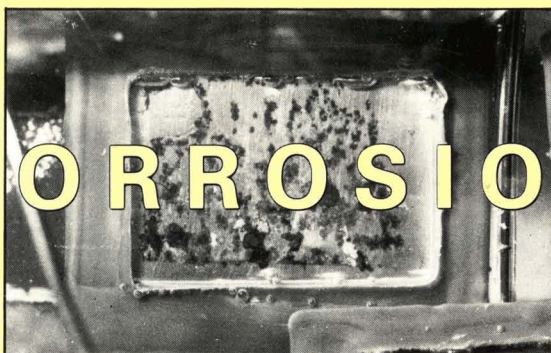
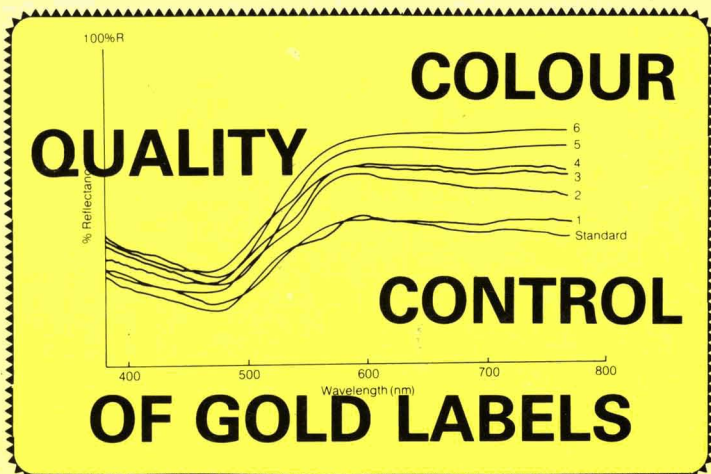


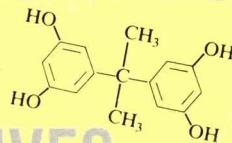
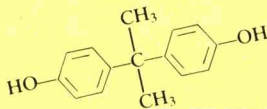
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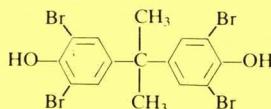
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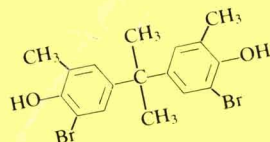
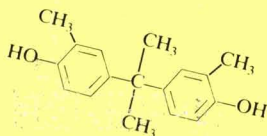
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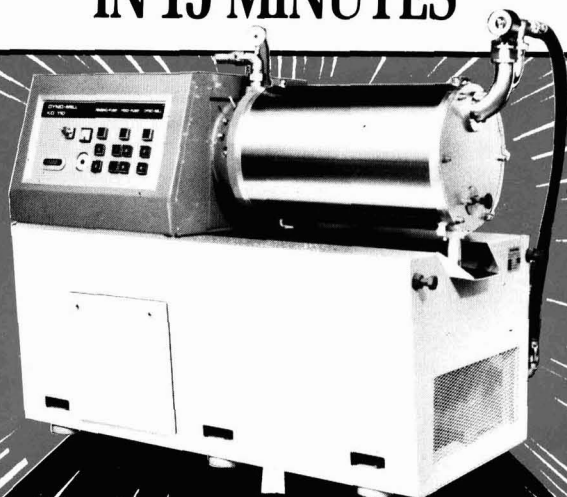


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The influence on corrosion of the adhesion of a coating to a metal substrate

K. R. Gowers* and J. D. Scantlebury

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Abstract

Potential measurements were conducted on mild steel specimens with adherent or non-adherent lacquer coatings, under immersion in aerated 3% sodium chloride solution.

It is thought that the beneficial role of adhesion was in impairing the formation of a layer of electrolyte at the coating-substrate interface, thus preventing the spread of areas of corrosion over the substrate surface. Striking similarities were found in the potential/time behaviour for specimens cut from the same lacquer-coated substrate, suggesting the corrosion processes to be particularly dependent on the physical structure of the coating.

Introduction

The relationship between the corrosion processes underneath a coating and its adhesion to the substrate is complex. It is not certain whether corrosion is consequent upon loss of adhesion or vice versa.

James¹ made specimens of cold-cured epoxide resin paints on substrates of either steel or glass panels. He immersed these in deionised water and compared the loss of adhesion. Where blistering occurred on steel, it also occurred on glass, and in many cases it occurred on glass, but to a negligible extent on steel. In one case blistering occurred on steel without there being any corrosion. James therefore suggested that the primary process was blistering, with corrosion consequent upon this.

However, Gay² studied mild steel panels coated with various paint systems, immersed in sea water, and found that corrosion of the steel substrate accompanied blister formation, although it sometimes occurred at an appreciable distance from it. If corrosion did not occur, the blisters did not develop to an appreciable size, implying the dependence of loss of adhesion upon the corrosion processes.

Garber and Zuev³ showed a relation between corrosion and adhesion by comparing the corrosion rate of steel bonded to chlorinated neoprene or polyethylene films with different adhesives (chlorinated neoprene, polyisobutylene, or liquid polysulphide rubber), and exposed to a 10% salt acid environment. The corrosion rate was found to be inversely dependent on the strength of the adhesive, it being slowest for liquid polysulphide rubber, faster for polyisobutylene, and fastest when chlorinated neoprene was used as adhesive.

However, a correlation between loss of adhesion and corrosion does not always seem to exist. For example, Schwenk⁴ immersed steel specimens coated with bitumen, polyethylene, tar pitch epoxide resin, and tar pitch polyurethane in 0.5M sodium chloride solution (sometimes with addition of hydrochloric acid or sodium hydroxide). He maintained that loss of adhesion itself had no adverse

effect on the protection from corrosion, a conclusion also arrived at by Walker⁵.

Walker used tensile tests to measure the adhesion of several different types of coatings to steel substrates before and during immersion in distilled water or 3½% sodium chloride solution. He found that there was an appreciable loss of adhesion within about the first 10 hours of immersion, several of the coatings losing between 50 and 75% of their original adhesion. No correlation was found between adhesion and corrosion, coatings with lowest adhesion sometimes showing the greatest corrosion resistance.

Many workers have found the properties of attached coatings to be significantly different from those of the corresponding free films. Funke and Haagen⁶ measured gravimetrically the water uptake with time for a series of electrodeposited paint films, free or attached to steel substrates, held at 90% humidity. They found that if no interfacial failure occurred, the water absorption of the supported film remained below that of the free film. If interfacial failure did occur, the absorption curve of the supported film crossed over that of the free film. This behaviour has also been reported by D'Alkaine et al⁷ for epoxy resin paint coatings (free or attached to steel) in sodium chloride solutions of different concentrations.

Elisavetskii, Mironova, and Vedenov⁸ determined the diffusion coefficients for the diffusion of acetic through polyvinyl chloride based coatings, by measurement of absorption by weight and application of Fick's Law. They found the diffusion coefficients to be greater for unsupported films than for coatings attached to steel substrates, but both increased at approximately the same rate with increase in acetic acid concentration.

Murray⁹ measured absorption and desorption of chloride ions for free epoxy polyamide films and corresponding coatings attached to aluminium substrates, in 10% sodium chloride solution, using a chloride ion selective electrode. Desorption of chloride ions from the free films occurred more rapidly than from the attached coatings. Absorption was faster in the free films for the first six hours of immersion, but thereafter faster in the attached coatings.

Thus we have a general idea of a coated specimen being immersed in solution taking up water and other species at a slower rate than would a free film. However, after a certain initial period, it appears that the adhesion has fallen well below its original value, and the uptake of water and other species becomes easier than would be the case for a free film.

Associated with this is the work of Mikhailovskii et al¹⁰ on the corrosion of magnesium substrates underneath adherent and non-adherent coatings of polybutylmeth-

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acrylate in 26% hydrochloric acid solution. The corrosion rate was evaluated by measuring the change in electron conductivity of a thin metal substrate. It was found that the induction period before the onset of corrosion was significantly larger under adherent films than under free films. When corrosion started, it was smaller under adherent films at first, but the corrosion rates under adherent and non-adherent films soon became equivalent. It was suggested that the influence of adhesion lasted only until the surface atoms of the substrate were ionised.

Our work has used a similar technique to that of Mikhailovskii et al in that we have compared steel specimens with adherent or non-adherent coatings during immersion in 3% sodium chloride solution, relating the visual changes in corrosion to the changes in potential of the specimens.

The materials

The polymer used in the lacquer coatings was VAGH, manufactured by Union Carbide, and consisted of 91% vinyl chloride, 3% vinyl acetate, and 6% vinyl alcohol. VAGH resin was plasticised by an acrylic polymer, and dissolved in xylol and methyl iso-butyl ketone. The full formulation, designated vinyl acrylic (2:1) lacquer, was:

Vynilite resin VAGH	100g
Paraloid B-66 (Acrylic)	50g
Xylol	450g
MIBK	170g

The substrates were 1.2 mm mild steel "Gold Seal" test panels, supplied by Pyrene Chemical Services Ltd.

Experimental method

Four 15 cm x 10 cm mild steel panels were degreased with trichloroethylene, polished to 1200 grit with carbide paper, cleaned with trichloroethylene, and stored in a desiccator for one week. Two 15 cm x 10 cm free films were prepared from the vinyl acrylic (2:1) lacquer by casting on to glass plates, spinning and drying in a dust-excluding environment at room temperature, followed by immersing in deionised water, peeling off from the glass plates, and drying in a desiccator.

After again degreasing the mild steel panels, films of the same lacquer were likewise formed directly on two of the steel panels, again by spinning. The panels were cut in half, and an electrical connecting wire was attached to each 10 cm x 7.5 cm panel, the panels then being coated with a 3:1 mixture of beeswax and colophony resin, such as to leave only an area of 7.25 cm x 4.75 cm unmasked on each panel.

Each of the other two steel panels and each of the previously prepared free films was cut in half. One of the 10 cm x 7.5 cm free films was laid on the surface of each 10 cm x 7.5 cm panel and attached only at the edges of a 7.25 cm x 4.75 cm area (using the coating lacquer as adhesive). An electrical connecting wire was attached to each panel, and each panel was coated with beeswax and colophony resin mixture, such that only the 7.25 cm and 4.75 cm area remained unmasked.

Thus four specimens had been prepared with the lacquer film adherent to the substrate, and four specimens with the lacquer film non-adherent to the substrate. Measurements

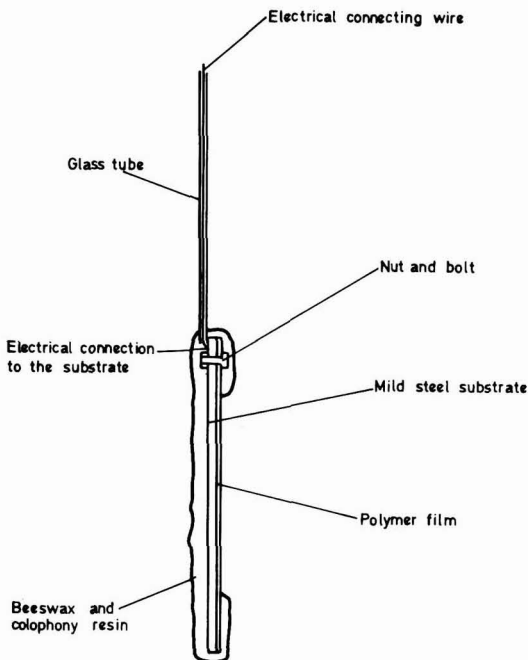


Figure 1. Specimen structure.

with an Elcometer minitector thickness gauge showed that the thickness of the coatings were all between 26 and 29 μm . A specimen is illustrated in Figure 1.

All the specimens were immersed in a tank of aerated 3% sodium chloride solution, and measurements of potential versus saturated calomel electrode were taken at regular intervals, over a time period of 800 hours, using a Sinclair Multimeter DM450. Visual observations were also recorded. The pH of the solution was measured with a Jenway 6030 pH meter as being 6.30, and the conductivity (measured with a Corning PTI-8 conductivity meter) was 21mS/cm. The temperature was thermostatically controlled at 24°C.

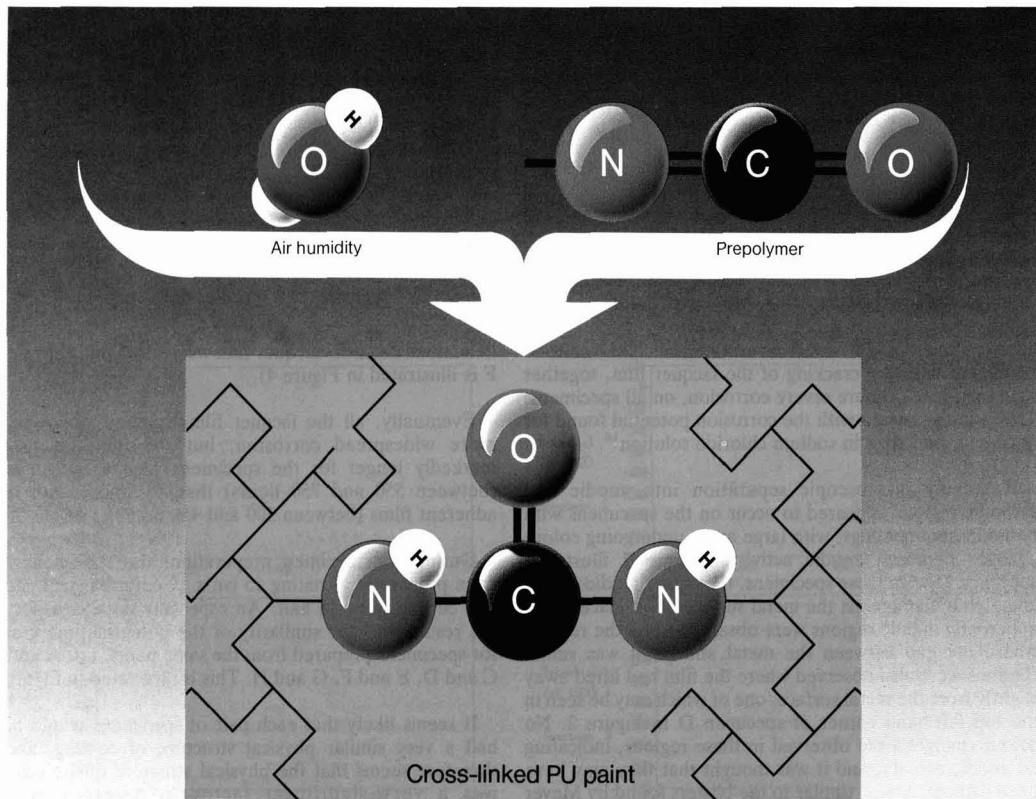
Results

Corrosion was observed to start within the first ten hours of immersion on the specimens with the non-adherent films, and after about twenty-five hours on the specimens with the adherent films.

Initially, blue coloration was observed on both types of specimens, followed subsequently by yellow, orange, brown and black. The behaviour appeared complex, and different areas of the specimens would start to corrode at different times.

It is not easy to interpret potential measurements, but it has been suggested that they are influenced by the effects of paint film resistance and anodic:cathodic area ratios, according to Mayne¹¹ and Leidheiser and Kendig¹². On both types of specimen, sudden falls in potential could often be correlated with an increase in the extent of anodic areas, given that the colour changes to blue, yellow, orange and brown could be associated with anodic activity, as suggested on the basis of experimental findings in previous work undertaken by ourselves¹³. A potential fall to

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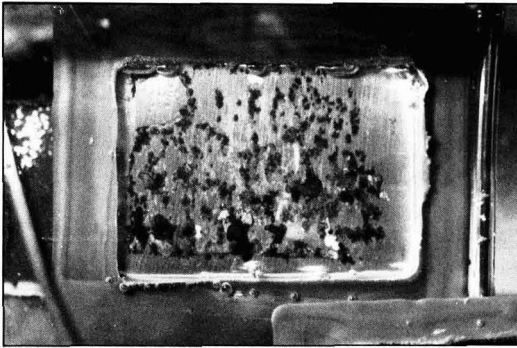


Figure 2. Specimen D after 265 hours in 3% sodium chloride solution, illustrating relatively macroscopic anodic and cathodic areas (This specimen had a non-adherent coating).

approximately -700mV versus saturated calomel electrode correlated with the cracking of the lacquer film, together with the onset of more severe corrosion, on all specimens. This is in agreement with the corrosion potential found for uncoated mild steel in sodium chloride solution¹⁴.

Relatively macroscopic separation into anodic and cathodic regions appeared to occur on the specimens with non-adherent coatings, with large areas undergoing colour changes denoting anodic activity. (Figure 2 illustrates specimen D). On these specimens, the paint film did not lie completely flat against the metal surface in all places. The apparently anodic regions were observed to be the regions where the gap between the metal and paint was small. Regions were also observed where the film had lifted away slightly from the metal surface, one of which may be seen in the top left-hand corner of specimen D in Figure 2. No colour changes were observed in these regions, indicating no anodic activity, and it was thought that they may have been cathodic areas, similar to the blisters found by Meyer and Schwenk¹⁵ in cathodic polarisation experiments.

Those specimens with the non-adherent coatings appeared to exhibit a type of crevice corrosion situation underneath the paint film. A similar type of situation has been proposed as causing the anodic undermining of paint films in some instances by Koehler¹⁶, and this crevice-type situation may be responsible for the region adjoining a scribe mark in a paint film having been found to be anodic under certain conditions, as illustrated by the work of Koehler¹⁶, Hepworth et al¹⁷, and Anderton¹⁸. A schematic illustration of the proposed situation is given in Figure 3.

It is thought that on the specimens with adherent coatings the adhesion would prevent diffusion of species along the metal coating interface, and indeed these specimens appeared to have smaller anodic regions. No areas of

Figure 3. Diagram of corrosion on a specimen with a non-adherent coating.

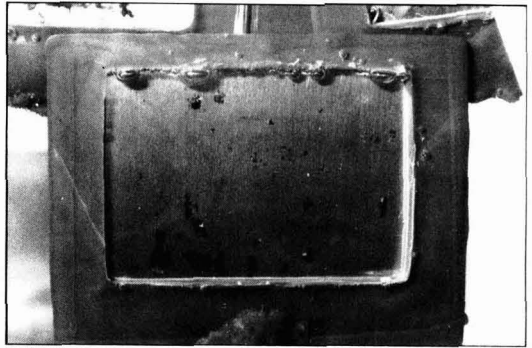
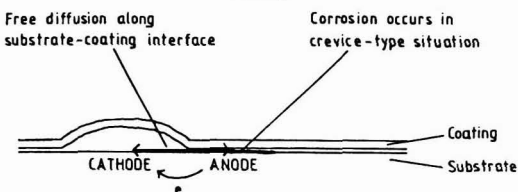


Figure 4. Specimen F after 265 hours in 3% sodium chloride solution, illustrating relatively small anodic areas and absence of cathodic delamination (This specimen had an adherent coating).

delamination of the lacquer film were observed. (Specimen F is illustrated in Figure 4).

Eventually, all the lacquer films cracked, followed by more widespread corrosion, but the time taken was markedly longer for the specimens with adherent films (between 550 and 750 hours) than for those with non-adherent films (between 300 and 450 hours).

During the specimen preparation, the specimens had been prepared by coating 15 cm x 10 cm mild steel panels and cutting these in half. An especially notable aspect of the results was the similarity of the potential/time graphs for specimens prepared from the same panel, i.e. A and B, C and D, E and F, G and H. This is illustrated in Figure 5.

It seems likely that each pair of specimens would have had a very similar physical structure of coating, and it therefore seems that the physical structure of the coating was a very significant factor in determining the potential/time behaviour of each specimen, and presumably also the corrosion behaviour in general.

Discussion

Based on the results obtained from these experiments, it was thought that the most important factor determining the degree of protection of the metal substrates by the polymer coatings was the physical structure of the coating, and particularly any defects in the coating. This explains why supposedly identical specimens gave markedly different behaviour, and is related to the findings of Mayne and co-workers¹⁹⁻²², concerning the inhomogeneous nature of polymer coatings. Mayne and co-workers related this to the degree of cross-linking in the coatings, but Googan²³ has drawn a comparison between this and the influence of physical defects in the coating.

Corrosion was thought to be promoted by chloride ions, as proposed by Schober²⁴ and Bellobono et al²⁵, and these would be able to diffuse through any physical defects in the coating to the coating-substrate interface.

The formation of a layer of electrolyte at the coating-substrate interface has been proposed by (amongst others) Funke and Haagen⁶, Koehler²⁶, Bellobono et al²⁵, Leidheiser, Wang and Standish²⁷, and Rozenfel'd et al²⁸. In our experiments, a much more discreet distribution of relatively macroscopic anodic and cathodic areas was

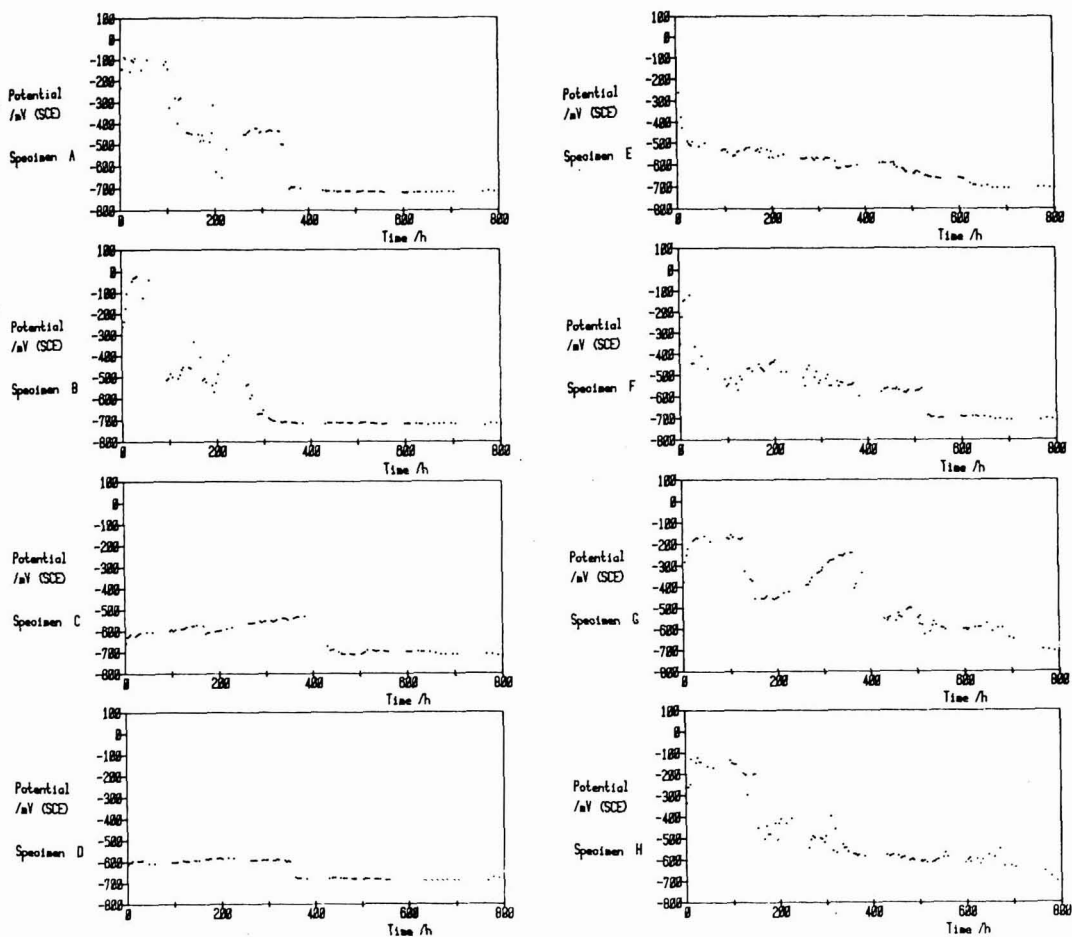


Figure 5. Potential/time curves. Note the similarity between specimens cut from the same panel, i.e. A and B; C and D; E and F; G and H.

observed when there was no adhesion, both on specimens contaminated and uncontaminated before coating. It is thought that the beneficial role of adhesion was in impairing the formation of a layer of electrolyte at the interface, and thus in preventing the spread of the macroscopic areas of corrosion over the substrate surface.

It is proposed that this electrolyte layer at the interface would consist of a relatively concentrated solution with respect to the external solution, and could thus promote further uptake of water through the coating due to osmosis, and that this might cause cracking of the coating.

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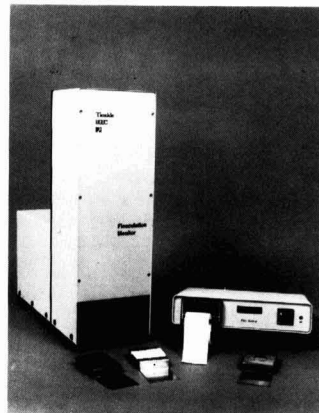
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Colour quality control instrument system with particular reference to the printing of gold labels

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Abstract

A colour measurement system for discriminating differences on small areas of printed gold labels is described. The system is non-dedicated and incorporates an integrating spheroid which conforms to the regulations of CIE. Colour difference is computed from L, a, b colour space, derived from tristimulus values. The flexibility of the system allows measurement to be extended into the UV region for varnished coatings, where small differences can be further resolved by the application of derivative spectroscopy.

Introduction

The measurement of colour is an important aspect of quality control in the printing industry. Care has to be taken to ensure that the final colour matches that specified by the customer, be he a publisher or a manufacturer whose packaging is used as a trademark, to inspire appeal and reliability in his product. In the production of tinted paper, particularly with delicate colours, the colour can drift over a long time especially if the only checks made are against a sample from the last batch. Even the reproducibility of black ink is significant as some newspaper and magazine printers maintain a special 'tone' for specific items. To match a particular black by visual means only is an extremely difficult task. In the consumer market colour, too, is important. Manufacturers would not wish to have their sales prospects affected by poor quality labelling, because a lighter shade might be the result of fading, which in turn could indicate deterioration of the contents. Similarly, variation in the label colour may reflect poor quality control of the product inside. Fastness to light of the ink/paper combination is thus another important parameter to measure and control.

To achieve colour control the manufacturer needs to define to the label printer strict limits of acceptability. The printer then has to ensure that these are maintained by checking from batch to batch, and also within batch to ensure colour uniformity over the whole printed surface area.

This article describes a Colour Measurement System which meets these requirements. It employs the CIE¹ recommendations for the specification of colour and the use of non-dedicated colour measurement instrumentation. The instrumentation's applicability to the needs of the printing industry is highlighted by its power to discriminate subtle shades of gold on small areas of labels printed for various manufacturers in the alcoholic beverage industry. Reference is made to its capability for extending reflectance measurements into the ultra-violet region of the spectrum to investigate the presence of UV-absorbing coatings used in the printing process. The advantage of using derivative spectroscopy to enhance detail from the colour measurement reflectance spectra, as a sensitive means of discrimination between "similar" samples, is also described.

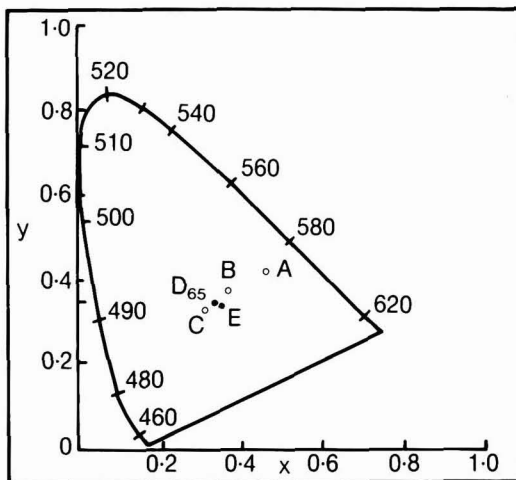


Figure 1. CIE chromaticity diagram showing spectrum locus, standard illuminants A, B, C and D₆₅ and equal energy white, E.

The CIE System

The Commission International de l'Eclairage first approached the specification of colour in 1931. A full description of the CIE system is outside the scope of this paper but a clear explanation is given in the literature^{2, 3}.

When we observe a coloured surface, a number of factors influence the way in which we interpret colour. Although any colour can be defined in terms of three primary colours matching functions, coloured objects depend for their appearance on the lighting conditions under which they are viewed. Four standard illuminants have therefore been defined by the CIE to represent those most widely encountered. Illuminant A represents normal tungsten lighting; illuminant B, noon sunlight; and illuminants C and D, daylight. To take into account the different colour balance of the various illuminants, the colour matching functions are weighted appropriately for each particular illuminant. The colour of a surface can then be defined by three tristimulus values, X, Y and Z, which actually relate to the reflectance of three primary colours and to the overall brightness or "luminance".

An important concept in the CIE System is the chromaticity diagram shown in Figure 1. The axes of the diagram x, y are defined in terms of the three tristimulus values. All non-fluorescing colours lie within the curved part of the graph (the "spectrum locus") with equal energy white lying in the centre. However, the Y tristimulus value is a direct measure of luminance (or brightness of the sample) and so the Y axis would be perpendicular to the

page in the chromaticity diagram. Thus, a colour can be specified in the CIE System simply by its chromaticity co-ordinates x , y , and its luminance value, Y .

Various ink colours are specified for the printing trade in terms of their chromaticity co-ordinates with limits on their tolerances expressed as an area on the chromaticity diagram. These specifications are contained in British Standards BS 2650 (lithographic inks), BS 3020 and BS 4160 (letterpress inks).

Colour matching

When the printer is asked to produce material to a given standard he will be concerned with the closeness of match, or tolerance allowed, between standard and sample. If the material is to be printed by a batch process, then successive batches will be required to lie within certain defined tolerances. The CIE System described above would appear to provide a very simple means of specifying these tolerances. Unfortunately, in the chromaticity diagram, the colour space is non-uniform—i.e., two blues just noticeably different would appear very close together, whereas two greens, also only just noticeably different, may be spaced relatively further apart due to the “stretching” of the area representing green colours. Attempts have therefore been made to derive a more uniform colour space distribution by mathematical transformation, e.g. the widely used CIE 76⁴ formula. This squeezes the colour space so that the two blues and greens mentioned above appear the same number of units apart.

Further parameters used to specify colour are chroma (the degree of colour saturation relative to brightness) and hue, the type of colour. Both of these can be inferred from the transformed chromaticity diagram.

Instrumentation for colour measurement

Any instrumental technique for colour measurement must simulate the response of the human eye and the effect of a particular illuminant. This can be achieved physically, e.g. with coloured filters or mathematically by computing the tristimulus values X , Y , Z , from a reflectance spectrum. Two basic types of instrument are thus to be found.

The first is a simple colorimeter in which the spectral distribution of an appropriate source (usually D_{65}) and the response functions of the eye are matched as closely as possible by careful choice of the detector/filter/lamp combination. These instruments usually only read X , Y , Z values for one illuminant. Also because of the difficulties in relating the colour matching functions between one instrument and another, they are normally recommended for relative measurements only. Care has to be taken with their use as they can give mis-leading results on samples which exhibit metamerism (samples which match perfectly under one illuminant but appear as two distinct colours under another).

The second option is a spectrophotometer with which the actual reflectance spectrum of the sample is plotted. Data are then processed on- or off-line to give tristimulus values and chromaticity co-ordinates for any desired illuminant. Example of such an instrument is the Philips Analytical PU8800 UV/Visible spectrophotometer (Figure 2). Unlike dedicated colour instruments which utilise a series of individual interference filters over the visible range only,

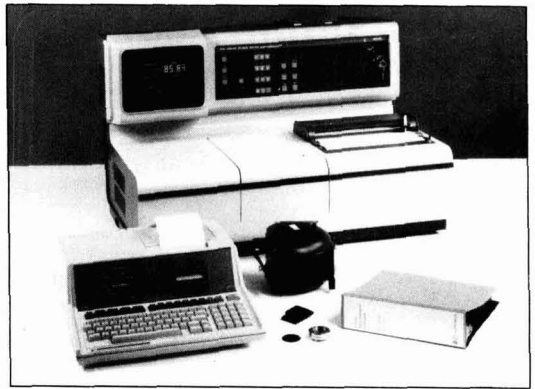


Figure 2. Philips Analytical PU8800 Colour Measurement System.

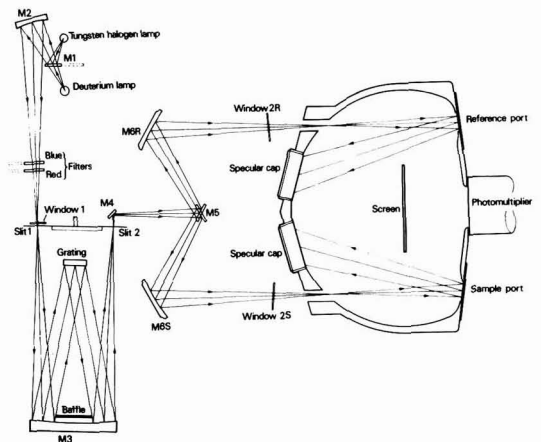


Figure 3. Schematic diagram of the optics of Philips Analytical PU8800 Spectrophotometer with Integrating Spheroid used for reflectance measurements.

the PU8800 can be used as a general purpose instrument covering the entire UV/Visible spectrum.

The PU8800 range of instruments incorporate a master holographic grating monochromator covering the range 190-900 nm. There are also a video display, built-in recorder and printer options. In the scanning mode, which is used to obtain data for colour measurement, the PU8800 also offers baseline memory, overlaid spectra, digital smoothing and first to fourth derivative.

A schematic diagram of the optics is shown in Figure 3. Light from either a tungsten halogen or deuterium lamp is passed via an Ebert monochromator to the chopper where it is split into two beams and then passes into the very large sample compartment. For reflectance work this contains an integrating spheroid. A full description of the integrating spheroid theory may be found in a number of books^{5,7} and the spheroid itself is illustrated in Figure 4.

The PU8800 spheroid can be used to measure either diffuse or total reflectance by rejecting or including the specular reflectance component. (The specular component is rejected by replacing white specular caps shown in the optical diagram with black “gloss traps”).

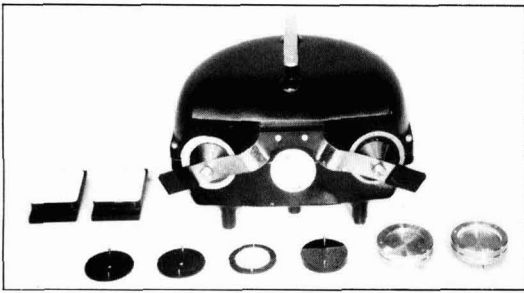


Figure 4. The Integrating Spheroid with microsample and powder sample holders.

The sample compartment is large enough for 160 mm × 170 mm samples to be mounted in both beams but small samples down to 3 mm in diameter may also be measured with the microsample holders because the areas of gold available for measurement on the printed labels were very small. Powder holders are available for the rapid mounting of powdered pigments or inks used for printing. The integrating spheroid itself can be installed in a few seconds and locates precisely on two pins at the base of the sample compartment.

A particular feature of the spheroid is that the photomultiplier can never "see" directly the patch of specularly reflected light. In some systems this causes systematic inaccuracies which, though significant, are very difficult to detect. A single strategically placed baffle contributes considerably to the averaging process and hence to overall accuracy. All aperture sizes and beam angles etc, conform to the CIE specification. Various standards are available for checking the performance of a colour measurement instrument and the PU8800 has been shown to give excellent agreement with published values for a set of NPL calibrated tiles⁸.

Data processing

The level of data processing to be employed in a given system depends on the throughput of the laboratory concerned. The calculation of CIE co-ordinates, though not difficult, is very repetitive and time-consuming. Whilst the reflectance data can be obtained with the basic spectrophotometer, the volume of data generated for true colour comparisons demands the use of on-line computation. Philips Analytical has produced a very powerful software package for the Hewlett-Packard HP85 (the package is shortly to be updated to run on an IBM environment PC). The PC controls the PU8800 through its two-directional RS232 interface and manipulates the reflectance data obtained providing measurement of colour or colour difference in three modes, diffuse or total reflectance transmission. Weighting factors for illuminants A, C, C₆₅ and D₇₅, all at 2° and 10° observer angles are written in as standard. Two additional illuminants of the user's own choice may also be loaded if required. Results are calculated in two internationally accepted forms, CIE tristimulus values and chromaticity co-ordinates with colour space transformation.

Reflectance data for up to 99 standards or samples can be stored on file for immediate recall in the form shown in Figure 5, and the system allows editing of black and white calibration values if required. Ten user programs can be

Corrected standard values recalled from spectral data files.

Philips Analytical PU8800

Colour Difference Measurement

Standard 25 GOLD FOIL

DI C

Corrected Values

λ	%	λ	%
380	20.16	390	18.73
400	17.90	410	16.33
420	15.73	430	14.76
440	14.03	450	13.95
460	13.89	470	13.69
480	13.93	490	16.28
500	20.30	510	24.89
520	29.11	530	32.36
540	34.35	550	35.01
560	35.35	570	36.28
580	39.73	590	42.38
600	43.10	610	43.03
620	42.87	630	42.56
640	42.39	650	42.05
660	41.70	670	41.42
680	41.46	690	40.92
700	40.86	710	40.47
720	40.13	730	40.02
740	39.35	750	38.90
760	38.52	770	38.31

Figure 5. Corrected standard values recalled from spectral data files.

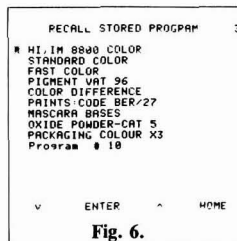


Fig. 6.

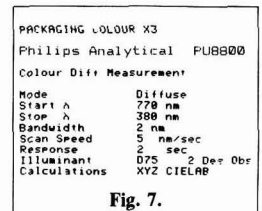


Fig. 7.

Figure 6. Fast set up and convenient operation via program stores.

Figure 7. Parameter listing for program recalled from program store.

named and stored as illustrated in Figure 6, facilitating the setting up of the system. The programs contain the PU8800 operating parameters plus the calculation mode, illuminant and report format needed for the final results (Figure 7). In two keystrokes the user can remotely set-up and start the PU8800, apply the requested colour measurement weightings to the data and obtain a formatted report from the built-in HP85 printer.

Application to measurement of colour differences in gold labels

The diffuse reflectance spectra of the gold portions of six similar labels were investigated for their differences against a specified gold "standard" and the results are shown in Figure 8.

Samples 2-6 showed a greater reflectance than the

standard. This is indicated by the spectra and also by their lightness, "L", values in Figure 9 which were greater than that of the standard. Figure 9 also shows, by way of example, a printout of the results for Sample 5 against the standard. As the figure shows, the results may be formatted in both tabular and graphical forms, complete with a listing of the instrumental conditions, calculation modes, operator and date.

A colour difference (ΔE) of 11.96 was obtained under the measurement conditions used (illuminant D₆₅, 10° observer angle). This was principally due to the increased lightness in Sample 5 with indication of a redder hue (higher 'a' value) than in the standard. ΔE values 4.72, 7.95, 8.91, 9.75 and 14.06 for the remaining Samples 1, 2, 3, 4 and 6 were obtained respectively. These differences could be detected visually and would probably lie outside the acceptable tolerances. The manufacturer has to decide what is visually acceptable and specify this to the printer. A difference of not more than 0.5 ΔE is an acceptable limit in most colour matching applications.

The results given here were based on the high measuring reproducibility of the system, where negligible values of 0.01-0.04 ΔE were obtained on repeat runs using the microsample holders. The attenuation of energy due to the small sample size clearly does not compromise either the reproducibility or the accuracy of the measurement. This is largely due to the high performance end-on photomultiplier employed in the PU8800 spectrophotometer used here. While *diffuse* reflectance is the measurement mode used to quantitate small differences in colour, measurements in *total* reflectance provided additional information on the degree of lustre exhibited by the gold colour through inclusion of the specular component. The increase in absolute reflectance from the diffuse mode varied from 3-10% over the visible range for Sample 5 to 17.34% for Sample 6.

Application of other operating modes

UV Reflectance

As indicated earlier, an enormous advantage of the PU8800 Colour Measurement System over tristimulus photometers is the facility to plot reflectance curves not only in the visible but also in the ultraviolet region. Figure 10 shows the reflectance spectra of two samples of gold foil, one coated with a varnish, the other not, in diffuse and total modes. The varnished sample is easily identified by its reflectance cut-off in the UV region between 270-290 nm, a property typical of many such coatings.

Derivative spectra

In certain situations it can be extremely difficult to ascertain small differences in detail from the analogue traces of a number of similarly coloured samples. In derivative spectrophotometry the absorbance spectrum is differentiated with respect to wavelength to produce first or higher order derivatives. The resulting derivative spectra contain much enhanced spectral detail making for more certainty in qualitative and better accuracy in quantitative analyses. Figure 11 shows both conventional (zero order) and second order derivative diffuse reflectance spectra for two slightly differing tints of gold on champagne labels. Differences in reflectance are seen to be enhanced in the second derivative and give a useful increase in sensitivity

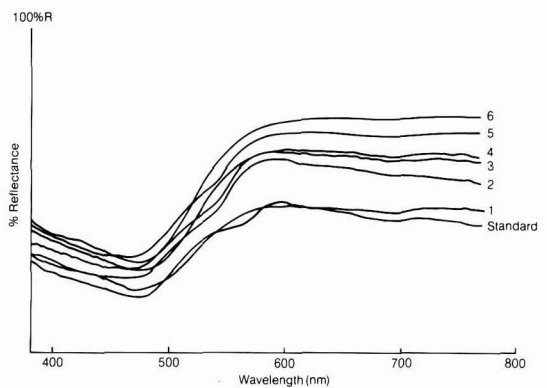


Figure 8. Diffuse reflectance spectra of six similar gold labels 1-6 plus 'standard' using microsample holders.

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Philips Analytical PU8800
Colour Difference Measurement
Sample SAMPLE 5 DI C
Standard 25 GOLD FOIL DI C
Sample SAMPLE 5

Illuminant: D65 10 Degree Obs
XYZ Std Sample A
X 33.14 58.26 17.17
Y 33.15 58.16 17.01
Z 15.79 27.20 11.41
x 0.4037 0.3938 -0.0099
y 0.4039 0.3938 -0.0199

Standard 25 GOLD FOIL DI C
Sample SAMPLE 5

Illuminant: D65 10 Degree Obs
CIELAB Std Sample A
L 64.28 76.17 11.89
a 6.13 7.37 1.24
b 32.87 32.38 -0.49
c 33.44 33.21 -0.23
h 79.44 77.19 2.31
AE = 11.96
  
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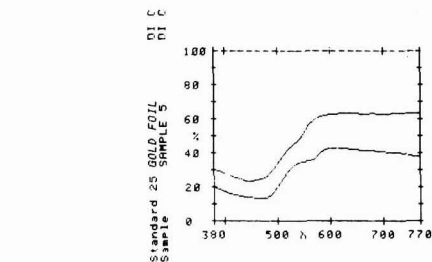


Figure 9. Typical report format showing corrected values, graphics and results for Sample 5 measured against 'standard'.

for quantitative measurements. The application of derivative to colour measurement on the PU8800 does not compromise the operation of the software as digital information is unaffected by use of the derivative mode, enabling both sets of information to be obtained simultaneously.

Transmission

The PU8800 Colour Measurement System may be used in the transmission mode to enable measurement of light-transmitting samples to be made, e.g. investigations on solutions of raw materials used in printing, such as blue printing ink. Samples which both transmit and scatter light (turbid samples) are loaded at the entrance port of the integrating spheroid. Any forward scatter is collected by the spheroid and reflected onto the detector.

If the samples are clear liquids, the integrating spheroid

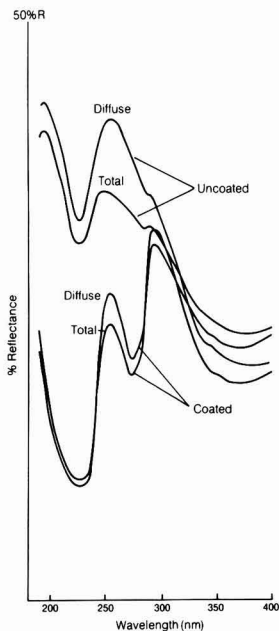


Figure 10. UV reflectance spectra of gold foil uncoated and coated with varnish.

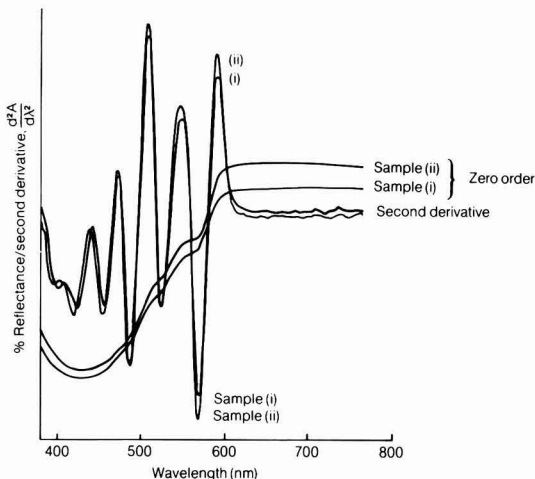


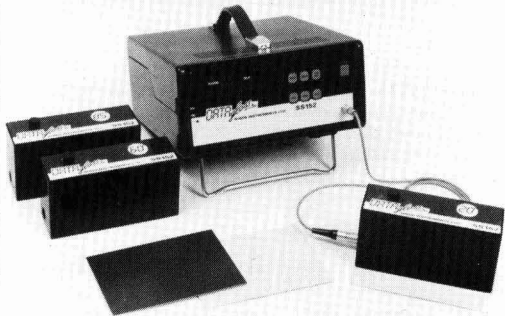
Figure 11. Zero order reflectance and derivative spectra of gold champagne labels, samples (i) and (ii).

is replaced by the conventional transmission optics, but the colour measurement software processes the resulting absorption spectrum in the manner described earlier in this article.

Summary

The PU8800 Colour Measurement System, based upon a high performance spectrophotometer with end-window photomultiplier, is used to measure reproducibly small differences in colour. The particular example quoted is the quality control of small areas of gold labels produced for products in a field where strict colour specification and control is of paramount importance. The applications of colour measurement and control in printing are extremely

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diverse and this paper can mention only a few. The Philips Analytical system can be reconfigured in seconds for conventional UV/Visible applications. This versatility places the technique of colour measurement within the reach of those laboratories which otherwise could not justify a dedicated measuring instrument.

Acknowledgement

Figure 1 is reproduced from the booklet "Measuring Colour" by kind permission of Tioxide International Ltd.

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Water-soluble compositions based on maleinised bisphenol derivatives of fatty acids

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Summary

New water-soluble compositions were prepared by the neutralization of the maleinised adduct of the reaction product of bisphenol compounds with different fatty acids. Comparison between the prepared compositions and other similar formulas regarding their evaluation as a paint vehicle is taken into consideration.

Introduction

Water-soluble resins have been described extensively in various articles and texts and hence needs no further elaboration here. The literature concerning water-thinnable compositions based on bisphenol derivatives of fatty acids is scanty and most of the data concerning their preparation are revealed from patents¹. Therefore, the information available for their preparation is insufficient.

An article appeared in 1970 describing the use of air-drying water-soluble resins². Among these resins, high molecular weight maleinised oils prepared by esterifying more complex polyhydric alcohols with drying oil fatty acids and reacting the esters with maleic anhydride. Suitable polyhydric alcohols include tripentaerythritol, bisphenol A diglycidyl ethers, and styrene/allyl alcohol copolymers. Air-drying water-thinnable glossy paints based on maleinised, fumarised drying oils, maleinised oil esters, adducts of polyesters, bisphenol A diglycidyl ethers . . . etc, have been reported. However, most of these resin systems do not give films with acceptable drying and gloss characteristics and also exhibit poor storage stability and colour retention.

The area of the present study is concerned with the preparation of vehicles, based on water-soluble oleoresinous composition of various bisphenols, possessing better film performance.

Experimental

Methods of preparation

*Preparation of bisphenol A Bis (4-hydroxyphenyl) propane*³:

Pure phenol (1 mole) was charged in one litre three-necked flask equipped with an efficient stirrer, thermometer and 500 ml separating funnel. A cold mixture of thioglycolic acid (1 g) and cold sulphuric acid (320 g) were added dropwise through the separating funnel to phenol with continuous stirring during which the temperature was maintained between 38-40°C. Acetone (0.576 mole) was then added dropwise for a period of 30 minutes, followed by toluene (3.4 ml). Vigorous stirring was maintained during the whole experiment for a period of six hours. The reaction product was then poured into ice-cold water containing 8 ml of concentrated ammonium hydroxide

solution. The crude mass was filtered, dried and recrystallised from benzene (m.p. 152°C).

Preparation of Bis (4-hydroxy-3-methylphenyl) propane:

A mixture of o-cresol (0.4 mole), acetone (0.2 mole), concentrated hydrochloric acid (100 ml) and concentrated sulphuric acid (50 ml) was placed in a one litre conical flask. The mixture was shaken periodically for four hours and allowed to stand for 24 hours. The obtained precipitate was washed with diluted acetic acid (1:3 by volume) and then recrystallised from acetic acid (1:1 by volume). The crystallised solid was then washed with water and dried at 70°C (m.p. 122°C).

Preparation of Bis (3, 5-dihydroxyphenyl) propane:

A mixture of resorcinol (0.4 mole), acetone (0.3 mole), 50 ml concentrated hydrochloric acid and 25 ml concentrated sulphuric acid was placed in a one litre conical flask. The mixture was periodically shaken for four hours and allowed to stand overnight. The solid obtained was filtered and washed with distilled water and dried at about 70°C (m.p. 90°C).

*Bromination of Bisphenol (general)*⁴:

Bisphenol (1 mole) was dissolved in cold glacial acetic acid and bromine (4 mole) was then added while stirring. The reaction mixture was then left to stand in ice-bath for 24 hours. The precipitate obtained was filtered off, recrystallised from glacial acetic acid, washed and dried at 70°C.

*Preparation of water-soluble phenolic based resin*¹:

These type of resins were prepared via two main procedures:

1. Solvent method which involves three main steps:

(a) Preparation of dihydric phenol diacetate:

A mixture of bisphenol A (0.5 mole), and acetic anhydride (1 mole) was refluxed at 140°C for 3-5 hours and then cooled at 50°C.

(b) Formation of fatty acid derivatives of dihydric phenol:

To the dihydric phenol diacetate prepared in the previous step, linseed oil fatty acids (1 mole) was added. The reactants were heated at 200-240°C for about six hours under nitrogen atmosphere and continuous stirring. The product was separated, washed, dried under reduced pressure.

(c) Maleinisation of the phenolic derivatives of fatty acids:

The product obtained in step (b) was cooled to room temperature and maleic anhydride (10% by weight) was added. After four hours heating at 200°C, the adduct was cooled and neutralised with triethylamine to about pH 8,

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Table 1

Characteristics of various prepared bisphenols

Types of phenol employed	Structure	Name	m.p. (°C)	Colour	Solubility*				
					H ₂ O	Ethanol	C ₆ H ₆	Xylene	Butyl Acetate
Phenol		Bis (4-hydroxyphenyl) propane	152	white	I	S	I	I	S
Phenol		3, 5, 3', 5'-tetrabromo-bis (4-hydroxyphenyl) propane	162	white	I	S	S	I	S
O-Cresol		Bis (4-hydroxy-3-methylphenyl) propane	122	faint pink	I	S	I	I	S
O-Cresol		5, 5-dibromo-bis (4-hydroxy-3-methylphenyl) propane	100	faint yellow	I	S	S	PS	S
Resorcinol		Bis (3, 5-dihydroxyphenyl) propane	90	faint yellow	I	S	PS	I	S

*I, S and PS represent Insoluble, Soluble and Partially Soluble respectively

and then diluted with ethanol solution (50%) to 50% solids.

2. Fusion method:

A mixture of bisphenol A (1 mole), oleic acid (2 mole) and the catalyst was heated at 150°, 200° and 220°C under continuous stirring and inert gas blanket. During heating, aliquate samples were withdrawn periodically for acid value determinations. The catalysts investigated were CaO, LiOH, ZnO and PbO within 0.02 to 0.1 per cent catalyst concentration.

The reaction was terminated when an acid value below 20 mg KOH was reached.

Another set of experiments were performed under similar conditions to those carried out with oleic acid using linseed oil fatty acids.

After the preparation of the fatty ether derivatives, they were subjected to maleinisation reaction with 10-15% maleic anhydride at 150-200°C. The adduct was washed with hot water till acid-free washings were obtained, then neutralised with triethylamine till pH 7-8 followed by dilution with ethanol solution (50% by volume) to obtain 50% solids. Manganese acetate was added (0.03 per cent

based on metal/resin) and the resultant varnish was stored for future use.

Methods of analysis, testing and evaluation were conducted according to standard methods and well-recognised techniques.

Results, Discussion and Conclusions

Preparation of Various Bisphenols:

Various bisphenol compounds were prepared through the reaction of acetone (1 mole) with various phenolic compounds (2 mole) in presence of acid catalysts. A list of the prepared compounds are given in Table 1.

Etherification of bisphenols with fatty acids:

Following the preparation of various bisphenols, attention was directed towards the preparation of their fatty acid derivatives. Two techniques were employed:

1. Fusion method in the presence of a catalyst:

Preliminary investigation indicated that among the various catalysts tested, CaO was found to be the most effective

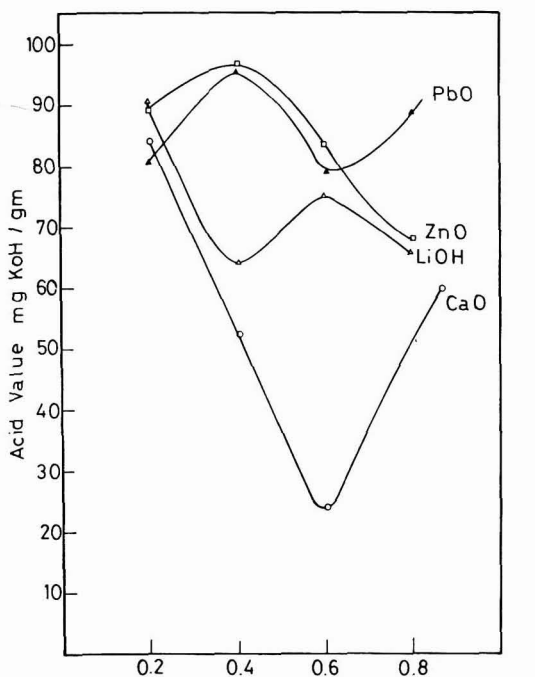


Figure 1. The effect of catalyst concentration on the etherification of bisphenol

especially at 0.6 mole concentration per mole bisphenol at 200°C. Other catalysts studied were LiOH, ZnO and PbO and the data obtained is presented in Figure 1.

2. Acetylation method:

The fatty acid derivatives of bisphenol prepared by the fusion method showed dark coloured products. For this reason, attention was directed towards the preparation of lighter coloured products. An alternative method for the preparation of fatty acid derivatives was employed and based on the reaction between fatty acids and acetylated bisphenol.

In this method, the bisphenol was first acetylated with acetic anhydride at refluxing conditions prior to etherification with stoichiometric amount of fatty acids. Two types of fatty acid derivatives were prepared from linseed oil fatty acids (LOFA) and dehydrated castor oil fatty acids (DCOFA).

Maleinisation of fatty acid derivatives of bisphenol:

Maleinisation of the products obtained in the previous step was carried out with maleic anhydride to introduce hydrophilic groups at the middle of the fatty chain. This study gave the following results:

(a) Increase in the maleic anhydride ratio increased the tendency for gelation.

(b) The temperature of maleinisation for non-conjugated fatty acid derivatives (200°C) was higher than that of conjugated derivatives (100°C). Higher temperatures lead to premature gelation.

(c) The optimum maleic anhydride ratio to just render the product soluble in basic solutions was 10% by weight. Higher anhydride percentage, of course, improved the water solubility of the maleic adduct at the expense of their alkali resistance.

(d) Partial replacement of DCOFA by LOFA was the only solution to overcome the problem of premature gelation in case of conjugated fatty derivatives. As a matter of fact, 70% replacement of DCOFA by LOFA is the optimum replacement condition.

Water solubilisation:

The maleic adducts obtained in the previous step was water-solubilised as amine salts and the various compositions tested are listed in Table 2. It should be noted that compositions Nos. 8-10 are introduced in this investigation for the sake of comparison. They share the following features in common:

1. The presence of a fatty chain.
2. The presence of an anhydride group due to maleinisation.
3. Their water solubility is achieved by neutralisation with a volatile base followed by thinning with a water/alcohol solution.

Table 2

List of various water-soluble compositions

No.	Type
1	10% Maleinized Bis (4-hydroxyphenyl) propane ether of LOFA
2	10% Maleinized Bis (3, 5-tetrabromo-4-hydroxyphenyl) propane ether of LOFA
3	10% Maleinized Bis (4-hydroxy-3-methylphenyl) propane ether of LOFA
4	7.5% Maleinized Bis (4-hydroxy-3-methylbromophenyl) propane ether of LOFA
5	10% Maleinized Bis (3, 5-dihydroxyphenyl) propane ether of LOFA
6	7.0% Maleinized Bis (4-hydroxyphenyl) propane ether of 30:70 DCOFA/LOFA
7	7.0% Maleinized (3, 5-tetrabromo-4-hydroxyphenyl) propane ether of 30:70 DCOFA/LOFA
8	15% Maleinized linseed oil
9	10% Maleinized linseed oil/dehydrated castor oil
10	15% Maleinized epoxy resin/linseed oil

Evaluation Studies:

The various water-soluble compositions were subjected to evaluation and the results were recorded in Table 3.

Viscosity measurements of the various compositions indicated the following two main observations:

1. The presence of alcohol is an essential ingredient in the formulation of water-thinnable compositions.
2. There is a sharp change in the viscosity diagram, upon

Table 3

Varnish and film characteristics

No.	Colour*	Drying time (hr)	Hardness†	Gloss‡ (%)	Flexibility‡
1	17-18	24	115	90	not affected
2	18	24	222	75	not affected
3	17-18	24	65	85	not affected
4	18	24	87	75	not affected
5	17-18	24	170	90	not affected
6	14-15	24	60	80	not affected
7	16-17	24	25	90	not affected
8	15-16	24	80	100	not affected
9	17-18	24	60	90	not affected
10	18	24	90	80	not affected

† Film thickness ranges between 0.01 to 0.02 mm

* By Gardner of 50% solids

‡ Films stoved at 130°C for two hours

dilution with 50% alcohol solution, at 80% solid content. Between 30-70% solids, the viscosity diagram showed no significant change.

Furthermore, films of various compositions were subjected to different evaluation techniques and the results obtained are given in Table 4.

Table 4

Film performance data

No.	Resistance* against													
	Water		Alkali		Acid		Solvent		Grease		Fire			
	a	s	a	s	a	s	a	s	a	s	a	s	a	s
1	Ex	Ex	P	Ex	Ex	Ex	G	Ex	Ex	Ex	F	F		
2	—	Ex	—	Ex	—	Ex	—	Ex	—	Ex	Ex	Ex		
3	G	Ex	P	Ex	Ex	Ex	F	Ex	Ex	Ex	F	F		
4	—	Ex	—	P	—	Ex	—	Ex	—	Ex	Ex	Ex		
5	—	Ex	—	F	—	Ex	—	Ex	—	Ex	Ex	Ex		
6	G	Ex	P	Ex	Ex	Ex	G	Ex	Ex	Ex	F	F		
7	—	Ex	—	Ex	—	Ex	—	Ex	—	Ex	G	G		
8	—	Ex	—	Ex	—	Ex	—	Ex	—	Ex	F	F		
9	—	Ex	—	F	—	Ex	—	Ex	—	Ex	F	F		
10	—	Ex	—	F	—	Ex	—	Ex	—	Ex	G	G		

* a and s represent air-drying and stoved films

Ratings are defined:

Ex = excellent, almost no change

G = good, no significant change

F = fair, slightly affected

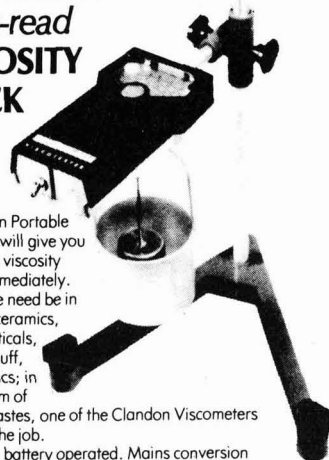
P = poor, almost complete failure

The following conclusions were drawn from the above record of results:

1. Alcohols are an important ingredient in formulating water-soluble compositions in order to achieve suitable and workable viscosity, transparency and longer storage stability.

2. Compositions based on brominated bisphenols showed the darkest coloured formulations and their films showed the lowest values of gloss. On the other hand, those containing DCOFA are the lightest coloured compositions.

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Clandon

3. The drying time of brominated compositions are longer than that of unbrominated bisphenols and maleinized linseed oil.

4. All varnish films showed satisfactory film flexibility. The hardnesses of brominated varnishes are higher than those of their corresponding unbrominated varnishes. Also the presence of DCOFA lowers considerably the hardness of the stove films. In general, the hardness of water-soluble bisphenol ethers of fatty acids are higher than other similar compositions.

5. Compositions based on various bisphenols showed excellent resistances against water, alkali, acid, solvent and grease.

6. The most interesting findings are that films of compositions based on bisphenols showed:

- Higher hardness values compared with others, and
- Excellent fire resistances. Compositions based on brominated bisphenols are more fire resistant than their corresponding unbrominated compositions.

References

- US Patent 3,298,918, Chem. Abstr. 66: 56647w (1967); US Patent 2,595,343, Chem. Abstr. 46: 8895f (1952), and US Patent 2,502,518, Chem. Abstr. 44: 6657f (1950).
- Hunt, T., *JOCCA*, 1970, **35**, 380.
- Beilstein Hand Buch der Organ. Chem., 1943, Band VI, p. 1011.
- Hassan, E. A., Naser, A. M. and Wassel, M. N., *Paint India*, (1978), **28**, 13.

Sources of Toxicological Information

L A O'Neill

Paint Research Association, Waldegrave Rd, Teddington, Middlesex TW11 8LD, UK

Abstract

Toxicological information relevant to the coatings industry may come from many sources. It is necessary to have access to textbooks, the toxicological literature, inventories, registries, safety data sheets, legislation, other official publications, data bases etc. The main sources are listed.

The library of the Paint Research Association probably contains the widest collection of literature on the paint industry in the world. With increasing attention focussed on health and safety matters, publications on toxicological aspects form a prominent part. One function of the publications is to provide the raw material from which the abstracts journal 'World Surface Coating Abstracts' is produced. This paper lists in the Appendix the main sources of toxicological information, based on experience at the Paint RA. They cover textbooks, journals, inventories, legislation, databases, etc.

The main Paint RA publication on the subject is "Health and Safety, Environmental Pollution and the Paint Industry", 2nd edition 1981. This was updated by the Quarterly Bulletin "Hazards, Pollution and Legislation in the Coatings Field" 1981-85, which was collated into a cumulative supplement and continued from 1986 by "Survey of Hazards, Pollution and Legislation in the Coatings Field".

Textbooks are normally the first source for information. These range from the expensive Patty in six volumes to the large Sax, the useful Casarett and Doull and the pocket edition of Sax.

The Sax books can be misleading to inexperienced readers as they sometimes do not emphasize the real hazards of a substance. When consulting any of the textbooks it must be remembered that they may be out of date by the time they are published, so any information should be supplemented by a search of the recent literature.

Toxicological information appears in a very wide range of journals and no library can contain the full range. Those listed in the Appendix are the current holding at the Paint RA and considered the most useful. To fill the gap it is necessary to consult the secondary source journals containing abstracts.

Before any legislation can be enforced on new substances it is necessary to compile an inventory of existing substances. This has been done in the USA so that pre-manufacturing legislation can be enforced. The European inventory, required for premarketing notification, is not yet ready but a draft may be consulted at the HSE.

The most complete set of data on toxic substances, but in very condensed form, is given in the NIOSH Registry.

Legislation in the UK may be followed from the Daily

List and from the EEC in the Official Journal. The US legislation is in the Federal Register but this is very extensive. Legislation in Germany and France is more difficult to follow.

Labelling guides to meet current legislation are issued by national associations, as are safety data sheets, but these require regular updating. Many series of publications are offered by the HSE. The Toxicity Reviews on specific substances are outstanding.

The last resource for an up-to-date search is a computerised data base. For recognised paint components a search on the WSCA data base is often adequate. For other substances one of the large toxicological data bases is required. TOXLINE or CHEMICAL ABSTRACTS are usually the most satisfactory but the former is a combination of several data bases and gives much duplication. A British Library publication compares the main data bases.

Appendix

Paint Research Association Publications

Health and Safety, Environmental Pollution and the Paint Industry, 2nd edition, 1981.

Hazards, Pollution and Legislation in the Coatings Field Quarterly Bulletin, 1981-1985 (Combining Survey and Abstracts). Replaced in 1986 by the Survey of Hazards, Pollution and Legislation in the Coatings Field (Contains Survey only).

World Surface Coatings Abstracts.

Text books

Sax "Dangerous Properties of Industrial Materials", Van Nostrand Reinhold Co., 6th Edn, 1984.

"Patty's Industrial Hygiene and Toxicology", Vols. I, IIA, IIB, IIC, III, 3A, John Wiley & Sons, 1978-1985.

"Casarett and Doull's Toxicology", Macmillan Publishing Co., 2nd Edn, 1980.

Sax and Lewis "Rapid Guide to Hazardous Chemicals in the Workplace", Van Nostrand Reinhold, 1986.

Primary source journals

American Industrial Hygienists' Association Journal
British Journal of Industrial Medicine
Cahiers de Notes Documentaires
Environmental Science & Technology
Food & Chemicals Toxicology

*Presented at the OCCA London Section Symposium, "Health and Safety in the Coatings and User Industries", Royal Institution, 10 April 1986.

Journal of Applied Toxicology
Journal of Occupational Medicine
Safety Practitioner
Scandinavian Journal of Work, Environment & Health
Toxicology and Applied Pharmacology

Secondary source journals

Chemical Hazards in Industry
Health and Safety Commission Newsletter
Health and Safety Information Bulletin
Lead Abstracts
RAPRA Abstracts

Inventories and Registries

Toxic Substances Control Act Inventory, 6 vols 1979 and Cumulative Supplement II, 1982.

European Inventory of Existing Chemical Substances (EINECS). Compendium of Known Substances, 3 vols 1981. European Core Inventory, 4 vols 1981.

The EINECS inventory is not expected to be available before the end of 1986, but a draft is available for personal consultation at the HSE, Baynards House, London.

NIOSH Registry of Toxic Effects of Chemical Substances, 3 vols, 11th Edn, 1981-2, published 1983 plus supplement, 2 vols, 1985.

Legislation

UK. The Daily List (HMSO). Legislation made as Acts of Parliament and implemented by Statutory Instruments and Approved Codes of Practice, available HMSO.

USA. Legislation published in Federal Register. Items related to paints are usually noted in the NPCA publication "Coatings".

West Germany. Federal Legislation published as Bundesgesetzblatt. Numerous state laws, semi-official publications and guidelines published as Bundesarbeitsblatt, Richtlinien, DIN standards, etc. Sources of all types are listed in the DIN Catalogue of Technical Rules, 2 vols, Beuth Verlag, 1985.

France. Legislation made as Arrête, Décret or Circulaire. Usually obtainable from the British Library.

EEC. Directives etc. published in Official Journal of the European Communities L series. Information and notices are given in the C series.

Safety data sheets and labelling guides

Paintmakers' Association

Raw Materials Safety Data Handbook, 2 vols, 1976 and 1979. Labelling Guidelines 1985.

British Resin Manufacturers' Association

Safety Data Sheets for Handling Resins (included in Resin Index, 1986) Guidelines for the Classification, Packaging and Labelling of Resin Products, 1983.

National Paint & Coatings Association (US). Paint Industry Labelling Guide, 3rd Edn, 1985, 2 vols.

Health and Safety Executive and Commission publications

Best practicable means leaflets
Codes of practice
Emission test methods
Guidance notes
Guidance booklets
Regulations booklets
Industry advisory reports
Methods for the determination of hazardous substances
Toxicity reviews
Toxic Substances Bulletin
See Publications in series: List
Health and Safety Executive, Sheffield, 1984

Critical reviews on specific chemicals and test methods

Health and Safety Executive

Toxicity Reviews

European Chemical Industry Ecology & Toxicology Centre

Technical Reports

Monographs on test methods, risk assessment etc.

World Health Organisation

Environmental Health Criteria

International Agency for Research on Cancer Monographs.

NIOSH

Criteria for Recommended Standards.

OECD

Guidelines for Testing of Chemicals, 1981.

Atmospheric exposure limits

UK

Occupational Exposure Limits 1985

Health & Safety Executive Guidance Note EH40/85

USA

Threshold Limit Values for Chemical Substances in the Work Environment.

American Conference of Governmental Industrial Hygienists, 1985-86.

W. Germany

Maximum Concentrations at the Workplace and Biological Tolerance Values for Working Materials. Deutsche Forschungsgemeinschaft, 1984.

France

Valeurs Limites pour les Concentrations des Substances Dangereuses dans l'Air des Lieux de Travail (also includes USSR values).

ND 1555-121-85. Cahiers de Notes Documentaires, 1985, No.121, 473.

Documentation of The Threshold Limit Values

American Conference of Governmental Industrial Hygienists, 5th Edn, 1986.

Sicherheitsdaten MAK-Werte.


L. Roth, Verlag Mecomed Industrie, Munich, 3rd Edn, 1984.

Data Bases

Base	Producer	Host
WSCA	Paint RA	Pergamon InfoLine
Toxline	US National Library of Medicine	Blaise-Link
Medline	US National Library of Medicine	Blaise-Link
Chemical Abstracts	American Chemical Society	STN International
Hseline	Health & Safety Executive	Pergamon InfoLine
Ecdin	EEC	I/S Datacentralen af 1959

Searching International Databases: a Comparative Evaluation of their Performance in Toxicology.

J. King, British Library, Library and Information Research Report 3, 1983.



Eastbourne

OCCA CONFERENCE 1987

Details of the lecture programme appear in the January issue of the *Journal* and the social programme opposite. Further copies of the registration brochure can be obtained from Priory House. Photostats of the registration form (both sides) are acceptable but must be accompanied by the appropriate remittance.

next month's issue

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

Improvement in the dust repellency characteristics of textured coatings by D. Bagchi, *Research and Development Division, Berger Paints India Ltd, Howrah, India.*

Paste inks, past, present and future by G. H. Hutchinson, *Croda International Inks Federation, UK.*

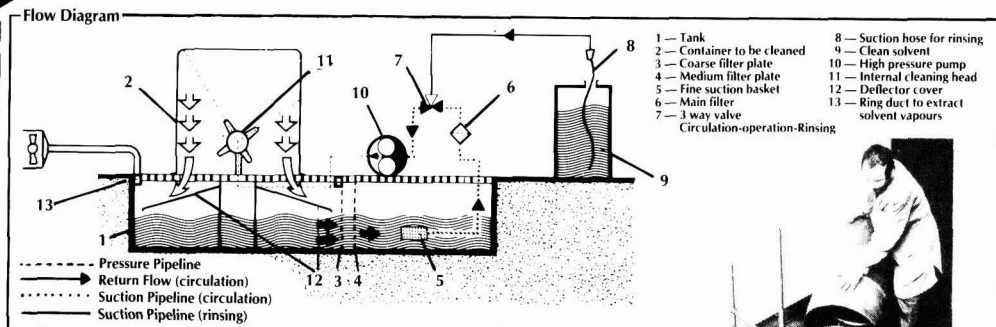
Leather finishing by M. J. Osgood, *Earnshaw Ltd, Northallerton, UK.*

Photoacoustic spectroscopy of printing inks by A. P. Kushelevsky and M. A. Slifkin, *Department of Electronic and Electrical Engineering, The University, Salford, UK.*

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cleaning processes, and K'archer expertise also ensures that manufacturers keep abreast of Health & Safety regulations, particularly where caustic chemicals and other hazardous substances are utilised. Contact OBS now for full details of the superbly engineered range of cleaning systems from K'archer.



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OCCA Conference 1987 Eastbourne

Social Programme

WEDNESDAY, 17 JUNE

Conference assembles in the evening.

- 6.30 p.m. Reception for Overseas Members and Overseas Visitors in the Duke's Room of the Grand Hotel (**By invitation only**).
- 8.30 p.m. To celebrate the 50th Anniversary of the London Section of the Association, the Section has arranged an evening's entertainment at the Grand Hotel. Delegates will be the guests of the London Section who will be the hosts on this occasion.
- 10.00 p.m. Session Lecturers' and Chairmen's Meeting in the Duke's Room.

THURSDAY, 18 JUNE

First Technical Session in the Devonshire Suite.

- 9.00 a.m. — 12.15 p.m. Coach tour to Beachy Head and Alfriston. This excursion will stop for a short time at Beachy Head for passengers to see the light-house and then go on to Alfriston, which claims to be the oldest village in Sussex and was renowned in olden days for its smuggling activities. Here a stop would be made allowing time to look around the village and also to have coffee in one of the many old world cafes. Cost of excursion £4.00 per person. (Details will be shown on the notice board at the Conference Office).
- 9.30 a.m. — 12 noon Informal Reception immediately after the Technical Session when those attending the Conference will be received by the President and Mrs. Redman.
- 12.15 p.m. Second Technical Session in the Devonshire Suite.
- 2.00 p.m. — 4.30 p.m. Coach tour to Bramber, driving through the beautiful countryside into West Sussex. Bramber houses the ruins of a castle and many historic buildings. There is also a museum of 38,000 smokers' pipes from 180 different countries and afternoon tea may also be taken here. Cost of excursion £5.00 per person. (Details will be shown on the notice board at the Conference Office).
- 2.00 p.m. — 5.00 p.m. Coach to Drusillas for English Wine Tour and Cuckmere Carvery. The tour will include a guided tour of the wine cellars, rural cider museum and vineyard followed by tastings of English wine in Walton Oak Barn. This will be followed by a Carvery Dinner at 7.30 p.m. in the Thatched Barn Restaurant at Drusillas. Photographs may be taken by delegates. The inclusive cost of tour and dinner which includes drink, entertainment, service and VAT is £16.95 per person. (The Grand Hotel will give a rebate to all resident delegates attending this function and not taking dinner at the hotel). The Association will provide transport by coach. (Details will be shown on the notice board at the Conference Office).
- 5.30 p.m. **(prompt)** **Note: In view of limited seating facilities and since final numbers have to be notified well in advance, early application is advised.**

FRIDAY, 19 JUNE

Third Technical Session in the Devonshire Suite.

- 9.00 a.m. — 12.15 p.m. Coach tour to Battle. Friday is Market Day in Battle where they hold a good general market. Battle Abbey is also well worth a visit. Cost of the excursion £4.00 per person. (Details will be shown on the notice board in the Conference Office).
- 9.30 a.m. — 12 noon President's Reception for Council Members, Overseas Presidents etc. in the Duke's Room (**By invitation only**).
- 12.30 p.m. — 1.00 p.m. Fourth Technical Session in the Devonshire Suite.
- 2.00 p.m. — 4.15 p.m. Coach tour to Rye and Winchelsea — No trip to Sussex would be complete without visiting the quaint, cobbled street, Cinque Port town of Rye. There will be ample time to see the town as well as having afternoon tea in one of the many cafes. Cost of the excursion £5.50 per person. (Details will be shown on the notice board at the Conference Office).
- 2.00 p.m. — 5.30 p.m. Arrangements have been made for a Golf Tournament to be played at the Royal Eastbourne Golf Club. Green Fees, to be paid direct to the club, at the time of going to print are £10 per player. Refreshments are available. The "OCCA Conference Golf Trophy" presented by Mr. S. Sharp, will be held until the next Conference by the winner of the Golf Tournament. Also available for competition is a trophy donated by Pearson Panke Ltd. to be awarded to the runner-up.
- 1.30 p.m. Association Annual General Meeting in the Devonshire Suite.
- 4.15 p.m. Reception.
- 7.00 p.m. Association Dinner Dance in the Grand Hotel. Evening dress (black tie) or dark suit will be worn. Members are asked to indicate their seating preference for the Dinner on the enclosed form. It is hoped that it will be possible to maintain separate tables seating 10 persons.
- 7.30 p.m. — 1.00 a.m.

SATURDAY, 20 JUNE

Conference disperses after breakfast.

Macpherson plc

Trimbond

The Macpherson group recently held a press conference at their Bishop's Stortford headquarters to publicise their "Trimbond" in-mould coatings. The presentation was introduced by Charles Wenham, chief executive of the group which is well-known to the general public for its do-it-yourself paints, sold through Woolworths, and is also prominent in trade sales paints, wood finishing, general industrial finishing, specialised coatings such as anticondensation and fire-retardant coatings, and polymers and resins. For several years the group has been owned by Kemira of Finland, and is now trading profitably.

Keith Waddington, the group's Research Director, outlined the technology of "Trimbond", which he developed. It is a different method of painting plastic components such as wheel arches, spoilers, bumper units and side runners for the lower parts of cars—this is the principal market at present. In brief a special polyurethane paint is sprayed from a standard two-component gun to a film thickness of about 40 microns on the inside of a metal mould heated to around 60°C, then the mould is closed and a polyurethane plastic injected. The inherent heat of the mould ensures rapid flash-off of solvents from the paints as the mould is closed, and then cures the paint and plastic together. Cross-linking between the paint and the plastic ensures excellent adhesion, however flexible the component, since the paint virtually becomes part of the plastic. The paint contains its own mould release agent. Satin, eggshell or sharp profile texture finishes are obtained, depending on the finish of the mould surface; at present finishes with a gloss up to 92 per cent are possible—this is not high enough for the upper body work of cars where 96-98 per cent is required. The polyurethane finishes use aliphatic isocyanates which provide first class durability and colour-retention properties, but are

expensive; the basic polyurethane plastic uses aromatic isocyanates which are considerably cheaper. The finished components have good weathering properties—no change after two years' Florida exposure—good resistance to humidity, UV light, stone-chipping and abrasion, whilst of course they do not suffer from corrosion, so are ideally suited for the lower parts of motor cars. Development work is in hand to provide high gloss components which could be used on the upper parts. An interesting point is that the exposed surface of the finished component is the underside of the paint film applied to the mould—this caused some initial problems with metallic finishes which have now been overcome. The process has been adapted for plastics other than polyurethanes.

Plastic components have of course been used for some years in cars, paints being applied over previously moulded components. This involved cleaning the parts to remove mould-release agents then applying a two-coat stoving paint system. The overall cycle took two or three hours and required considerable expenditure of energy, typically one-and-a-half hours at 100°C. The rejection rate was often as high as 10 per cent and the adhesion of paint to plastic not particularly good. The "Trimbond" process is complete in about two or three minutes, requires no additional heat energy above that required for the moulding, and the reject rate is only about 1 per cent. These advantages cause the processing costs to be only about one-quarter of the post-painting process, and lead to the overall cost of a superior in-mould painted component being only about half that of a post-painted plastic component.

At present the market is mainly in the motor industry but future applications are likely in the domestic appliance field, furniture, computer housings and leisure products. Macphersons have licensed their process to Glidden in the USA and licence negotiations with other paintmakers abroad are in progress.

T. A. Banfield

occa meetings

Auckland Section

Meetings various

The Auckland Section held three meetings in October 1986.

The first of these was on 8 October, at the Commercial Travellers Club. Forty-six members were present to hear the speaker, Dr Marcel Gaschke, from Ciba Geigy, USA.

Dr Gaschke's subject was "New epoxy products and technology for marine and maintenance coatings". This covered the changes in chemical resistance, curing times and viscosity that could be achieved by using either modified aromatic amine adducts or cycloaliphatic amine adducts as hardeners in Bisphenyl A or Bisphenyl F resins. The effects of force curing were also discussed.

The second meeting was held on 15 October 1986, at the Sorrento, and was a joint meeting with APPITA (Australia and New Zealand Pulp and Paper Industry Technical Association).

Forty-eight OCCA members were present to hear three speakers. Stephen Parker, Technical Manager of Coates Bros. NZ, spoke on some novel aspects of screen printing. Mr Parker outlined screen inks uses for making printed circuit boards; incorporating heat sensitive crystals to make printed temperature strips; and the incorporation of encapsulated perfume for "scratch and sniff" novelties.

Ian Boyd, (APPITA) spoke on various print proofing systems which are available, and the trend toward increasing automation of machine proofing systems. Mr Boyd then addressed members on polychromatic colour removal, and demonstrated the effects of this in a visual display.

Don McDonald (OCCA Auckland Section Committee) spoke to the meeting about the forthcoming 1987 Conference, and invited members of APPITA to attend.

The third meeting was held on 29 October 1986 at the Sorrento. The speaker was Mr John Green, BIP Resins, United Kingdom, and his subject was "Modern Amino Resin Technology for Coating and Printing Ink Systems".

Fifty members were present to hear Mr Green, who detailed how amino resins were first made and went on to describe the performance characteristics and weather resistance of a range of resins. Aspects of partly and fully methylated melamines as well as butylated and isobutylated resins were discussed especially in regard to their application for industrial stoving enamels.

Members were fortunate to have two overseas speakers during October and be able to share the knowledge of these gentlemen.

H. Simes

London Section

Pearlescent pigments

The second technical meeting of the 1986/87 session was held at the 'Pearly King', Bromley E3, on 13 November 1986, when some 45 members and guests heard an extremely professional talk by Stan Novinski, Technical Manager of The Mearle Corporation on "Pearlescent pigments, in Paints and Coatings".

Mr Novinski reviewed the history of Pearl pigments referring back to the early days of natural pearl essence which come from the scale of the herring, in fact the earliest recorded use of natural pearl for coatings in the automobile industry was as early as 1931.

The present day source of pearl pigments is of course from mica which is mined in such areas as Georgia. The ore is first mined as a clay/sand/mica mixture which is then separated, the mica delaminated and the product classified. Different effects may be obtained by coating the product with, for example, metal oxides (eg TiO_2) or combinations perhaps with ferric oxide or aluminium powders. By varying coating thickness colours can be produced utilising various wavelengths with an oil/water rainbow effect.

One of the main applications is in the automobile industry where as many as 35 per cent of the cars in the USA are coated with a pearlescent finish. On new colours the figure may be as high as 85 per cent. Other areas of usage include (coil coating) for architectural applications, and also the newer technology of powder coating. Not least important is of course in cosmetics where lipsticks, nail varnishes etc, can all be enhanced by the use of such pigments.

Finally a vote of thanks to the speaker and particularly to Cornelius Chemical Company who kindly sponsored the meeting was proposed by Dr Healey.

D. Bannington

Midlands Section

EMI/RFI Shielding

A lecture was presented to the Midlands Section on 22 January 1987, by Mr J. H. Ling of Coates Electrographics Ltd at the Clarendon Suite, Stirling Rd, Edgbaston, Birmingham.

The speaker explained that the need for shielding had arisen from the use of plastic packaging for electronic equipment. Old fashioned metal casing had not given any problems. Sensitive electronic equipment must be protected from radiated or conducted EMI originating from both natural and man-made sources. Most countries have legislation designed to limit interference. In Britain BS6527 published in 1984 closely follows the American and German standards.

Plastic on its own does not absorb or dissipate EMI/RFI so it needs to be made conductive. This is usually done by cladding the inside of the plastic container with metal. The conductive coatings are made by dispersing metals such as Silver, Nickel, Copper or Graphite in a binder system like acrylic, 2 pack Urethane and 2 pack Epoxy. The coating consists of about 80 per cent metal and needs to be formulated to overcome the rapid settlement of the metal flakes. Other methods used to give the plastic a conductive coating are:

1. Molten metal spraying—usually zinc.
2. Electroplating.
3. Vacuum Metallising.
4. Ion Plating.
5. Adhesive Foils.

The speaker concluded his talk by showing slides to illustrate the effectiveness of the various metals that are used. Spray applied coatings offer a quick and inexpensive method of obtaining a conductive surface.

A lively question time followed the talk and the meeting closed with a vote of thanks proposed by the Chairman.

B. E. Myatt

Newcastle Section

Propylene glycol ethers and acetates

Thirty members attended the fourth meeting of the 1986/87 session on 8 January 1987, to hear a lecture by Dr Z. Dawoodi (BP Chemicals) entitled "Propylene Glycol Ethers and Acetates in Coatings Applications".

He began by surveying the useful properties of glycol ethers and their esters in coatings. They are colourless, low viscosity liquids, with relatively mild odours and excellent solvency properties, moderate to low evaporation rates and good miscibility with other solvents. Thus they promote

good film formulation, free from the various film defects associated with poorer, or excessively volatile solvents.

Latest toxicological studies of these solvents have shown that the methyl and ethyl ethers of ethylene glycol, and their acetates, can cause bone marrow damage, male infertility and teratogenic effects in humans, whilst the butyl ether may cause blood defects. No such effects have been noted for the propylene glycol-based ethers and ether acetates: consequently, these are now being promoted as substitutes for the more hazardous ethylene glycol derivatives. The main burden of Dr Dawoodi's lecture lay in the work carried out in various solvent systems comparing the effectiveness of ethoxypropanol and ethoxypropyl acetate with methoxypropanol and methoxypropyl acetate for this purpose.

Solvency properties of the glycol ethers were illustrated by solution viscosities and dilution ratios with nitrocellulose resin. No significant differences were found between ethyl glycol ether and the two propylene glycol derivatives; however, graphs of evaporation rate of true solvent and

dilutents in the solvent blend showed that the more rapid loss of methoxypropanol gave a "leaner" solvent blend in the later stages of film formation, suggesting potential film defects. By using 50 per cent excess methoxypropanol a closer match to ethylglycol ether could be obtained, but at an obvious cost penalty. Similar effects in solvent blends for acrylic resins were illustrated and ethoxypropanol was clearly shown to be the best substitute on technical grounds.

The acetate esters showed similar results in typical VR solvent blends, both nitrocellulose and acrylic-isocyanate: whereas solution is not a problem, evaporation characteristics showed ethoxypropanol to be much nearer in performance as a weight for weight replacement of ethyl glycol acetate than methoxypropanol.

After a short question period, the vote of thanks for an interesting and clearly presented lecture was given by the Chairman, Mr R. G. Carr.

J. Bravey

news

Lankro expands surfactants investment

Lankro Chemicals Ltd, of Eccles, near Manchester, has announced that a major plant for the production of ethoxylated surfactants using Lankro technology and quality standards will be installed on the Tekchem site at Hartlepool, Cleveland, under long-term contractual arrangements. Tekchem, a division of Baker International, is situated near the major UK source of ethylene oxide. Lankro is further investing £1/2m on its sulphonation facility involved in the production of speciality anionic surfactants.

Deanshanger Oxides production expansion

Deanshanger Oxides Ltd, announces a major expansion of its Deanox Synthetic Iron Oxide production facilities at Deanshanger, Milton Keynes. Deanshanger will invest £10m to modernise and extend their existing production and technical facilities. The expansion programme covers increased production capacity, extensions to the range of Deenox Iron Oxide pigments and major environmental improvements. These pigments are widely used for concrete, roof tiles, paint, plastics, paper and rubber.

PPG acquires major surfactants producer

PPG Industries has acquired Mazer Chemicals Inc, of Gurnee, Illinois, USA, a major surfactants producer. Mazer had 1985 sales of some \$50 million and will operate from Gurnee as a PPG subsidiary.

Paintmakers Open Tech in Surface Coatings

It has been over two years now since the first materials were produced and piloted to students from Paint Manufacturers. Over 500 enrolments have now taken place and these include a steady growth of personnel from users of surface coatings. Surface Coatings Technology is offered to students by the Distance Learning format, through eight modules of study material, each consisting of notes and audio tapes. The first two of these—Basic Technology and Paint Application—are particularly useful for those who specify, test or apply Surface Coatings or even inspect or investigate finishes on manufactured articles. Employees of the vehicles and domestic appliances trades have enrolled to study these, which on successful completion qualify them for Paintmakers and BTEC certificates. Local tutor support centres are available throughout the country. For full details of dates, centres, content, costs etc, apply to: The Open Tech Project Office, The Paintmakers Association of GB Ltd, Alembic House, London SE1 7TY. Tel: 01-587 1466.



Sheen 1650 colorimeter

0.1) and absorbance from 0 to 1,000 (\pm 0.001).

Reader Enquiry Service No. 30

New Servo thickener and adhesion promoter

Servo Delden (represented in the UK by Hls UK, Orpington) has produced a new thickener called *SER AD FX 1020*. This weak smelling PU-thickener is a liquid and may be added during the let-down stage to obtain optimal rheological properties in dispersion paints. The new liquid adhesion promoter called *SER AD FX 520* is used in aqueous coatings to improve adhesion to galvanised steel.

Reader Enquiry Service No. 31

New drum handling equipment

Simplex Mechanical Handling Ltd of Bedford has available the new *RS drum handler* for fork lift truck users, which has a patented "parrot's beak" clamp. This new innovation offers reduced bulk, greater visibility and a larger gripping surface. Available in units to handle from

products

Low cost liquid colorimeter from Sheen

Sheen Instruments of Teddington has introduced a liquid colorimeter. The 1650 digital colorimeter is designed to give routine colorimetric determinations over the visual spectrum. The machine measures transmittance over 0-100% (\pm

BASF Coatings + Inks Launched

A new company, BASF Coatings + Inks Ltd. has been formed to serve the growing coatings and ink markets. Backed by BASF it incorporates all the surface coatings, resins and printing inks operations of the BASF Group in the UK. Its formation brings together Glasurit Beck, Valentine, Inmont and Fishburn.

The products previously sold by these companies will now be marketed under their brand names by different divisions within BASF Coatings + Inks. These divisions cover five business areas: Printing Inks, Automotive Refinish, Automotive OEM Finishes, Industrial and Building Products, and Container Coatings. BASF Coatings + Inks will employ around 1,100 people and have annual sales of £75 million.

BASF Coatings + Inks has announced the management team for this newly formed company, whose photo is shown on the right.

The product areas for each of the divisions are:

Automotive Refinish

The Automotive Refinish division will supply a range of high quality paint systems for automotive and commercial refinishing, suitable for all types of bodyshops. Products are supplied under the separate brand names of Glasurit, Inmont and Valentine. The Glasurit brand is the market leader in two-pack solid colour and base coat metallic systems for use in low-bake conditions. The Inmont brand offers a complete range of high-tech products for both air-dry and low-bake conditions. Valentine is a leading brand for air-dry nitro-cellulose and synthetic enamels.

Automotive OEM Finishes

The Automotive OEM Finishes division will supply paint products and systems to



BASF Coatings + Inks Ltd management team: Mr G. Watson (centre foreground) with (from left to right): Mr A. Mathews, Director and General Manager of Automotive OEM Finishes; Mr R. Parker, Director and General Manager of Printing Inks; and Mr P. French, Director and General Manager of Industrial and Building Products.

the UK's leading vehicle manufacturers, such as Jaguar, Ford, GM and Rolls Royce. Its products cover every stage of the vehicle finishing process and include: electrocoatings, primer/surfacers, sealers and a comprehensive range of low, medium and high solid top-coats with ancillary products.

Printing Inks

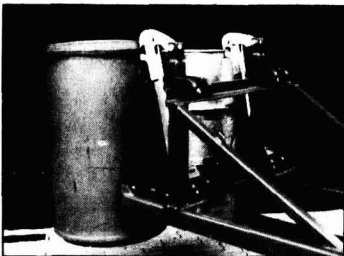
This division will be a supplier of heatset web offset inks for magazines and catalogues, radiation-cured inks for cartons, flexo and gravure inks for packaging and cold-set non-rub inks for newspapers. Developments include EB curing formulations and water-based flexography formulations. The division will market two major brands: Fishburn and K + E.

Industrial and Building Products

This division will supply surface coatings and resin based products to a wide range of different markets from energy industries, such as British Gas, to furniture suppliers, like Arenoff Office Furniture. The industrial products side of the division is divided into resin and paint sales. Building products include a translucent wood finishing system, a moisture regulating white window paint, a façade renovation system, and concrete repair and protection systems.

Container Coatings

The Container Coatings division will manufacture and supply a wide range of coatings for metals, papers, and foils. Its clients will include packaging manufacturers.



RS drum clamp

one to four drums at a time, there are three basic types specifically for metal, plastic and plastic L-ring drums, and plastic lidded drums.

Reader Enquiry Service No. 32

New propylene carbonate solvent

Arco of Windsor has introduced *Arconate* Propylene Carbonate (PC), a high boiling

oxygenated solvent with low toxicity and broad solvent powers. This solvent is effective in high bake coil coatings, offering viscosity, miscibility and water resistance equal to EEA-based solvents.

Reader Enquiry Service No. 33

Flexible UV Coatings

Floridienne of Watford has introduced a new flexibilising prepolymer called *Florplast UV-382* for use in radiation cured inks/coatings. This compound is a straight chain polymer with terminal acrylic unsaturation which ensures compatibility and reactivity with other prepolymers and reactive monomers.

Reader Enquiry Service No. 34

**OCCA CONFERENCE
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meetings

Powder Technology

The Postgraduate School of Powder Technology at the University of Bradford will be organising a course on the fundamentals of Powder Technology with an emphasis on concepts and practical problems. This will be held at Bradford University from 13-16 April 1987. For further information contact: Dr M. J. Rhodes, Course Director, University of Bradford, Postgraduate School of Studies in Powder Technology, Bradford, West Yorkshire BD7 1DP.

Rheology

Rheo-Tech International Ltd is holding its first Rheology Training Course at King's College London, Strand, London WC2R 2LS, on 7-8 April 1987. The aim of the

course is to teach delegates the basic principles of rheology through a series of lectures, discussions and practical periods. For further information contact: RTI Ltd, 120-122 Woodgrange Road, Forest Gate, London E7 0EW.

FSCT Annual Meeting/Show

The FSCT Annual Meeting and Paint Industries' Show will be held at the Dallas Convention Centre, Dallas, Texas, on 5-7 October 1987. The event consists of three days of technical programme sessions and exhibits running concurrently. "People and Technology: Cornerstones of Progress" will be the theme of the technical programme sessions. There will be more than 240 exhibitors of products and services used in the formulation, testing and manufacture of paints and related coatings. For further information contact: Staff of FSCT, 1315 Walnut Street, Philadelphia, PA 19107, USA.

literature

World demand for ceramic coatings to increase

Ceramic coatings are expected to experience growth of 12% annually through the next decade. By 1995, world sales of ceramic coatings will reach US\$3.3 billion according to a recently completed study by Kline & Co. The greatest opportunities for these coatings will be in automobile and turbine engines and chemical processing applications.

Ceramic coatings are non-metallic, inorganic materials which are deposited on a wide variety of substrate materials including metals, polymers, ceramics and composites. These coatings consist of a broad range of materials such as oxides, carbides, nitrides and borides.

The world market for ceramic coatings was valued at about US\$1.1 billion in 1985. An estimated 45% of the market for ceramic coatings is for optical coatings for construction applications—see Figure 1.

It is expected that ceramic coatings will be used in automobile and turbine engines long before structural ceramics or ceramic

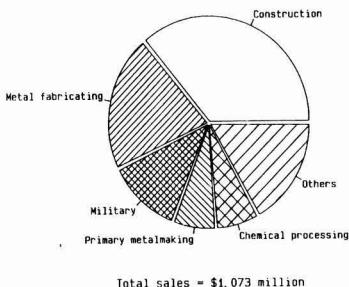


Figure 1. World market for ceramic coatings by end-use industries, 1985.

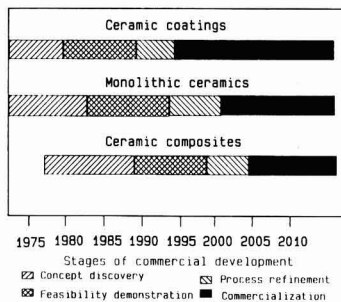


Figure 2. Commercial status of various forms of advanced ceramics for engines, 1975-2010.

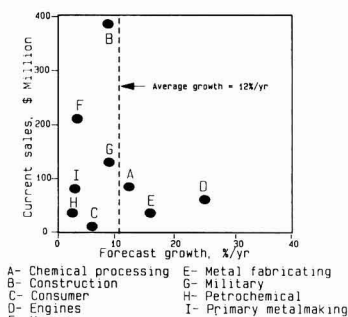


Figure 3. Current sales and forecast growth for ceramic coatings by end-use industry, 1985-1995.

composites as shown in Figure 2. Here the applications will include coatings on cylinder liners, cylinder heads, and piston caps.

The emergence of automobile engines as a market for ceramic coatings will foster a 25% a year growth in ceramic coatings for engine parts—as shown in Figure 3.

The Ceramic Coatings Study is available on subscription from Kline SA, Rue Froissart 89, B-1040, Brussels, Belgium.

US chooses Red

The US Colorant Market, a 243-page analysis examines the consumption of dyes and organic pigments in the US. Thirty-five per cent (27 million lbs) of organic pigment consumption per year is red toner, blue toners account for 27% and yellow 25%. Organic pigments are expected to generate 2.3% more sales each year to 1990, starting from a base of \$555 million in 1985. The price of the report is \$2,000 and is available from: Frost & Sullivan Ltd, Sullivan House, 4 Grosvenor Gardens, London SW1W 0DH.

OCCAA

A small number of spare copies is available of a fascinating article which appeared in November 1986 issue of Surface Coatings, Australia, concerning the first 40 years of Association activities in Australia. Applications for copies should be made by written request to John Ware, BJN Paints, PO Box 118, Concord West 2138, Sydney, Australia.

people

Dr Andrew Mawby, Marketing Director for PPG Industries (UK) Ltd has been appointed Market Manager, Europe for all PPG Automotive Refinish Products.

Paul Burger has been appointed Managing Director of Lithgow Saekaphen Ltd, the Clwyd-based specialists in the application of protective coatings and linings.

OCCA news

West Riding

Golf Trophy

Near perfect weather conditions greeted members and friends of the West Riding Section for their annual golf match, held on 16 October 1986. The event was held at the Wetherby Golf Club and the weather doubtless helped the high scores which were recorded during the day.

The 22 entrants teed off from 1 pm onwards, the tournament being played under the Stableford Scoring System. The winner of the competition was Tony Wood of the West Riding Section with 42 points. Prizes were presented by West Riding Chairman Terry Wright and all competitors received a prize, including the Social Secretary who recorded the lowest score.

The day was rounded off with an evening

meal to the usual high standard. Thanks are expressed to individuals and companies who donated prizes.

Dinner Dance

On Friday, 28 November 1986, the 28th Annual Dinner Dance of the West Riding Section was once again held at the Crown Hotel Harrogate. The event was attended by 281 members and guests which was the highest for some years. After the meal,



West Riding Dinner Dance presentation: Mr T. Wright (Chairman W.R.) presenting Mr R. H. Hamblin (right) with an original painting of Hebden Ghyll to commemorate his last official dinner with the Section.

which was once again up to the very high standard of the Crown Hotel, Frank Redman, the principal speaker, replied on behalf of the ladies with a short and witty speech. Terry Wright drew the winning tickets for the draw and the first prize, a weekend for two at a Trusthouse Forte Hotel, was won by John and Nancy Lockie.

The party then moved to the ballroom for dancing until 1 am to the music of the Lincoln Four and the evening ended with soup and coffee.

G. C. Alderson

London Section

Ladies' Night

The London Section Annual Ladies' Night took place on Friday, 5 December 1986, at the Royal Chace Hotel, Enfield. The function was attended by 194 people, the principal guests being the Association President Mr F Redman and Treasurer Mr B Gilliam, the Chairmen of the Newcastle Section Mr G Carr, and the Midlands Section Dr G Lewis, the Presidents of the Birmingham Paint, Varnish and Lacquer Club Mr G Fowkes and the Polymer Club Mitcham Mr D Bannington and their wives. Also present was the Association Director and Secretary Mr R Hamblin.

After an excellent meal the London Section Chairman Mr Ken Arbuckle proposed a toast to the ladies and guests, followed by a response from Mr Frank Redman.

Formalities over, dancing got underway to the lively music of the 'Rise' Group. A raffle was held during the interval and dancing continued until 1 am.

K. Arbuckle

Photograph overleaf

OCCA ties at £4.25 each are now available from the Association's offices, with a single Association Insignia on either a blue or maroon background.



West Riding Dinner Dance, back row (left to right): Mr M. Prigmore (Bristol Section Chairman), Dr G. Lewis (Midlands Section Chairman), Mr F. B. Redman (President), Mr R. Barrett (Scottish Section Chairman), Mrs Barrett, Mr R. H. Hamblin (Director and Secretary). Front row (left to right): Mrs Redman, Mrs Prigmore, Mrs Lewis, Mr T. Wright (West Riding Chairman), Mrs Wright.



Manchester Section Annual Dinner Dance. Back row (left to right): Mr A. Taylor, Mr G. Carr, Mr F. Morpeth, Mr D. Hughes, Mr B. Borrell, Mr T. Jolly, Mr N. Seymour, Mr R. Barrett, Mr R. Hamblin. Front row (left to right): Mrs Taylor, Mrs Carr, Mrs Morpeth, Mrs Hughes, Mr Windsor, Mrs Windsor, Mrs Barrett, Mrs Borrell, Mrs Seymour, Mrs Jolly.

Manchester Section

Dinner Dance

The Manchester Section Dinner Dance was once again held at the Hotel Piccadilly in Manchester on 17 October 1986.

The principal guest for the evening was Mr Derek Hughes, Chairman of England Hughes Bell & Co Ltd, accompanied by his wife. Also among the guests were Ron Barrett—Chairman of the Scottish Section, and his wife; Alex Taylor—Chairman of the Irish Section, and his wife; Robert Hamblin—Director and Secretary of OCCA; Gordon Carr, the Newcastle Chairman and his wife and Terry

Wright—Chairman of West Riding Section and his wife.

After an excellent meal in the Peacock Suite, Derek Hughes gave a short but humorous speech, and the section chairman Barry Windsor responded with a speech welcoming the guests.

After the speeches, dancing commenced to the strains of "Satin Blast". Dancing continued until 2 am whence a most enjoyable evening ended. Once again the Hotel Piccadilly had made us most welcome, and were even kind enough to make everyone feel more at home by providing an attendant odour of paint from the hotel refurbishment programme.

M. G. Langdon



London Section Annual Dinner Dance. Back row (left to right): Dr G. Lewis, Mr F. B. Redman, Mr D. Bannington, Mr G. Fowkes, Mr G. Carr, Mr B Gilliam, Mr R. H. Hamblin. Front row (left to right): Mrs Lewis, Mrs Gilliam, Mrs Redman, Mr K. Arbuckle, Mrs Arbuckle, Mrs Carr, Mrs Bannington, Mrs Fowkes.

new members


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

Ordinary members

- Adams, J. (*London*)
- Benn, D. R., BSc (*Hull*)
- Christidis, D., BSc (*General Overseas — Greece*)
- Evans, P. R. (*Transvaal*)
- Flack, J. R., PhD (*Ontario*)
- Flatley, T. J. (*Manchester*)
- Gould, P. (*London*)
- Hird, P. (*Hull*)
- Hull, D. S., BSc (*Ontario*)
- Hunter, K. (*Newcastle*)
- Husbands, M. J., PhD (*West Riding*)
- Khalpey, B. A., BSc (*Zimbabwe*)
- Lee, Y. K., BSc (*General Overseas — Malaysia*)
- Mottershead, D. R., BSc (*Manchester*)
- Prest, A. (*Newcastle*)
- Rowley, D. A., BSc (*Ontario*)
- Seo, Y., BSc (*Ontario*)
- Steven, G. J., BSc (*London*)
- Stockwell, J. R. (*West Riding*)
- Turner, S. K. (*London*)
- Whiteman, K. A. (*Zimbabwe*)
- Witman, J. H., BSc (*General Overseas — USA*)

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11. **Oil Inks Technical Services Executive** to be responsible for Product Presentation and Service plus Sales Support to major accounts.

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13. **UV Chemist** for Development and Field Trials for Inks and Coatings.

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