table 1  
Adhesive strength of dewaxed shellac in the presence or absence of adhesion promoters

Sample No.	Dewaxed shellac/spirit	Bond strength (ton/sq inch)
1	(a) 30:70 (w/w)	0.075
	(b) 40:60 (w/w)	0.083
	(c) 50:50 (w/w)	0.08
2	40:60 (w/w)	
	(a) 2 per cent maleic acid (b) 4 per cent maleic acid	0.1 0.12
3	40:60 (w/w)	
	(a) 5 per cent urea	0.14
4	40:60 (w/w)	
	(a) 5 per cent hydrolysed lac	0.18
	(b) 10 per cent hydrolysed lac	0.22
	(c) 20 per cent hydrolysed lac	0.21
5	40:60 (w/w)	
	(a) 5 per cent carbon black	0.15
	(b) 5 per cent barytes (c) 5 per cent Titanox	0.12 0.11
6	40:60 (w/w)	
	(a) 4 per cent maleic acid + 5 per cent carbon black (b) 10 per cent hydrolysed lac + 5 per cent carbon black	0.21 0.23

fold in the case of hydrolysed lac when compared to plain shellac. Hydrolysed lac has been found to impart flexibility as well as an increase in bond strength to shellac solutions. A further increase in hydrolysed lac content (30 per cent on the weight of shellac) did not show any improvement. The effects of pigments and extenders were also studied by incorporating, for example, carbon black, barytes and titanium dioxide in the optimum composition (Table 1). The bond strength was doubled in the case of the addition of carbon black and increased by one and a half fold when barytes or titanium dioxide were added, as compared to plain shellac. In an effort to further increase the bond strengths of the compositions, a combination of 4 per cent maleic acid and 5 per cent carbon black, or 10 per cent hydrolysed lac and 5 per cent carbon black (on the weight of shellac) were added and mixed thoroughly by ball-milling. The results obtained from these compositions showed practically no improvement over the results obtained using hydrolysed lac alone as the adhesion promoter.

#### Delamination test

Composites of two teak panels bonded with the optimum composition containing hydrolysed lac were kept at cent per cent humidity in a desiccator for seven days. After removal the bond strengths were determined and found to differ little from the untreated composites.

## Impedance of detached paint films

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### Introduction

Over many years, Mayne and his co-workers<sup>1-7</sup> have carried out extensive measurements on the electrical resistance of numerous types of detached films. Two of their general observations are particularly interesting. They found that when a paint film was immersed in aqueous solutions, there was a fast change (minutes) followed by a slow change (days or weeks) in the resistance of the immersed film. They also found that when they used solutions of different conductivity (by changing the molarity), the resistance of the paint film might increase (D type) or decrease (I type) with the resistance of the solution. A particular paint film has both areas of D and I conduction and the type of conduction in a particular area depends on several factors including the crosslink density. The overall behaviour of a film depends on the D to I area ratio.

However, these measurements were all done using DC with quite high voltages (up to one volt). A DC measurement is effectively measuring a single point on an impedance diagram and this point is a function of how long the operator allows his system to stabilise. Hence it seems probable that the AC impedance of detached films might give more detailed information.

### Discussion of technique

There are three major problems to be overcome when measuring the AC impedance response of a thick detached paint film. The first is that because of the high film resistance, any stray capacitance can dominate the high frequency response unless great care is taken. A further

From the above results it is concluded that the optimum composition containing hydrolysed lac could be used for joining wood to wood in, for example, wooden toys, furniture joints etc.

### Acknowledgement

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problem arising from the high film resistance is that the current through the film will be very low and so the signal to noise ratio is low. The third problem is that most paint films carry a charge and unless the measuring technique is sophisticated (as in the frequency response analyser (FRA)), the measured voltage across the film will have a DC component. Table 1 shows the possible electrode arrangements for a detached film cell, using one or two electrodes on either side.

Arrangement A was used by Mayne in his studies. This arrangement is quite satisfactory while the film has sufficiently high resistance to avoid polarizing the reference electrodes. However, it is undesirable to use a reference electrode as an auxiliary or working electrode.

Arrangement B was used for this work with a two electrode circuit<sup>8</sup>. It is easy to set up, and provided the film does not have a large density of fixed charges it gives reasonable results. If the film does carry a large charge then the FRA will use a less sensitive range and the data becomes more scattered. The third arrangement (C) mimics the usual test of a painted immersed panel<sup>9</sup>, i.e. in a three electrode circuit the perturbing potential is across the film and the double layer on the working electrode. If the film resistance is high then the potentiostat may oscillate. Some form of buffering would be needed if the film resistance is comparable with the input impedance of the FRA. Electrode arrangement D is analogous to putting a reference electrode under a blister<sup>10</sup>, and since the perturbing voltage is not applied across the film, the impedance measured is not affected by the film.

The fifth arrangement (E) is certainly the best for



investigating a film but it does require more electronics. This is the arrangement used in the Hittorf cell and biological work. In the high impedance system discussed here, it would probably be better to use a constant current drive. In both B and E, the platinum electrode could be replaced by steel but this introduces an extra double layer and also the complication of iron ions. The only advantage is that the electrode potentials remain more stable.

### Experimental

Coal tar epoxy resin supplied by W. J. Leigh and Son (Epigrip G876) was used to prepare free films by pouring the mixed solution onto a flexible PVC block. The films were cured for a week in a dust free tower at room temperature and then one week at 50°C. The films were removed from the substrate after soaking in distilled water. The films were dried out and stored in a desiccator. The film thickness was measured with an Elcometer Minictector 150 Type FN using a polished pyrene panel as a substrate.

The film (F) was mounted between neoprene rubber gaskets (R) and clamped between 13 mm diameter QVF elbows (see Figure 1). The exposed film area was 2.27 cm<sup>2</sup>. Two 1 cm<sup>2</sup> platinum electrodes were used and the impedance measured using a two electrode current to voltage converter<sup>8,11</sup>. The high impedance of the paint films meant that a parallel RC network was used in the feedback loop in order to reduce the high frequency gain of the amplifier and thus prevent oscillations. The perturbing voltage was 10 or 20 mV r.m.s. and the frequency scan started at 200 kHz.

The solution was kept at the same level in both arms in order to prevent pressure gradients. Great care was taken to avoid wetting the outside of the cell and shorting out the film. The solutions used were KCl from 0.4 mM to 1 M (generally in 1, 2, 4 steps each decade) and Na<sub>2</sub>SO<sub>4</sub> from 0.5 mM to 0.5 M (in 1, 5, 10 steps). The measurements were made starting with the lowest molarity and the cell was rinsed with the appropriate solution before it was filled. The cell was then soaked in distilled water, dried and the whole series repeated. Impedance measurements were also carried out using deionized water. A series of measurements which lasted for one month were taken of a film immersed in 1 mM KCl solution.

### Results and discussion

Figure 2 shows a typical impedance plot for a coal tar epoxy film with deionized water and Figure 3 shows the same film with 1 M KCl solution. The high frequency semicircle vanishes with more conductive solutions (i.e. higher molarities) and this suggests that the equivalent circuit in Figure 4 could be used. At high frequencies and low solution conductivity,  $1/wC_2$  will be small compared with the solution resistance (R1) and the impedance response will be governed by R1 in parallel with the stray capacitance (C1). At lower frequencies or higher conductivities, the semicircle is caused by the film, i.e. C2 in parallel with R2. In the low frequency limit both  $1/wC_1$  and  $1/wC_2$  become large and the response is a diffusion tail.

Table 2 shows the diameter and depression angle of the paint film semicircle and also the paint film capacitance for various KCl molarities. Table 3 shows similar data for Na<sub>2</sub>SO<sub>4</sub> solutions. In both cases a coal tar epoxy film of about 125 ± 15 μm was used and after the films had been soaked in deionized water and dried, the results were generally reproducible within 10 to 20 per cent. The R1

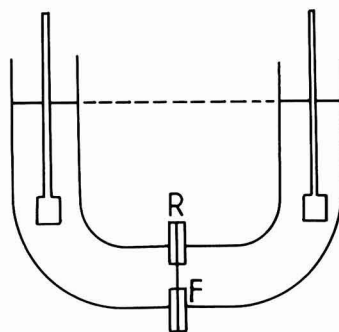


Figure 1. Detached film cell with film clamped between neoprene gaskets

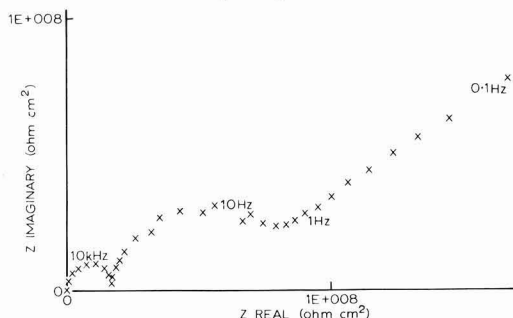


Figure 2. Impedance of 125 μm detached coal tar epoxy film in deionized water

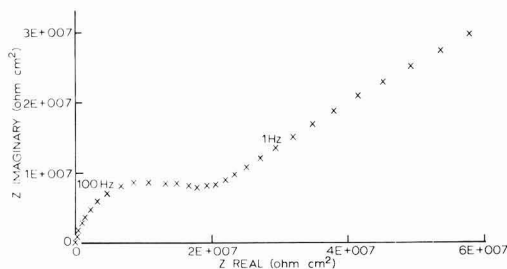


Figure 3. Impedance of 125 μm detached coal tar epoxy film in 1 M KCl

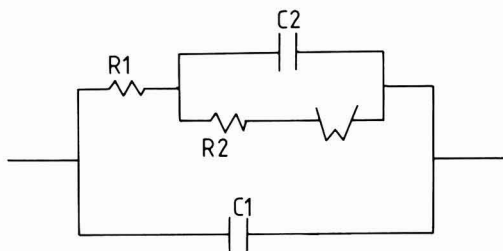


Figure 4. Equivalent circuit model for impedance of detached film cell. R1 is solution resistance, C1 is stray capacitance, R2 and C2 are film resistance and capacitance, and W is a diffusion term

values are not given but they agreed with the calculated resistance between the two platinum electrodes.

The method used to calculate the capacitance (slope of  $Y''$  versus  $w$  plot<sup>12</sup>) means that the values are quite reproducible. However, the film resistance (R2) and depression angle results were obtained by fitting a

Table 1  
Electrode arrangements for detached film impedance measurements

Code	Side one		film	Side two	
	Auxiliary electrode	Electrode 2		Working electrode	Electrode 4
A	reference			reference	
B	platinum			platinum	
C	platinum	reference		steel	
D	platinum			steel	reference
E	platinum	reference		platinum	reference

Table 2  
Coal tar epoxy (125  $\mu\text{m}$ ) in various KCl solutions

Solution	$R_F$ (M $\Omega$ cm <sup>2</sup> )	$C_F$ (pF/cm <sup>2</sup> )	Dep. angle
0.4 mM	21	43	23
1 mM	22	40	17
4 mM	22	53	15
10 mM	22	56	13
20 mM	21	56	13
80 mM	23	55	13
0.1 M	25	54	12
1 M	22	55	12

Table 3  
Coal tar epoxy (125  $\mu\text{m}$ ) in various Na<sub>2</sub>SO<sub>4</sub> solutions

Solution	$R_F$ (M $\Omega$ cm <sup>2</sup> )	$C_F$ (pF/cm <sup>2</sup> )	Dep. angle
Deionized water	80	80	20
0.5 mM	73	62	16
2.5 mM	77	42	14
5 mM	75	46	13
25 mM	75	50	11
50 mM	75	53	11
0.25 M	72	54	12
0.5 M	72	55	11

semicircle to the appropriate portion of the impedance plot and so are not as reliable. A further problem in estimating  $R_2$  and depression angle results for different conductivity solutions is that the "semicircles" are distorted by high frequency phase shift and overlap with the diffusion tail. Both these effects are worse for the more conductive solutions.

The quite surprising result for both KCl and Na<sub>2</sub>SO<sub>4</sub> solutions is that over three or four decades of molarity the paint film resistance does not depend on solution conductivity. Ramp<sup>13</sup> studied the 1 kHz resistance of ion exchange membranes and found that up to about 50 mM KCl, the membrane resistance was independent of solution concentration. Since Ramp only used one frequency, it is possible that his "constant membrane resistance" was partly a result of his cell geometry. Kinsella<sup>14</sup>, using direct current measurements, found that some paint films showed a molarity independent resistance, but not over such a large variation of conductivity. Thus while it is possible that a balance of D and I areas has caused the constant resistance, it seems more likely that DC techniques are measuring a diffusion effect of some sort and that multi-frequency measurements are needed to obtain the true film resistance. It is also possible that some conduction in the paint film is related to the coal tar

pigmentation. However it does seem that the solution ions play a part in the film conduction. Comparison of the molarity series and time series KCl runs with the Na<sub>2</sub>SO<sub>4</sub> molarity series, shows a factor of the three lower resistances for a similar paint film. This may be simply an ion size effect or a reflection of different transport numbers.

The depression angle of the film semicircle drops as the solution becomes more conductive. It appears to change over a larger molarity range than the resistance does, but from 4 mM to 1 M KCl solution it is fairly steady about 12-14°. This depression has been modelled by a distribution of time constants<sup>15</sup> or more recently by a transmission line model<sup>16</sup>. The depression should get worse as the solution becomes more resistive because the "shorting" effect of the solution will cover a smaller area and so there will be more different time constants (i.e.  $R/C$ ) contributing to film conduction. It should be possible to estimate the size of the in-homogeneities in the film by measuring the solution conductivity below which the depression starts to increase.

The film capacitance for the Na<sub>2</sub>SO<sub>4</sub> solutions is high for the very low conductivity solutions, drops sharply, and then rises slowly by about 30 per cent as the molarity changes by three orders of magnitude. The initial high values of capacitance are probably due to penetration of the film by un-bound water ( $\epsilon = 80$ ). This will raise the effective dielectric constant and hence the capacitance. As the ion concentration increases, the water will increasingly be bound into solvation sheaths with a subsequent reduction in dielectric constant and capacitance. The subsequent steady state rise in capacitance, over the four hours taken for a run, may be due to water diffusing further into the film, but the 30 per cent rise seems to be a rather large water uptake for a coal tar epoxy. The fact that a long-term KCl immersion test did not give a large capacitance change also indicates that water uptake is not the controlling factor. A further possibility is that the outer layers of the paint film may be so penetrated that the effective thickness of the film is reduced and hence the apparent capacitance is increased. It should be noted that the capacitance values obtained are higher than those expected for a 125  $\mu\text{m}$  thick paint, possibly due to the effect of the coal tar solids.

The capacitance results from the longer-term immersion in 1 mM KCl are given in Table 4. They showed about 7 per cent increase over a day and then remained fairly constant for at least a month. This behaviour has been previously reported from coal tar epoxy on a mild steel substrate<sup>17</sup>. The change is almost certainly caused by long-term water uptake. Standish<sup>18</sup> measured water uptake on both detached and attached paint films. He used gravimetric methods and found that the water uptake was the same in both circumstances.

Table 4  
Coal tar epoxy (125  $\mu\text{m}$ ) in 1 mM KCl solution

Time (hours)	$R_F$ ( $M\Omega \text{ cm}^2$ )	$C_F$ ( $\text{pF/cm}^2$ )
0.1	27	41
0.25	28	42
0.63	28	42
1	26.5	42
1.46	26.5	42
3.32	31	42
20.1	25	45
25.5	29	46
168	27	45
672	27	45

The resistance of the film showed very little change during the month long immersion test. This is not in agreement with the results of Mayne *et al.* but is similar to results from 20  $\mu\text{m}$  polybutadiene detached films in 3 per cent NaCl<sup>19</sup>. Kendig found a small resistance drop in 24 hours but the resistance then remained constant for at least seven days. The reason for the discrepancy between this data and DC experiments is not understood and clearly more data are required to reconcile the results.

### Conclusions

Multiple frequency measurements of the impedance of detached coal tar epoxy films gave data which showed that the resistance of the paint film did not depend on the solution molarity or the time of immersion. This result is at variance with previously reported DC work and raises some questions about the interpretation of DC results in diffusion controlled systems.

The capacitance calculated from the impedance data changed with solution molarity much more than with long immersion time. This suggests that changes in water activity are a major factor in film capacitance changes.

### Acknowledgements

The help given by J. Rowlands of AMTE, the financial support of the Procurement Executive, MoD and the laboratory facilities provided by Professor G. C. Wood are all gratefully acknowledged.

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## next month's issue

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

Alternative driers to cobalt and lead by G. de W. Anderson and N. A. R. Falla

Fractional precipitation of lac. Part 3: heat and water resistance by A. Kumar

Studies on adhesion of water-soluble, alkyd-based paints: role of pigments by N. Premkumar, M. N. Sathyanarayana, R. S. Balakrishna, M. M. Shirsalkar and M. A. Sivasamban

Micaceous iron oxide in protective coatings by S. Wiktorek and J. John

Further information from the publishers of the titles reviewed can be obtained by completing the Reader Enquiry Service form at the back of the Journal.

### Photopolymerisation of surface coatings

C. G. Roffey  
John Wiley & Sons, 1982, pp. 353, illus., £45.75

Presumably the title means that all the chapters concern coatings and this explains the absence of any chapter specifically devoted to types of coatings. The claim in the preface of the work as a literature review is unfortunately devalued by the usual delay between writing and publication: the preface is dated 1980 and was obviously written

## reviews

after completion of the literature review but the book was not published until 1982. As a result, very few of the references (up to 250 at the end of a chapter) are to work published as recently as 1978 and most of these are to one particular book, itself no doubt also a victim of the publication time lag.

# reviews

volume Second Edition of 1963, the Colour Index progressed to the five volume Third Edition of 1971, an expansion which mirrored that of the colorant manufacturing industry over about 50 years. A second revision of the Third Edition (1982) totalled seven volumes of which volumes 1-4 were unchanged, volume 5 (an index) was replaced, and volumes 6 and 7 were added to volumes 1-4.

Any user in the pigments field might need to consult most of the 7 volumes in order to track down the required information. In addition, the quantity of information covering pigments was less than one sixth of the total. The present volume selects all of the pigment information (and in addition that on solvent dyes) from the seven volumes of the 1982 Third Edition, so catering at lower cost for the more restricted needs of users in the paint, printing ink, plastics and other non-textile industries.

The system and layout is identical with that of the Third Edition, of which it forms a part, and it can be updated by amendments. Quarterly lists of amendments to the Third Edition have been issued since 1971, and lists 38-45, from January 1981, should apply to the pigment volumes.

The contents of this volume are:

Colorants classified according to usage (ex vols 2,3,6,7)  
(arranged under C.I. generic names) pp.1-261

Colorants classified according to chemical constitution (ex vols 4,6,7) (arranged under C.I. constitution numbers)  
pp. 263-422

Index of C.I. generic names pp. 443-502

Alphabetical index of commercial names pp. 503-642

An example of a search routine will illustrate the C.I. system:

The commercial product Lake Red C together with its manufacturers is listed in the alphabetical index on page 564. Its C.I. generic name is Pigment Red 53 and its C.I. constitution number is 15585. In the generic names index on page 459, 24 chemically identical products (from 26 manufacturers) are listed. On page 300 the chemical constitution of C.I. 15585 is stated and the variations of C.I. 15585:1 and :2 are presented. On page 54 the fastness properties of C.I. Pigment Red 53 are laid out, and the differences between the parent and 53:1 and 53:2 are again detailed.

Entry for a search is possible from any of four headings, and the excellent cross-referencing facilitates checking.

A complex tabulation such as this cannot be free from error, and those which occurred in the original Third Edition have persisted. The occurrence on page 451 of the unfortunately named "...Yellow NBG" should be ascribed to unfamiliarity with English rather than to a printer's error.

The new volume brings a considerable improvement in convenience of access (and of accommodation) to the full set where only pigment references are needed. The SDC are to be congratulated for detecting the need for such a condensation, and it is to be hoped that their market survey is accurate and will be attained.

*Reader Enquiry Service No. 22*

*D. A. Plant*

The book describes the basic physical chemistry of the subject, summarises information available at the time of writing on UV lamps, housing and reflectors, and has a lengthy chapter on photoinitiators and photosensitisers (with 39, 67 and 234 references respectively). The general chapter on film forming materials discusses in detail the various resins employed, together with their chemistry, and the diluents as well as the required film properties and the curing process. The chapter on inks covers printing processes, printing inks, solvent-based and solventless methods of ink drying (with particular emphasis on UV systems for different printing processes), a summary of the advantages and disadvantages, and 259 references. The chapter on photoresists is followed by a general chapter on hazards, giving details of test methods but only a very cursory review of the extensive literature.

This is a useful book which would have been more valuable without the delay in publication and with a chapter specifically devoted to types of coatings, as well as a literature review on hazards of the same standard as those of the other chapters.

*Reader Enquiry Service No. 21*

*S. C. Haworth*

## **Colour Index, Third Edition (1982), Pigments and Solvent Dyes**

**The Society of Dyers and Colourists, Bradford, England, and the American Association of Textile Chemists and Colorists, Research Triangle Park, North Carolina, USA**  
pp. 648, £72.50

The Colour Index may be described as a hybrid between a dictionary and a telephone directory, and comprises large elements of both, even though there are fewer entries under Pigment Yellow 12 than under Smith. A review of such a work is virtually impossible by normal methods. There are over 600 pages of tables in the present volume, making reading difficult and comment on presentation or literary style superfluous. In the scientific field however, there are many compilations of tabular information where the purpose is to unify basic information in a particular and usually specialist field. This is the precise purpose of the latest volume of the Colour Index, which, resulting from co-operation between the Society of Dyers and Colourists (UK) and the American Association of Textile Chemists and Colourists, has gained international acceptance as a work of record.

There are several thousand chemical types of colorant, both natural and artificial, and scores of thousands of commercial names of products used in industries consuming colorants as a major or minor part of manufacturing processes. The purpose of the Colour Index is to organise and rationalise the information covering the names, chemical types, chemical constitutions, properties and broad applications of past and present colorants.

From the single volume First Edition, via the four

## London

### History of the titanium dioxide industry

The first meeting of 1983 was held on 13 January at The Princess Alice, Romford Road, Forest Gate, E7. The Section Chairman, Mr Brian Gilliam, introduced the speaker for the evening, Mr G. E. Watts of Tioxide International. The talk for the evening was entitled "History of the titanium dioxide industry".

The element titanium was discovered in 1790 by a Cornish parish priest, William Gregor. It was independently discovered again a few years later by a German chemist, Martin Klaproth; it was he who named it after the mythological Titans.

For a long time it was regarded as a chemical curiosity, and it was not until the early years of the twentieth century that two independent teams in the USA and Norway developed a commercially viable process for the manufacture of anatase  $\text{TiO}_2$  pigments. By 1920 both companies came under the control of the National Lead Company.

Mr Watts went on to describe the joint ventures, with local interests, that the National Lead Company entered into that resulted in the formation of British Titan Products, and the start of production in 1934.

Rutile  $\text{TiO}_2$  was introduced in Europe just before the Second World War. After the War, National Lead surrendered its holdings in BTP so that in 1948 British Titan Products became an independent  $\text{TiO}_2$  producer.

In the years after the War, plants capable of producing rutile grades were built by Laporte, Bayer, Thann, Montedison, Kemira, Ishihara and a number of American producers.

The industry was expanding rapidly at this time and BTP (which adopted the name Tioxide) built plants in Australia, India, South Africa, Canada and France.

The next major event in the history of the industry was the development of the chloride process. It was Du Pont who led the way and after many years of work introduced their chloride grades in 1967. It resulted in an improvement in product quality which in time was matched by those using the sulphate process.

In the final part of his talk, Mr Watts described the present market structure of the industry. Global purchases are in the range of 2.0-2.2 million tons. Thirty groups of companies manufacture  $\text{TiO}_2$  and the top ten account for about three quarters of the total. The largest groups, Du Pont, Tioxide and NL, account for 44 per cent of the total, none of the remainder has more than 6 per cent of the world market.

After a question and answer session, Dr H. Hamburg, a Vice-President of the Association, proposed a vote of thanks to the speaker and to Tioxide International who had provided the buffet and bar facilities before the meeting. The audience responded in the normal manner.

*B. A. Canterford*

## West Riding

### Recent developments in powder coatings

A lecture meeting of the West Riding Section was held at the Mansion Hotel, Leeds on 1 February 1983. A lecture on powder coatings was given by Mr David Heath, technical manager of Holden Surface Coatings.

After giving a brief introduction to the topic, Mr Heath outlined the various types of thermosetting powder systems currently available. These were: epoxy, polyester and acrylic resin-based.

This was followed by a historical account of the development and growth of the powder coatings industry.

Mr Heath went on to compare low bake with high bake epoxy and polyester powders. Gel time curves and a table of the disadvantages and advantages of the two systems were shown.

With the aid of numerous slides, the speaker described a typical modern powder coating manufacturing process. He emphasised that a complete production line could cost around a £0.25 million. Mr Heath pointed out that because of the relatively high energy cost of this type of production system, several new methods were currently being investigated. These were:

- (a) Spray drying liquid paints
- (b) Aqueous powder systems

Finally, the many applications and usages of powder paints were detailed, as were several new specialised developments for such coatings.

After a lengthy and interesting question period, the vote of thanks was given by Mr David Maltman.

*D. V. Maltman*

## Midlands

### New trends in the pigmentation of finishes

The final technical lecture this session of the Midlands Section was held on Thursday 17 February 1983 at the Clarendon Suite, Stirling Road, Edgbaston, Birmingham. Members and guests heard a paper read by Mr I. Cameron of BASF entitled "New trends in the pigmentation of finishes". Mr Cameron said that Mr W. Kelsch, who wrote the paper, was sorry that he could not give the talk in person but a colleague, Frau Ingeborg Rühle-Welter, was on hand to answer any technical queries that might arise.

The speaker said that recent health and safety regulations had affected the industry regarding labelling,

processing and in waste disposal. With regard to chrome yellows and molybdate reds within the EEC, materials containing more than 1 per cent soluble lead compounds must be labelled with a St Andrew's Cross. This means that a finish which contains more than 10 per cent of a conventional chrome pigment must be labelled with St Andrew's Cross. Special chrome pigments have been developed which have very low soluble lead contents so that labelling with the Cross is not necessary.

When chrome pigments are replaced by organics it is necessary to replace them on a volume basis and not a weight basis to obtain satisfactory coatings. Even so the durability may be inferior and also the raw material cost significantly higher. Another alternative is to use nickel or chrome titanium yellows tinted with an organic pigment. These give good gloss and colour retention on weathering, with great hiding power and lower raw material costs compared with the organic types.

Mr Cameron concluded his talk by referring to possible replacements for zinc chromate. In Germany in October 1981 it became obligatory to inform the customer that paints containing this pigment were "carcinogenic and extremely harmful". Zinc phosphate may be used but relatively high quantities are required, mainly because its solubility in water is low. Certain zinc salts of organic acids at fairly low concentrations have been used, especially with zinc phosphate, to give good salt spray results and good long term protection. Some multiphase pigments which are combinations of organic and inorganic inhibitors have been developed. These give, in some cases, superior results to zinc chromate, and when compared with zinc phosphate require only about half the amount.

A lively question time followed the talk and the meeting finally closed with a vote of thanks proposed by Mr B. Rushton, which was endorsed by the audience in the usual manner.

*B. E. Myatt*

## Trent Valley Branch

### Paints for concrete

The fourth technical meeting of the current session was held on 24 February at the BR School of Engineering, Derby. A joint lecture entitled "Paints for concrete" was presented by Mr Jonathan P. Bourne, of Mebon Paints and Honorary Secretary of the Trent Valley Branch, and Mr Trevor Forrester Coles of the CEGB.

The format of the meeting was a review of the reasons for coating concrete and the types of coatings satisfactory for this application by Mr Bourne, followed by the user's experience presented by Mr Forrester Coles with the use of slides and specimens.

It is necessary to protect concrete in certain applications against environmental attack, to decorate for

aesthetic, environmental or architectural considerations, or to prevent the attack of chemicals in concrete storage vats. Concrete also deteriorates due to the action of water in different phases leaching out free lime which reacts with atmospheric carbon dioxide to form a surface laitance of calcium carbonate which flakes off easily. Concrete is also attacked by the dreaded acid rain which contains dissolved acidic gases.

In considering the method of protection, as with all surface coatings it is vital to prepare the surface adequately to ensure bonding of the top coat.

Concrete surfaces are very variable in their configuration and satisfactory preparation is achieved by blasting to remove surface laitance, concrete hardeners, water-proofer and curing agents, and to expose air pockets near the surface.

A satisfactory coating must have a well-balanced pigment to binder ratio, be stable to moisture and possess a correct permeability level. For the best protection the primer/sealer must be alkali resistant and is usually a two-pack epoxy or a single-pack moisture-cured urethane. It may be necessary to utilise an epoxy filler to repair damaged areas and the top coat will be a heavy duty formulation to suit the environment. The heavy duty coatings used for immersed areas of concrete such as vessels and piles are usually pitch epoxy urethanes, which give good chemical and water resistance, or sometimes solvent-free elastomers. For external and exposed areas, such as bridges, floors and vessels, pure epoxies, chlorinated polymers, moisture-cured urethanes, urethane acrylics, or solvent-free urethane elastomers are used. The choice depends upon the optimisation of the required properties.

Mr Forrester Coles commenced his part of the lecture by taking us on a slide tour of a typical power station site. He highlighted the various concrete structures, cooling towers, concrete platforms, storage bunds and pumping stations, which are all subject to varying degrees of attack from the environment, stored chemicals, mechanical attack or sonic vibrational attack.

Again it was stressed that the concrete surface laitance is mechanically weak and that unless it is removed by blasting before primer/sealer application the coating may lift off.

The types of coatings used by the CEGB were similar to those already described by Mr Bourne.

Problems are experienced in application to rough surfaces – brought about as a result of rough formwork used when pouring – application to concrete which has been waterproofed by the incorporation of silicones or stearates, or application to surfaces which are pockmarked with blow-holes.

After a lengthy and informative question period the vote of thanks was proposed by Mr J. Tomlinson and heartily endorsed by all present.

### Organic finishing in the bicycle industry

For the final technical meeting of the 1982-83 session held at the BR School of Engineering, Derby on Thursday 17 March, a paper entitled "Organic finishing in the bicycle industry" was presented by Mr J. L. Barlow of TI Raleigh Ltd, assisted by his colleague, Mr R. Flint.

With the assistance of photographic slides and various

coated parts of bicycles, Mr Barlow demonstrated the methods of application and the finished product which displayed exotic colours rivalled only in their flamboyance by those used in fashion and cosmetics. TI Raleigh Ltd have, at any one time, up to 100 different colours in use in the combined coating systems.

In the early days of cycling 90 per cent of cycles sold were black, but in the early fifties, when it became a buyer's market, full pigmented gloss coats were in demand with pastel colours for mopeds. There was a tendency to imitate the colours in fashion, and shades such as "shocking pink" in combination with peacock blue, followed by coffee and cream were produced. For particular export markets "specials" were formulated such as a brass-like finish for West Africa (where their most prized possessions are a Singer sewing machine, a bicycle and a brass bedstead), and a smoked finish for Greece.

Until about 14 years ago only solvent-based paints were used and applied by electrostatic spraying, but now a combination of paint and powder coatings are applied. Initially only epoxy powders were used and were applied by hand

spray guns, but they chalked badly on exposure to UV light and therefore had limited use. Now polyester powder is mostly used and applied in a fully automated plant.

Conventional paint is sprayed by pneumatic air-operated electrostatic reciprocating high speed discs.

A six-stage priming plant is in operation. It comprises a caustic soda dip, a water rinse, sulphuric acid pickle, a second water rinse, a de-brassing process (in which copper and zinc are electrolytically removed), and transfer to an alkali reversal bath from which the metal emerges bright and amenable to a zinc phosphate spray, finishing with a chromate wash.

Currently a new coating plant is being installed which will have four production lines and handle up to 300 cycles per hour.

The vote of thanks for a colourful and enlightening talk was proposed by Mr Jonathan Bourne to Mr Barlow and Mr Flint and was heartily endorsed by all those present.

J. C. Ellis

Further information on any items mentioned below is obtainable by completing the *Reader Enquiry Service* form at the back of the *Journal*.

### **Burmah acquires Sericol**

Burmah Speciality Chemicals Ltd has acquired all the shares in Sericol Group Ltd, a privately-owned British company with a turnover in excess of £17m and a staff of some 500.

The company specialises in the manufacture and distribution of inks and associated products for the screen printing process. According to Burmah, its technology is among the most advanced in the sector and it is market leader in the United Kingdom.

Sericol has a factory in Broadstairs, Kent, a London sales, marketing and administrative office and six distribution depots throughout the country. It has further sales and distribution in France, Germany and Switzerland, exports over half of its production to countries throughout the world and won a Queen's Award for Export Achievement in 1981. It licenses technology to manufacturers in Australia, New Zealand, Mexico, Spain, Japan and India.

The company will continue to trade as Sericol. Alex de Gelsey, its founder-chairman and chief executive, will continue as managing director and will join the board of Burmah Speciality Chemicals Ltd.

*Reader Enquiry Service No. 31*

### **Hercules modernises**

Hercules Incorporated announced in March a major modernisation project to improve operating efficiencies at the ethylcellulose and EHEC (ethyl hydroxycellulose) manufacturing facility located at its Hopewell, Virginia plant. The multi-million dollar project is to be carried out in stages with final completion scheduled for the first quarter of 1985.

According to Edwin S. Moler, business center director, coatings, "Hercules has been a leading manufacturer of ethylcellulose and EHEC for many years. This modernisation programme is an indication of the company's continuing commitment to these high value added speciality chemicals".

Ethylcellulose and EHEC, marketed by Hercules on a worldwide basis, are used in the manufacture of gravure, flexographic and silk screen printing inks, and in protective coatings.

Headquartered in Wilmington, Delaware, Hercules is a diversified worldwide manufacturer of speciality chemicals. Sales for 1982 were in excess of \$2.4 billion.

*Reader Enquiry Service No. 32*

### **Plasma technology, market research**

A study to forecast uses and markets for applications of plasma technology to polymer coatings and surface treatments is under way at Battelle's Columbus Laboratories.

The study will also review the current state of the art of plasma polymerisation in the deposition of polymeric materials. It is being sponsored by a number of companies and will help participants determine whether plasma polymerisation represents an opportunity or a threat to their operations.

According to Dr Edmund J. Drauglis, who heads Battelle's study team, recent economic and environmental considerations have prompted increased interest in plasma technology and its potential applications.

The technology can be used to apply



thin, pinhole-free, conformal, adherent polymeric coatings to a variety of substrates, such as glass, metals, wood, paper, plastics and elastomers.

Such coatings are said to be particularly useful for resistance to corrosion, abrasion and moisture, for lubrication, biocompatibility, and for gas-barrier selectivity.

"They can also be used to modify surfaces of polymeric materials", Dr Drauglis said. "In this way, they can be used for cleaning surfaces, improving adhesion or printability, reducing tack, or for activating surfaces for subsequent grafting reactions." He added that because plasma polymerisation does not use solvents it is pollution-free. In the face of environmental restrictions, this characteristic of plasma polymerisation is making the process attractive to many companies.

To carry out their study, Battelle researchers are analysing available data and gathering field information about various subject areas, including materials and equipment, processing, coatings and surface treatments, properties of coatings and treated surfaces, process economics, applications, markets, patents, and new concepts. Researchers then will assess the information before analysing and forecasting market size through to 1992.

Participation in the one-year study is still available to interested companies for US\$8,500.

*Reader Enquiry Service No. 33*

# news

## new products

### Test panel spraying

Startronic Ltd, the technical development centre for the Sheen Instrument Group, has developed an automatic paint sprayer for test panels which is controlled by a microprocessor to give a high standard of repeatability. Known as the Sheen Startronic Automatic Paint Spray, it is designed to spray test panels or groups of test panels up to 600 mm x 600 mm. It also has potential use as a production sprayer where the requirements are comparatively simple but highly repetitive.

For safety reasons the traversing mechanism is pneumatically controlled. Many programs are available within the computer memory but only four are normally chosen for access by the operator, the other programs being available by key access (holders of the key to the access switch).

Standard programs allow for variations in speed, lap distance, number of laps, number of successive coats, dwell time and spray cycle. Width can be chosen to suit operation.

At all times the gun is at a uniform distance from the plane of the test panels but an additional mechanism will be available shortly to add to existing units to allow for automatic withdrawal of the gun for, say, final coats.

The unit is suitable for pressure or gravity feed automatic spray guns of many types; these are fitted with quick release connectors to permit a complete gun change to take place in minutes. Gun angle can be altered to suit the user. The complete unit weighs approximately 150 Kg but overall size excluding the projection of the gun is 900 mm high x 850 mm wide x 400 mm deep, making it easy to transport and capable of going through a standard doorway.

*Reader Enquiry Service No. 34*

### New fluoropolymer coating

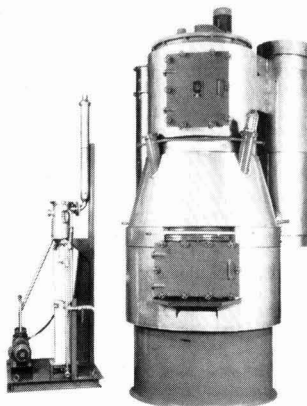
A significant advance in coating capability is claimed to have been achieved by Chemplast Inc. with the introduction of a PFA dispersion coating that allows accurate applications of PFA from 3-30 thousandths of an inch.

The new Chemfluor PFA dispersion coating is a fluoropolymer coating that combines the excellent corrosion resistance and release properties of conventional TFE coatings with the ability to withstand severe environments, for

example temperatures in excess of 500°F. In addition, the melt flow characteristics of the new material result, says Chemplast, in a virtually pinhole-free coating which will achieve optimum corrosion resistance and/or uniform electrical properties.

Chemfluor coatings, it is claimed, can be applied to most substrates regardless of their size and shape. While the most common substrate is metal, virtually any material that can withstand the curing temperature can be coated. This includes glass, rubber, wood and even plastic. Coatings can be applied as thin as 3-5 thousandths of an inch for lubrication purposes and as thick as 25-60 thousandths of an inch for corrosion resistance.

*Reader Enquiry Service No. 35*



**Continuous solvent recovery unit. Monthly capacities range from 9,600 to 153,000 litres of clean solvent**

### Continuous solvent recovery

Ateliers Sussmeyer, one of the world's leading manufacturers of plant for the chemical and paint industries, has introduced a continuous solvent recovery unit which is claimed to be reliable and economical in operation.

The equipment operates on a direct heat transfer and distillation principle and can cope with the slurries from a continuous operating period of eight hours. Before starting the working shift, pasty and solid residues are manually removed via a drainport. This operation is described as being non-skilled and taking around half an hour. Alternatively an automatic sludge removal system is available as an optional extra. The contaminated liquid is pumped into the unit, distilled via the heat exchanger, and the clean solvent is then piped away into a collecting vessel.

According to the manufacturer: based on an eight hour day and a 20 day month, and using the SRP-2 unit as an example, the equipment is capable of an output of 19,000 litres of clean solvent per month; operating costs being itemised as follows: 0.035 litre of fuel oil per litre of clean solvent, 0.035 kW of electricity

per litre of clean solvent, and 6 litres of cooling water per litre of clean solvent.

According to the manufacturer the units are maintenance free and there are six in the range with installed power ratings from 4.5 to 25 HP, and monthly production capacities from 9,600 litres to 153,000 litres of clean solvent.

*Reader Enquiry Service No. 36*

### Solution polymers for printing industries

Two new solution polymers for high quality water-based inks and over-print varnishes have been developed by the General Industries Division of Allied Colloids. They are in the Glascol range and are designated LS6 and LS8.

Glascol LS6 has been developed for glossy water-based flexographic inks to be used on paper and board. Allied Colloids describes this polymer and inks made from it as follows:

"It has excellent pigment wetting properties and is designed to be used as the sole binder since it can be used both to disperse the pigments and as the let-down vehicle.

Inks made on Glascol LS6 exhibit good gloss, excellent wet and dry rub resistance, and good soap and alkali resistance when dry. These properties make Glascol LS6 highly suitable for glossy inks for packaging or for printing on wallpaper.

The product shows excellent shear stability and good re-solubility within itself thus suggesting possible water-based gravure applications."

Glascol LS8 has been developed for glossy water-based varnishes which have to resist blocking under heat-seal conditions. Again from Allied Colloids:

"The product has a very high non-blocking temperature (ca.200°C) and good flow, gloss, shear resistance and re-solubility. It is thus highly suited to varnish applications by a wide variety of processes including gravure, dry offset, flexographic and roller coating. When dry the varnish has excellent wet and dry rub resistance, and good soap and alkali resistance."

*Reader Enquiry Service No. 37*

### Rheological "fingerprinting"

The new Series III Deer Rheometer is claimed to make possible the complete rheological investigation and characterisation of non-Newtonian liquids, gels, pastes, suspensions and semi-solids.

The new electronic instrumentation incorporates state of the art micro-processor technology and facilitates direct interfacing to any microcomputer using the IEEE bus system, e.g. Commodore PET, Hewlett Packard, Apple etc.

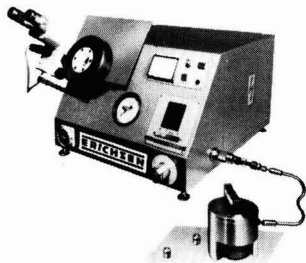


Optional add-on modules include a programmer unit which allows the user to preset automatic torque profiles including ramp up, peak hold, ramp down and cycle. Also offered is an oscillatory drive unit which permits dynamic elastic and viscous evaluations to be carried out using the instruments sinusoidal drive capability.

It is especially useful for non-destructive studies in the region of elasticity prior to the yield point. Having exceeded the sample yield point the instrument will proceed to extremely slow rotation for investigation of visco-elastic properties. Thereafter the shear stress may be increased for use as a conventional viscometer.

The infinitely variable constant stress system, incorporating a frictionless air bearing and drive assembly, allows a "rheological fingerprint" of products to be established against which batch quality and performance, e.g. shelf life, ageing, settlement rate, restructuring etc., can be checked.

*Reader Enquiry Service No. 38*



**Pearson Panke's new instrument for cupping and adhesion tests**

#### **Cupping and adhesion tests instrument**

A new instrument available from Pearson Panke Equipment Ltd designated Model 202C has been designed for the cupping test in accordance with many international standards including BS 3900 Part 4E: 1969. The test is carried out by observing (either with the naked eye or a microscope) a coating material on a sheet metal substrate as a bulge is formed in the metal until a crack appears. The test provides information on a number of important physical properties of paints and coating materials, especially in regard to their suitability for applications where some deformation is likely to occur.

The machine is driven electro-hydraulically and provided with a means of control which is said to make its operation extremely simple and flexible. The speed is variable from 12 mm per minute to 40 mm per minute, and the depth reached when failure is observed can be read off to an accuracy of 0.1 mm on a digital display. Alternative types of microscope can be provided depending on the demands of the application.

The machine in the illustration is equipped with a stereo-microscope with ten-fold magnification and a viewing area of 18 mm<sup>2</sup>. The microscope is kept in focus on the relevant zone by moving together with the drawing punch.

Alternative test tools can be set up for strips that are available only in narrow widths.

The machine shown is also equipped with the special attachment for the adhesion test for paints in accordance with ISO 4624. For this test a cylindrical block is stuck to the paint surface and a vertical pull is applied to establish how much force is needed to pull the paint off the base. The attachment for this test is connected to the hydraulic system of the testing machine, which is provided with a pressure gauge to display the force that is used.

According to Pearson, the outstanding feature of the machine, however, is that specimens of virtually unlimited size can be accommodated, which is an entirely new feature. The test head is of C-shape construction, entirely open on one side so that the test can be carried out on the edge of a large sheet or wide strip.

*Reader Enquiry Service No. 39*

## **literature**

### **The colour chemists**

A book entitled "The Colour Chemists" by A. S. Travis has been published by the Brent Schools and Industry Project to provide background information for sixth formers and teachers. Colour, both natural and synthetic, is also an important topic lower down the school.

The application of organic chemistry to industry first occurred in a dye-stuffs factory opened in 1857 beside the Grand Union Canal at Greenford Green near Sudbury and since the Association's offices are situated near to both the site of the factory and to the home of Sir William Perkin, a note on the "Perkin Connection" by the Director & Secretary appeared on p. 210 of the June 1978 issue of *JOCCA*.

"The Colour Chemists" provides a brief introduction to the early development of an industry which eventually provided modern technological society with many new and novel synthetic materials for a wide range of applications.

The author, Dr A.S. Travis, is a member of the Chemistry Department at Preston Manor High School in the London Borough of Brent. Before joining the teaching profession he was involved in the textile and printing industries for almost 20 years.

Copies of "The Colour Chemists" are available price £4.00 (inclusive of postage) from Jack Peffers, Brent Schools and Industry Project, Brent Teachers

# **news**

Centre, Ealing Road, Alperton, Middlesex (Phone: 01-902-3723).

*Reader Enquiry Service No. 40*

## **meetings, etc.**

### **1984 OCCA Exhibition**

It has been decided by OCCA's Council that in future OCCA Exhibitions are to be held every two years alternating with the Association's Biennial Conference. The venue for the next Exhibition is to be the Cunard International Hotel, Hammersmith, London and will be held from 1-3 May 1984.

Organisations wishing to receive a copy of the Invitation to Exhibit on publication should contact the Association's offices at the address on the contents page (Tel: 01 908 1086) or complete the Reader Enquiry Service Form (No. 250) at the back of the Journal.

A series of lectures by exhibitors will again be arranged, based on that so successfully introduced in 1982. These lectures were widely praised by visitors, and those giving lectures were very impressed with the response. Organisations intending to exhibit who are interested in presenting talks, films, demonstrations etc. should contact the Director & Secretary at the Association's offices.

*Reader Enquiry Service No. 250*

### **Technician's viscometry course**

Warren Spring Laboratory is to hold a two-day training course for technicians in viscometry from 28-29 June 1983 at the Laboratory in Stevenage.

This new course is aimed at laboratory technicians and experimental workers who use viscometers in their everyday work. Lectures and practical sessions will introduce participants to the latest developments in and recommended practice for measuring non-Newtonian viscosity (the flow curve) on a range of laboratory instruments. Attention will be paid to data treatment and to proper error correction. Extra topics will include viscometer selection and the testing of difficult materials.

The fee is £190 + VAT including lunches and refreshments at WSL.

For further details contact Mrs C. A. Moules, Warren Spring Laboratory, Department of Industry, PO Box 20, Gunnels Wood Road, Stevenage, Herts SG1 2BX (Tel: 0438 3388 or Telex 82250).

# bsi news

## British Standards

The publications listed below are new and revised British Standards. An existing BSI publication bearing a number identical to one announced below is automatically withdrawn. In all other cases of supersession, details are given in the appropriate announcement and a corresponding entry appears in the "Standards withdrawn" section.

3900: PVC/10  
Methods of test for paints  
3900: Part A6: 1983 Determination of flow time by use of flow cups 12 page A4 size Gr 4.  
Specifies a "break-point" method for the determination of flow time by use of ISO flow cups Nos. 3, 4 and 6 and a procedure for calibrating these cups. Limited to flow times of less than about 100 s. Supersedes BS 3900: Part A6: 1971. (ISBN 0 580 13067 3)

## Amendments

3900: PVC/10  
Methods of test for paints

The publications listed below and their prices are obtainable from: BSI Sales Counter, 195 Pentonville Road, London N1 9ND (personal callers), BSI Sales Department, 101 Pentonville Road, London N1 9ND (orders by post). Telephone: 01-537 8801. Telex 232 18.

3900: Part A3: 1970 Standard panels for paint testing  
Amendment No. 1 Gr 0 AMD 4200

## Proposed for confirmation

A note of any objections to the proposals below should be sent to the Director, Standards, by 31 May 1983.

4756: 1971 PVC/28  
Ready mixed aluminium priming paints for woodwork.

## Proposed for withdrawal

A note of any objection to these withdrawals should be sent to the Director, Standards, by 31 May 1983.

2782: Method 103A: 1970 Softening point of synthetic resin (ring and ball method)  
Superseded by BS 4692

## New work started

Resistance welding properties of primers and weld-through sealers.  
Will specify requirements for the welding properties and types of protective welding primer and weld-through sealer that

permit spot, seam or projection welding.  
Revision of BS 4129. WEE/29

## Draft British Standards for public comment

83/50746 DC BS 3483. Methods for testing pigments for paints. Part A3. Comparison of resistance to light of coloured pigments of similar types (ISO/DIS 787/15) PVC/1

## New ISO Standards

ISO 6427: 1982  
Plastics - Determination of matter extractable by organic solvents (conventional methods) 9 page F

ISO 7143: 1982  
Binders for paints and varnishes - Aqueous dispersions of polymers and copolymers - General methods of test 1 page B  
No equivalent BS

## Revised ISO Standards

ISO 473: 1982  
Lithopone pigments for paints - Specifications and methods of test 4 page C  
Will be implemented in revising BS 296

Information regarding membership of OCCA is obtainable from the Association's offices, see contents page for address.

# OCCA news

## OCCA Conference 1983

This year's Conference is to be held in York from 15-18 June at the Viking Hotel. The Conference programme, together with additional information to that shown below, can be found in the house advert on page ix.

## Conference preprints

Preprints of the papers are now being prepared and it is expected that these together with details of accommodation, badges, programmes etc, will be sent to those who have registered early in June 1983. It is a feature of the Association's Conferences that preprints are sent well in advance of the function in order to enable delegates to read them before the Conference, at which the lecturers illustrate their topics but do not read the papers in their entirety. This allows for a much longer discussion period than at many other conferences, and has proved of immense value to those attending previous Association Conferences.

## Registrations

The closing date for registrations for the Conference was given as 1 April 1983. This was primarily for the benefit of the hotel management who would be in a position to let any accommodation not taken by that date. Registrations have been received from delegates in the United Kingdom and 15 overseas countries. *HOWEVER, APPLICATIONS CAN STILL BE ACCEPTED AND DELEGATES ARE URGED TO WRITE IN TO THE ADDRESS SHOWN ON THE CONTENTS PAGE OR TO PHONE 01-908 1086.*

Council has fixed the registration fees for the York Conference at £80 plus £12 Value Added Tax for members, £110 plus £16.50 VAT for non-members, and £25 plus £3.75 VAT for spouses. The concessionary rate of £40 plus £6 VAT has again been set for retired members and Registered Students of the Association.

Daily registrations, if required, can be arranged through the Association's offices.

**Non-members wishing to avail themselves of the preferential Conference fee for members should request application forms from the Association's offices and these should accompany registration forms.**

A list of the papers to be presented together with their summaries and biographies of the lecturers were published in the January and February 1983 issues of the *Journal*.

## Social events

York is probably the most beautifully preserved historic city in Britain and is expected to prove popular and interesting to delegates. The social programme arranged for the Conference (shown below) will afford delegates an opportunity to visit places of interest.

## Wednesday 15 June

Conference assembles in the evening. Reception for overseas members and overseas visitors in the Castle Suite of the Viking Hotel at 6.30 pm (by invitation only).

9.00 pm

Session lectures and chairmen's meeting in Castle Suite.

## Thursday 16 June

9.15 am - 12 noon

First technical session in the Henley Suite.

9.30 am - 11.30 am

River Ouse Cruise (refreshments available), cost £3.00.



The Guildhall, and River Ouse, York

As an alternative to the cruise, subject to adequate response, a party will visit the National Railway Museum.

*12.15 pm*

Informal reception immediately after the technical session when those attending the Conference will be received by the President and Mrs Morris.

*2.00 pm – 4.30 pm*

Second technical session in the Henley Suite.

*2.15 pm – 6.00 pm*

Coach Tour to Harewood House. The house, designed in 1759 by John Carr and Robert Adam, is the home of the Earl and Countess of Harewood. It has the added attraction of a bird garden in its grounds, landscape park and an adventure playground. (Refreshments available.) Cost of the tour is £6.00 per person including admission charge and gratuities. Coach leaves from Viking Hotel forecourt.

Arrangements have been made for a golf tournament to be played at the York Golf Club, Strensall, York. Green fees, to be paid direct to the club, at the time of going to print are £6.50 per player. Caddy cars are available and arrangements for catering can be made. The OCCA Conference Golf Trophy, presented by Mr S. Sharp, will be held until the next Conference by the winner of the golf tournament.

*Evening*

Theatre party to Theatre Royal – details will be sent to those requesting information.

**Friday 17 June**

*9.15 am – 12 noon*

Third technical session in Henley Suite.

*9.00 am – 12 noon*

Coach tour of the City of York. Cost of tour inclusive of coach, entrance fees and refreshments in the medieval guildhall of the Merchant Adventurers in Fossgate, £3.50 per person.

*12.30 pm – 1.00 pm*

President's reception for Council members, overseas presidents, etc. (**by invitation only**).

*2.15 pm – 4.15 pm*

Fourth technical session in the Henley Suite.

*2.15 pm – 5.30 pm*

Coach tour to Castle Howard. A magnificent 18th century house near York, designed by Vanbrugh for Charles Howard, third Earl of Carlisle, still

**OCCA  
news**

occupied by the Howards. The house contains fine collections of porcelain, paintings and furniture and was recently used for filming the television series *Brideshead Revisited*. The costume galleries house Britain's largest private collection of 18th to 20th century costume (refreshments available). Cost of the tour is £5.00 per person including admission charge and gratuities.

*4.15 pm*

Association Annual General Meeting in Henley Suite.

*Reception 7.00 pm*

*7.30 pm – 1.00 am*

Association Dinner Dance in the Viking Hotel. Evening dress (black tie) or dark suit will be worn.

**Saturday 18 June**

Conference disperses after breakfast.

Further information may be obtained from the Director & Secretary at the address on the contents page of this issue (Tel: 01-908 1086; Telex 922670 OCCA G).

## Report of Council meeting

A meeting of the Council took place at 2.00 p.m. on Wednesday 23 February 1983 at the Great Northern Hotel, King's Cross, London N1 9AN. In the absence of the President, on business abroad, it was resolved by Council that Mr C. N. Finlay (President Designate) should take the chair. There were 27 members present.

Before turning to the business of the meeting, those present stood in silent tribute to the memory of the two former Council members – Mr H. R. Touchin (a former Chairman of the Manchester Section) and Mr J. D. W. Davidson (a former Chairman of the Scottish Section) – whose deaths had occurred since the last Council meeting. The Council also noted with sadness the death of Anita, wife of Past President Mr Silver, who had contributed much to the work of the Association.

The draft Annual Report for 1982 was tabled and minor amendments were noted.

The draft Agenda for the Annual General Meeting on 17 June was considered.

It was agreed to hold the Council Reunion Dinner at the Great Northern

Hotel, King's Cross, London after the Council meeting on 26 October 1983.

Details concerning the York Conference programme were discussed. It was reported that an exhibitor at OCCA-34, Pearson Panke Equipment Ltd, had kindly offered an additional trophy for the golf tournament and this was accepted by Council with thanks.

It was reported that Mr B. J. Lourey, the Federal President of OCCA Australia, Mr C. Boyce, President of FSCT, and Mr G. Abelsnes, President of SLF, would be attending the Conference.

It was hoped that M. R. Capanni, President of FATIPEC, would also be present and plans were in hand for meetings of the International Co-ordinating Committee and an OCCA International Committee. It was further reported that chairmen had been appointed for all four sessions as follows:

Session I Mr J. R. Taylor  
Session II Mr R. B. Tennant  
Session III Mr T. Graham  
Session IV Mr F. H. Palmer

Some of the 19 papers to be presented had been received and were being edited, so that preprints could be sent to delegates at the beginning of June.

Members of Council were urged to encourage as many members (and non-members) as possible to attend, since the programme was one which should appeal particularly to the paint industry, as almost half the lectures would be given by personnel employed in the industry.

The Chairman of the Manchester Section, Mr F. B. Redman, had written to the chairmen of the Hull, Newcastle and West Riding sections after consultation with the Director & Secretary suggesting that special arrangements at a concessionary rate for day-visits could be made by the four sections. Any member attached to these sections who wishes to participate in this venture should contact the Section Chairman concerned as soon as possible.

It was resolved unanimously that any member whose current subscription was three months in arrears should not receive issues of *JOCCA* after 1 April 1983 until payment of all subscription due, and would not be entitled to receive any issues published during the period of arrears.

It was reported that the Finance Committee would be meeting, as usual, in March in order to present the accounts for 1982 to the April Council meeting.

With regard to the Exhibition, Council

decided to ask the Exhibition Committee to organise an exhibition at the end of April/beginning of May 1984 and to consider the question of holding the Exhibition biennially, i.e. alternating with the Conference. It was reported that ISE had decided not to proceed with the arrangements for an exhibition to be organised by them and sponsored by OCCA in 1985 as they felt that the time was not propitious as two other major exhibitions had been postponed.

Council noted with interest the cover of the February issue of *JOCCA*, which showed the 80 countries to which the *Journal* is sent each month, and the high number of copies sold to non-members in comparison with those of other societies and also with the paid circulation of journals run by other publishers. Interest in advertising in the *Journal* had shown a pleasing increase in the first two issues of the year, which had been re-styled so as to give the maximum usage of the pages available. All members of Council and the Association were asked to ensure that advertising departments and suppliers were made aware of the value of advertising in the Association's *Journal*; advertising packs with full details are available upon request from the Association's offices.

Discussion on the monograph series took place since it had been hoped that members in retirement would be able to contribute monographs on specific topics such as "aircraft finishes" or any topic of general interest to the industries. Members of Council were asked to make it widely known that suggestions for topics and authors for monographs would be welcomed; any member wishing to offer suggestions or services in this venture should write to the Director & Secretary.

The Reader Enquiry Service had been in operation for more than three years and it was reported that this service had been intensively used by readers.

It was reported that the Jordan Award Committee had met but had not been able to recommend that an award should be made on this occasion. Senior members of the Association were asked to encourage younger personnel to submit papers for publication in *JOCCA*, which would make them eligible for consideration for the Award; those applying for the Licentiate might wish to re-submit written work for publication in *JOCCA* and this could be considered for the Award.

The Hon. Technical Education Officer explained the problems and financial commitments which would be involved in

producing a programme for distance learning, and it was noted that the Ontario Section's first Diploma course at a technical institute had been completed.

Other items reported to the Council were the preliminary work on the 1985 Edinburgh Conference, which will coincide with the Royal Highland Show, and the arrangements for papers nominated by the Association at the FSCT meeting in Montreal (12-14 October 1983) when Mr J. M. Rackham of BTP Toxide would present a paper, and at the FATIPEC Congress in Lugano (23-28 September 1984) at which a paper would be presented by Mr A. C. D. Cowley of ICI Organics Division.

The Director & Secretary reported that a meeting of the Professional Grade Committee had taken place earlier in the day and two members had been admitted to the Associateship Grade. The Professional Grade Committee recommended to Council that Regulation 5 governing the Licentiate should be amended by deleting the words "a dissertation" and inserting instead the words "written evidence". It was felt that this would encourage younger members, who might not wish to write a full dissertation on a subject, to submit reports projects or other work of relevance to their studies, and they would still be subject to a *viva voce* examination. Council accepted this recommendation and asked all senior members to make it widely known amongst younger members.

It was reported that the Society of Dyers & Colourists had presented the Association with two copies of the Pigments and Solvent Dyes volume of the Colour Index - one for review in *JOCCA* and the other, personally inscribed by the President of the Society (Mr Stewart Schofield), to be kept at Priory House in recognition of the assistance given by members of the Association in compiling the work.

Mr D. S. Newton agreed to serve on a BSI Committee on zinc phosphate primers and micaceous iron oxide paint.

There being no other business, the Council recorded its thanks to Mr C. N. Finlay for taking the chair and he declared the meeting closed at 4.00 pm.

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## Eastern Branch

### Annual Burns Supper

The Commodore Hotel, Edinburgh was again the venue for the Annual Burns Supper organised by the Eastern Branch of the Scottish Section, held on 11 February 1983.

Following the traditional pattern of previous years, some 74 members and guests enjoyed an excellent five course meal, the haggis and venison courses

being particularly favourably commented upon.

The Selkirk Grace preceding the meal was given by Mr A. McKendrick, and the address to the haggis was rendered by Mr A. Hamilton with such enthusiasm that all present could follow and understand the meaning in Burns' lines. Following the meal, the toast to the Queen was proposed by the Chairman, Mr T. McMahon.

The proceedings were continued by Mr W. Renwick giving the Immortal Memory, with interesting and new insights into the remarkable but short life of Robert Burns.

Further entertainment was provided by a selection of Burns' songs, sung by Mr A. Hamilton and accompanied on the piano by Mr M. Temple. A splendid example of the art of Scottish fiddle playing was given by Mr J. Ferguson, who performed a selection of fiddle tunes.

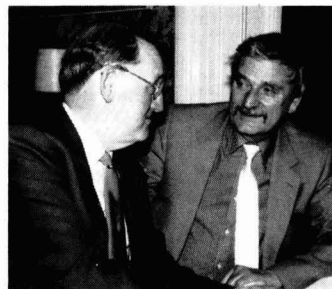
The poem Tam O'Shanter was recited by Mr H. Ward with such skill that the scenes described were all too clear in the imagination. Mr Ward also proposed the Toast to the lassies, and thanks to the guests and artistes were proposed by Mr G. Hutchinson. Pipe music was provided by pipers Mr G. Lanlands and Mr C. McPherson, who performed the task of piping in the haggis.

The evening was concluded by the singing of Auld Lang Syne, with general agreement that this event is one not to be missed in the OCCA calendar.

E. P. Sinclair

## Manchester Section

Manchester Section held its customary winter committee meeting at Grange-over-Sands on 4 February. This year we were pleased to receive the President as our special guest, along with four past Section chairmen and former officers and committee members.



The President, Don Morris, sharing an after-dinner anecdote with Jack Mitchell, past Chairman of Manchester Section

F. B. Windsor

**OCCA CONFERENCE**

15-18 June 1983

The Viking Hotel, York, England

**The efficient use of surface coatings****Session I "Formulation including manufacture"**

Thursday 16 June 9.15 a.m.-12 noon

**Keynote address**

Surface coatings in relation to external insulation

The need for speed and accuracy in the formulation and production of efficient surface coatings

Automated paint manufacture

Linear polymonosulphide and polysulphide polymers - general survey recent developments and applications

(paper presented on behalf of FATIPEC)

Chairman: Mr J. R. Taylor (Hon. Research &amp; Development Officer)

By Mr R. A. Fidler (International Paint PLC)

By Dr M. Wilkinson (Blundell Permoglaze Ltd)

By Mr R. J. McCausland (Bayswell Consultants)

By Mr W. Ollett (Crown Decorative Products)

By Prof. Brossas (University of Louis Pasteur)

**Session II "The use of computers and other advanced techniques in surface coatings"**

2.00 p.m.-4.30 p.m.

Introduction to computer technology

Solving paint problems with computers

Introduction of microprocessors in surface coatings

The use of NMR in the characterisation of polymers used in surface coatings

Efficiency and change in metal decoration

Chairman: R. B. Tennant

By Mr G. T. Eady (Ault &amp; Wiborg Paints Ltd)

By Mr H. J. van der Stoep (Sikkens Ltd)

By Dr A. Carrick (Kratos Ltd)

By Dr M. Marshall (MQAD)

By Dr A. Gamble (J &amp; C Ink Co. Ltd)

**Session III "Maintenance of quality and prediction of performance"**

Friday 17 June 9.15 a.m.-12 noon

Quality control and standardisation in the titanium pigment industry

Prediction of performance of exterior wood coatings

Prediction of salt spray results from formulation parameters (paper presented on behalf of FSCT)

Acoustic emission - further unpublished results of the new technique for the study of paint performance during environmental exposure tests

Wood protection - the interaction between substrate and product and the influence on durability (paper presented on behalf of SLF)

By Mr K. Kleive (A/S Jotungruppen)

Chairman: Mr T. Graham

By Mr R. Blakey (BTP Tioxide Ltd)

By Dr E. R. Miller (Building Research Station)

By Dr F. L. Floyd (Glidden Inc.)

By Mr T. A. Strivens (ICI Paints Ltd)

**Session IV "The efficient use of coatings application"**

2.15 p.m.-4.15 p.m.

Quality control of application of coatings and technical developments which have occurred

The use of modern application equipment and its efficiency

Paint finishing in the car industry

Fire retardancy of coatings systems and application techniques

Chairman: Mr F. H. Palmer

By Mr D. Bayliss (ITI Ltd)

By Mr M. Eaton (Kremlin Spray Painting Equipment Ltd)

By Mr Quick (Talbot)

By Dr F. G. R. Zobel and Mr D. Bishop (British Railways)



York is probably the most beautifully preserved historic city in Britain and is expected to prove popular and interesting to delegates. The social programme arranged for the Conference will afford delegates an opportunity to visit places of interest including York Minster, the world famous Castle Museum and the National Railway Museum. Coach tours have been arranged to Castle Howard, Harewood House and the City of York, together with a river cruise from the hotel's landing stage.

**REGISTRATION FEES**

Council has fixed the registration fees payable at the same level as for the 1981 Conference: £80 plus £12 Value Added Tax for members, £25 plus £3.75 VAT for partners and £110 plus £16.50 VAT for non-members. Council has again made a concession for Retired Members and Registered Students of the Association in fixing a reduced fee of £40 plus £6 VAT, the same rates as in 1981.

**DAILY REGISTRATION**

Daily registration will be available, again at the same rates as in 1981, to members of the Association at £45 plus £6.75 VAT per member per day for Ordinary and Associate Members (£25 plus £3.75 VAT for Retired Members and Registered Students of the Association), which will include copies of the preprints, but not facilities for attending the social functions.

**ACCOMMODATION**

Delegates attending the Conference will be accommodated in the Viking Hotel; the daily rates including VAT being as follows: single room £48.30, twin bedded room £40.80. For children under the age of 14 sharing their parents' room there is no charge for the extra bed; children occupying their own room will be charged at £12.

**GENERAL**

At the beginning of June 1983, members and non-members who have registered for the Conference will receive preprints of the papers to be given, together with a Conference folder, which will contain a Conference badge, a descriptive leaflet of York, street map, details of allocation of rooms, etc.

FURTHER DETAILS ARE SHOWN ON PAGES 152 AND 153 AND ARE AVAILABLE BY CONTACTING:

THE DIRECTOR & SECRETARY, OCCA, PRIORY HOUSE,

967 HARROW ROAD, WEMBLEY, MIDDLESEX HA0 2SF, UNITED KINGDOM.

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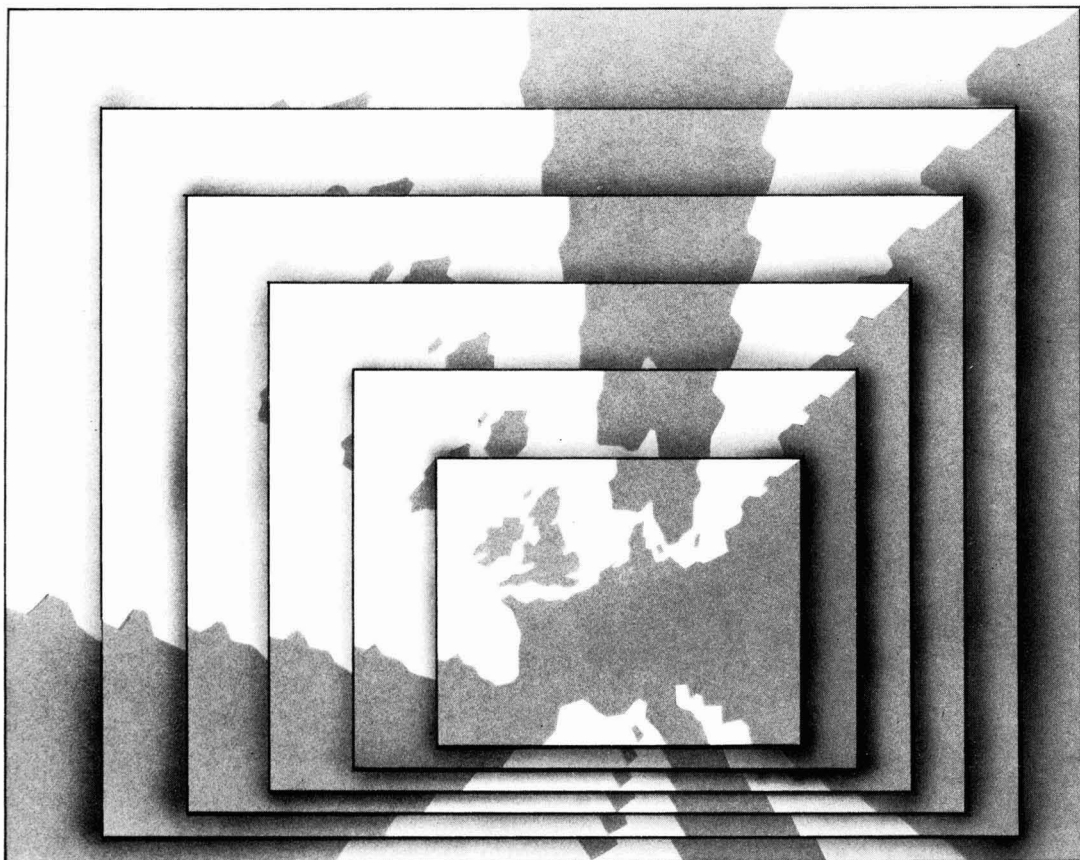
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