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JOURNAL OF THE IL & COLOUR CHEMISTS' ASSOCIATION

Micaceous iron oxide pigments

D. M. Bishop

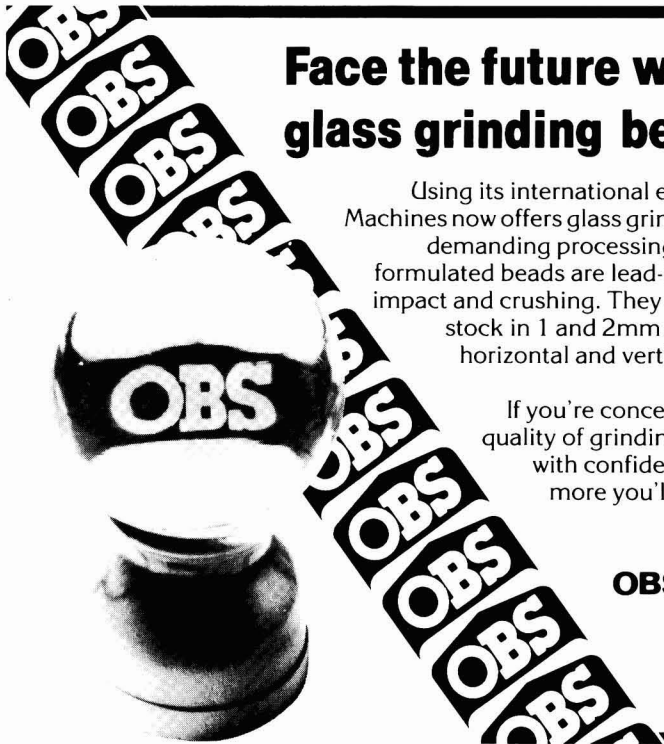
The formulation of textured coatings for plywood

J. Boxall and W. Worley

Electrochemical impedance on coated metal electrodes.

Part 1: Polarization effects

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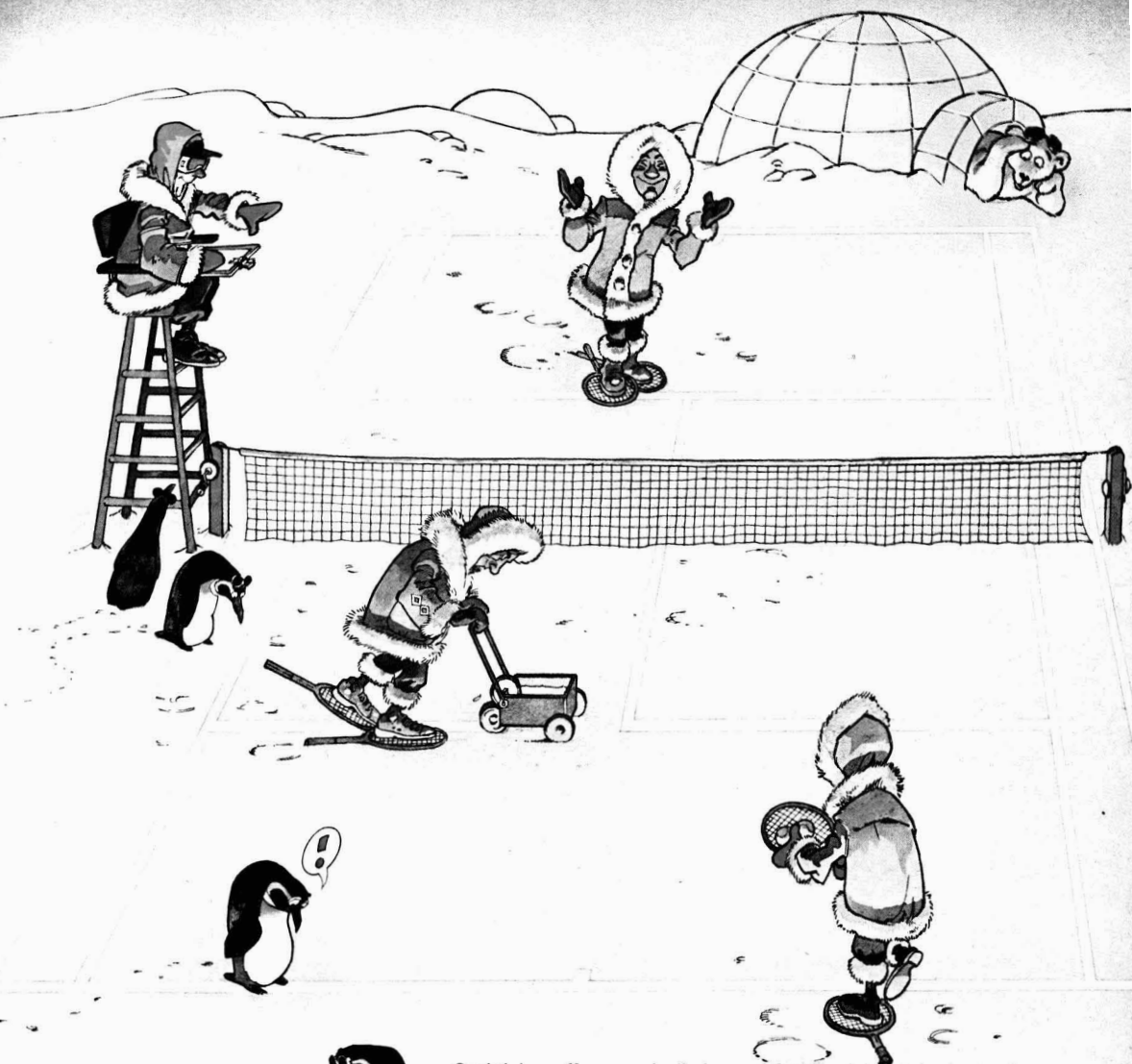
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OIL AND COLOUR CHEMISTS' ASSOCIATION

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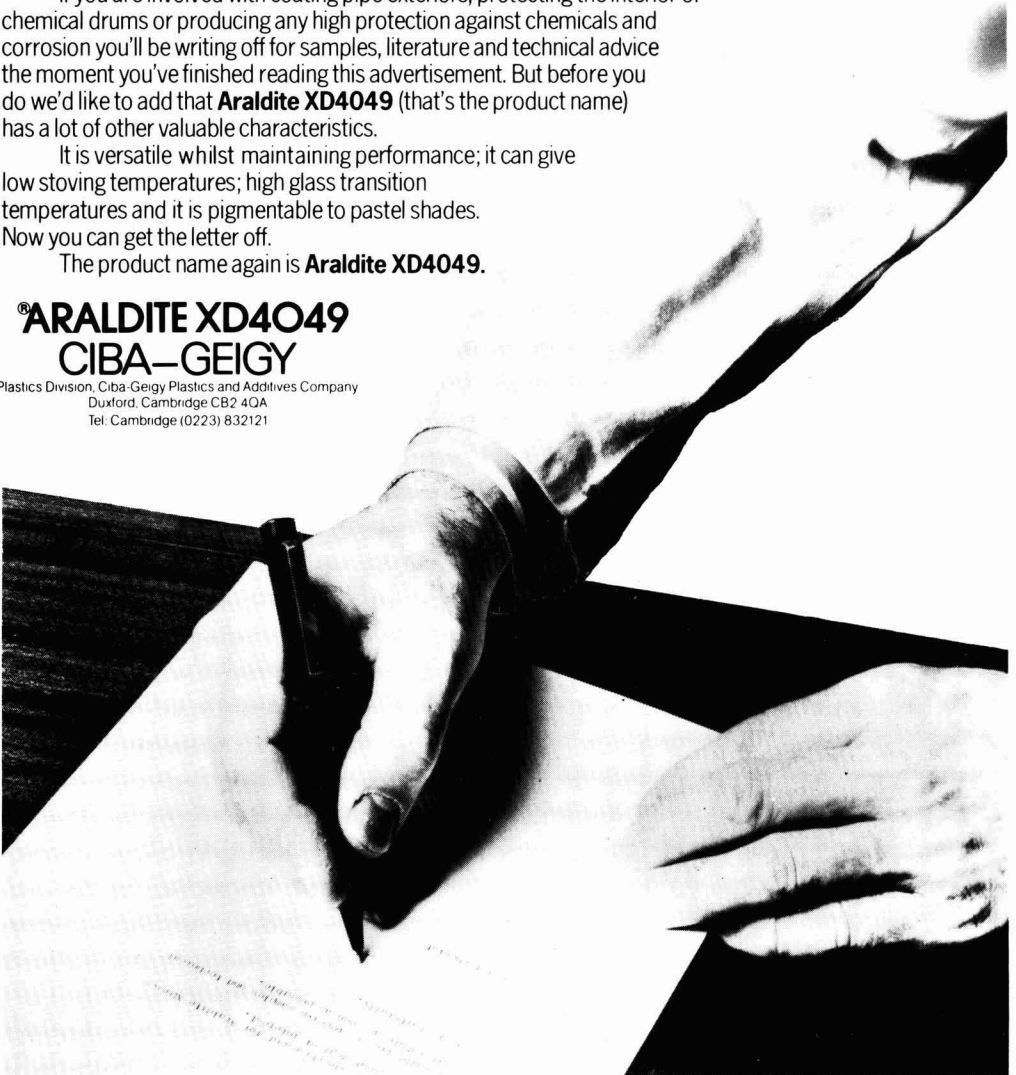
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Transactions and Communications

Micaceous iron oxide pigments

By D. M. Bishop

British Railways Board, The Railway Technical Centre, London Road, Derby DE2 8UP, England

Keywords

Types and classes of coatings and allied products

corrosion resistant coating

Raw materials for coatings

prime pigments and dyes

micaceous iron oxide

Properties, characteristics and conditions primarily associated with

raw materials for coatings and allied products

particle size

Introduction

Refs. 1-22, 28

Micaceous iron oxide is a naturally occurring ore of the Carboniferous period deriving its name from its similarity to mica in crystalline form (Figure 1) but chemically it is

mainly haematite α -Fe₂O₃. Its distinguishing feature is the unusual tabular crystal structure which can be fractured to give very thin platelet or lamellar fragments, which when used as a pigment in paints orientate parallel to the paint surface as shown in Figure 2. This orientation produces an increase in resistance to water permeation through paint films (and hence increased corrosion protection¹⁻¹⁵), reduces the ultra-violet degradation of the resin (with increase in coating durability^{1,3,5,11,12,16}) and prevents loss of film flexibility¹².

Micaceous iron oxides have always had strong connections with the railways and have been extensively used for eighty years as the major pigment in undercoats and finishes for the protection of railway civil engineering structures all over the world. It was probably in France, about 1880, that micaceous iron oxide was first used as a pigment in paints and Les Compagnies de Chemin de Fer Francais were soon interested¹⁶. Micaceous iron oxide paints have been regularly used on the Eiffel Tower since its erection in 1889^{17,18,22} and by the Société Nationale des Chemins de Fer Francais for seventy years or so¹⁶. In 1909 twelve tons of micaceous iron oxide paints were purchased (at £30 per ton and with a covering power of 14,260 square yards per ton) for the repainting of the Hawkesbury River Bridge in New South Wales, Australia, after two years testing¹⁹. Although used in Britain at the turn of the century on some of the smaller railways, such

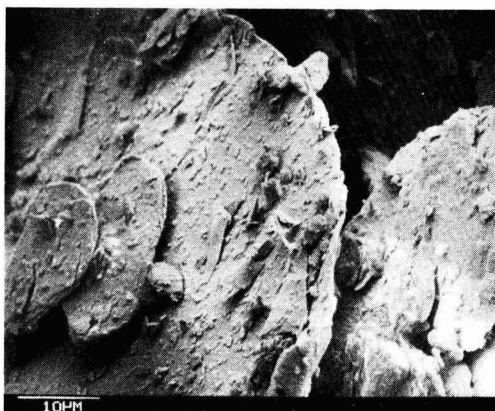


Figure 1. Comparison of the crystal structures of mica (top) and micaceous iron oxide (bottom)

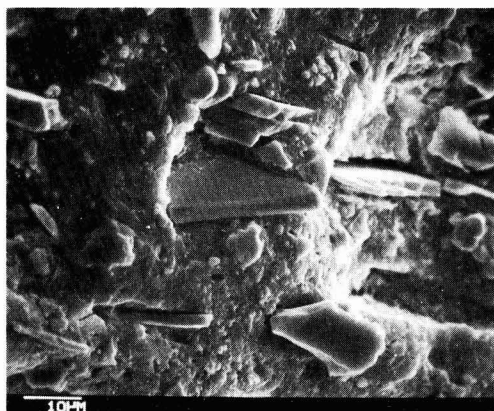


Figure 2. Layering of micaceous iron oxide pigments in paint applied in 1921 to the Royal Albert Bridge, Saltash, Cornwall

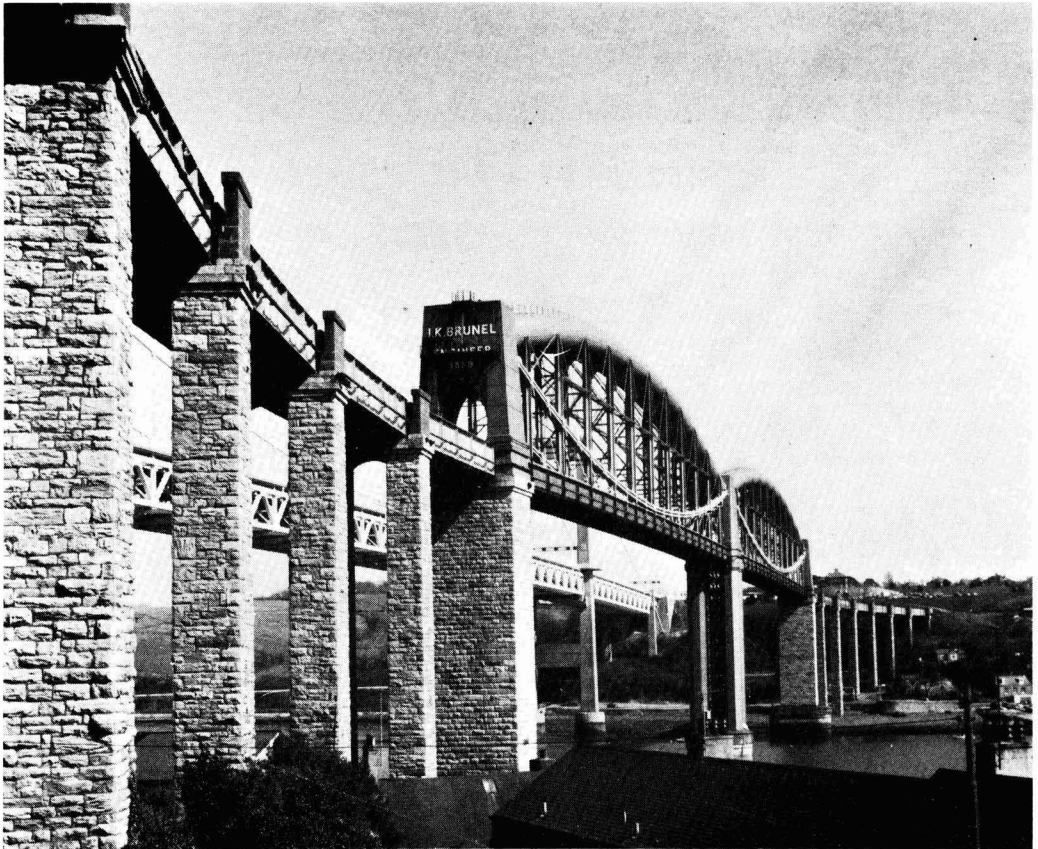


Figure 3. Royal Albert Bridge at Saltash, Cornwall

as the Cardiff Railway and Taff Vale Railway¹⁹, it was the Great Western Railway²⁰ which first used micaceous iron oxide paints in 1921. The German Railways^{3,16,21} were introduced to micaceous iron oxide between 1920-30 and after extensive tests generally adopted a similar protective system in 1940.

Although micaceous iron oxide has been found in various parts of the world^{5,16,17,28}, only two pigments have been approved for use in British Railways protective systems namely those from Devon, England and Waldenstein, Austria. In the last few years several alternatives have been commercially available with obvious differences in their physical properties. To ensure that the high level of protection achieved over the years with the two approved micaceous iron oxide pigments mentioned above (in various media) was maintained, it became necessary first of all to characterise the physical and chemical properties of the alternative pigments and later to evaluate their effect on the corrosion protection and the mechanical properties of paint films¹².

Micaceous iron oxide and the British Railways

Refs. 3,12,16,20-25, 27-29, 46

The micaceous iron oxide from the Ferrubron Mine in

South Devon, England was used from its introduction to the railways in the early 1900's until the mine closed for economic reasons in 1969 and the pigment became unavailable. In 1964 approval was given for the use of the pigment from Waldenstein, Austria and which had for many years been used by the German Railways²¹. In view of the importance of micaceous iron oxide in the railway protective systems over many years, and the lack of published information on the subject, its history and the reasons for the strong railway connections will be discussed.

Devon, England micaceous iron oxide

The English micaceous iron oxide industry²² had its origins in South Africa in the closing years of the nineteenth century. Edmund Meek Slatter, who for many years had successfully prospected and mined for gold and diamonds in the Veldt, decided to retire to his native Devon. He bought a property near Bovey Tracey on the southern edge of Dartmoor and when he took possession the estate agent said "I have charged you for everything in the property except for the shining stuff in the ground". This "shining stuff" was an irresistible lure to an old miner and in a short time he was extracting and refining, probably with no more elaborate equipment than a

vanning shovel, small quantities of the mineral we know as micaceous iron oxide. Slatter expanded his activities and by the turn of the century had persuaded J. Russell Thornbery of Griffiths Bros. & Co. (one time President of the Paint and Varnish Society now merged into OCCA) of the potential use of micaceous iron oxide as a pigment for paint, particularly for the protection of iron and steel. In 1902 the Ferrubron Manufacturing Co. Ltd was formed with Slatter and Griffiths Bros. as the principal shareholders. At its formation, the company possessed five mines on the southern edge of Dartmoor around Bovey Tracey but only the Great Rock mine at Hennock and the Kelly mine at Lustleigh were in operation in 1920. Unlike the Austrian mineral (see the section under "Austrian micaceous iron oxides" below) which is of such a massive formation that it is mined by the pillar and room method, that in Devon was found in geological "cracks" and a lode thickness of two feet was unusual. Because the lode width gave insufficient access and working space, blasting of the mineral face was a daily occurrence. The obvious gangue or adde from the 4-5 feet advance was trammed away to the dump, while the free and rock associated mineral was subjected to a refining process such as that used at the Great Rock mine in the '40s and shown in Appendix 1; the process was continuously being modified with improvements in mining techniques. The Kelly mine was difficult to work and smaller than that at Great Rock, and changing economic factors brought about its closure in the 1940's.

The Great Rock mine continued in production but from the 1950's it became more difficult to locate commercial quantities of micaceous iron oxide with the resources then available. By the 1960's it became apparent that the mine was reaching mineral exhaustion, resulting in a shortage of pigment for the paint trade and the inevitable closure of the mine in 1969.

In the beginning

The Great Western Railway was the first major railway company to use micaceous iron oxide paints which were manufactured by Griffiths Bros. & Co., who became world famous as suppliers of protective paint systems under the trade name "Ferrodor" (now part of Goodlass Wall & Co. Ltd). Most of the early selling of "Ferrodor" to the railways was through local engineers by an agent who operated from Cardiff and was probably the reason why micaceous iron oxide paints were first used on the smaller railways in the Cardiff area (before being absorbed into the Great Western Railway in 1922). The pigment was from the Ferrubron mine and the normal formulation was about 65 per cent (w/w) pigment and extender and the remainder boiled linseed oil and driers, the formulation remaining substantially unchanged for many years^{12,22}.

One of the first bridges to be painted with micaceous iron oxide paints was Isambard Kingdom Brunel's Royal Albert Bridge at Saltash, linking Devon and Cornwall across the River Tamar²⁰ (Figure 3). The bridge was completed in 1859 and has a total length of 2200 feet formed by the two main spans of 455 feet each and the seventeen approach spans ranging between 70-93 feet. The original process was conventional lead primers, chocolate brown undercoats and red oxide finishes as confirmed by cross-sectional examination of a paint flake from the track girder on the Devon span in which over thirty layers are present (Figure 4). It is probable that the early coats are the originals since the intervals between repainting appear to have been much longer than those of the present day,



Figure 4. Cross-sectional examination of paint flake from Royal Albert Bridge, Saltash, Cornwall

for example in 1911 a painting specification was referred to for costing, comprising a chocolate brown undercoat and a steel grey finish, for repainting the bridge²³ in 1921. The steel grey coating contained micaceous iron oxide as shown by the typical layering of the pigment in Figure 4

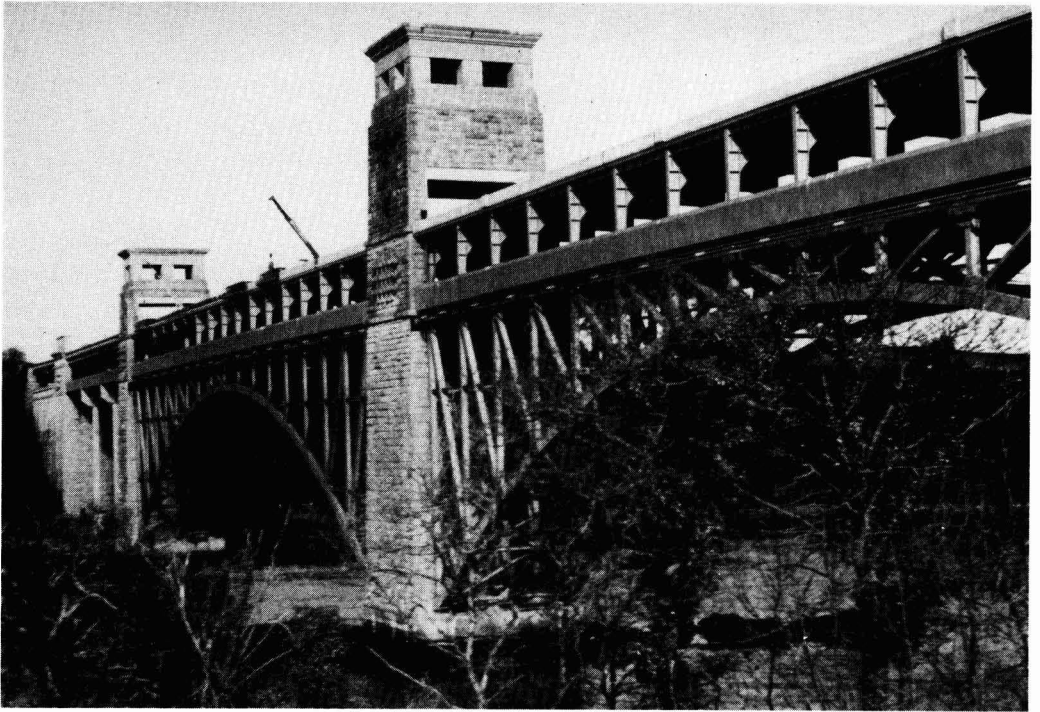


Figure 5. Britannia Bridge, Menai Straits, Anglesey

(also confirmed by X-Ray analysis) and the high magnification scanning electron micrograph used in Figure 2 to illustrate the pigment layering. Micaceous iron oxide paints have been regularly used since that date on this bridge, as can be seen from the cross-section, and it was in fact painted last year (1980) with micaceous iron oxide in an air-drying medium.

The use of micaceous iron oxide paints spread on the Great Western Railway and eventually to the London, Midland and Scottish Railway where it was first used as a proprietary paint²⁴ in 1929. A paint laboratory was set up in 1921 at the Carriage Works at Wolverton to quality control the paints for the London and North Western Company's rolling stock and was soon issuing composition specifications to the trade for the paints required. It was asked by the Purchasing Department in 1930 to ensure the quality of the micaceous iron oxide paints purchased for the civil engineers²⁴. Following the grouping of the railways in 1923, the laboratory became responsible for the specification and testing of the paints purchased by the London, Midland and Scottish Railway and became part of its new Research Department²⁵ in 1932. The other railway companies probably closely followed in using micaceous iron oxides and a London and North Eastern Railway "Paint Section - Progress Report: January-February 1936" stated that a micaceous iron oxide paint from Griffiths Bros. & Co. (London) Ltd (having become a limited company in 1916) had been exposed at the Forth Bridge test site. Over the years there was a gradual and sometimes reluctant change from the use of proprietary paints to those supplied against a "composition specification", such as that shown in the extract from the British

Railway "Paint Specification No. 35 covering Materials for use on Bridges, Buildings and Structures" November 1958 (Appendix 2). In 1970 there was a change to a "paint performance specification", British Railway "Paint Specification No. 70 covering Paints for Civil Engineers", with minimal guidance on the pigments and resins to be used, the paint manufacturers being required to formulate paints to meet specified protective properties, drying and overcoating times, etc; a typical up-to-date micaceous iron oxide paint formulation⁴⁶ is included in Appendix 2.

The Devon micaceous iron oxide was used continuously up to the early 1960's when the pigment became in short supply to the paint trade. This necessitated an examination of alternative sources of micaceous iron oxide and ended the long association between the railways and the Devon pigment.

Austrian micaceous iron oxide

The mine is situated at Waldenstein, on the border linking the Austrian provinces of Kaernten and Steiermark in one of the valleys between the mountains which rise to over six thousand feet. The iron workings, which were in existence before 1150 when a castle was built for protection, were converted to the production of micaceous iron oxide pigments in 1900 and have since become renowned worldwide for the quality and quantity of the ore.

There is an interesting parallel in that, as in England, the German Railways were first introduced to micaceous iron oxide by a paint company, between 1920-1930, and there followed an extensive evaluation programme by the

German Railways. The Railway Directorate for Constructional and Operational Engineering in Berlin had six exposure test sites whose locations had been chosen so that the paints were subjected to a wide range of climatic conditions²¹. Steel plates, primed with red lead, were coated with one and two coats of various finishing paints, including one based on micaceous iron oxide from Waldenstein, and were subjected to these different climatic conditions. After five years exposure, the superiority of the micaceous iron oxide paint was apparent, even in the highly industrial environment of Essen and the marine conditions of Westerland^{21,26,27}.

Following the highly successful exposure tests with the Austrian micaceous iron oxide and the unsuitability of the German ore mined in the Fichtel mountains, the owners of the micaceous iron oxide mines, in agreement with the German Railway Research Institutes in Munich and Kirchmoser, established a pigment company²⁸ in 1934. The objective of the company was to produce high quality pigments in order that the paint industry could meet the requirements of the German Railways, such as a minimum of 90 per cent w/w Fe_2O_3 in the pigments, satisfactory corrosion protection, good colour stability, etc²⁹. In 1940 the use of micaceous iron oxide paints was adopted for general use as a protective system^{3,16,28}.

Testing and approval

In 1963 there was a shortage of the grade of English micaceous iron oxide pigment approved for use in British Railway's Specification No 35 "Materials for use on Bridges, Buildings and Structures" and paint samples were submitted based on the Austrian pigments so that evaluation tests could be carried out. The corrosion tests clearly showed little or no difference in the protection given by paints based on the English and Austrian pigments and approval was given in 1964 for Waldenstein pigments to be used as an alternative. To date no further approvals have been given and micaceous iron oxide paints based on the Waldenstein pigment have been successfully incorporated into British Railway's modern long-life protective systems based on shot-blasting and metal spraying as used on the Britannia Bridge over the Menai Straits in North Wales (Figure 5).

Physical properties of pigments

Refs. 22, 33

By definition, micaceous iron oxides must possess a crystalline structure similar to mica, which itself is commonly used as an extender in paints in the form of muscovite $\text{KAl}_2(\text{Si}_3\text{AlO}_{10})(\text{OHF})_2$. Mica is the name given to a group of minerals characterised by their tendency to split into thin platelets or lamellae (Figure 1). The physical properties were characterised by scanning electron³³ and optical microscopy.

Scanning electron microscope

Typical micrographs, all at ca. $\times 200$ magnification, are shown in Figures 6-9 and the pigments fall into three distinct categories:

1. lamellar pigments
2. granular pigments
3. pigments of much smaller particle size than the other two groups.

Lamellar pigments

These are typified by the English and Austrian pigments as shown in Figures 6 and 7 where it can be seen that all the particles (except for a very small proportion of fines) possess the lamellar structure of mica.

The two English grades are from the Great Rock mine (from the notation "GR"); the GRF grade is a sample from water borne unstamped or "Free Run" mineral (Appendix 1), thus explaining the finer particle size, and the GRA grade represents the normal commercial product²². Although the two grades are physically different, the thicknesses are the same (2-5 microns). The coarse grade contains some platelets up to 100 microns in width but the majority are 75 microns or less; the fine grade, as shown by its red colour contains a lot of "fines" (less than 5 microns) and a few platelets over 30 microns in width.

It is remarkable how similar, in both platelet widths and thicknesses, the Austrian "Standard" grade is to both the coarse English grade and the Austrian sample originally submitted in 1964 (cf. Figures 6 and 7). The "DB" grade, which is recommended for use in brushing paints only, is coarser than the "Standard" grade in that it contains a significant number of platelets over 100 microns; the platelet widths are comparable to the "Standard" grade (2-5 microns). The "Airless spray" grade contains none of the large platelets (greater than 100 microns) in order to avoid the build-up of coarse pigments in the filters and spray tips (with eventual blockage) of airless spray equipment, which has been in general use for painting large structures. The French pigment has physical characteristics similar to the Austrian "Standard" grade.

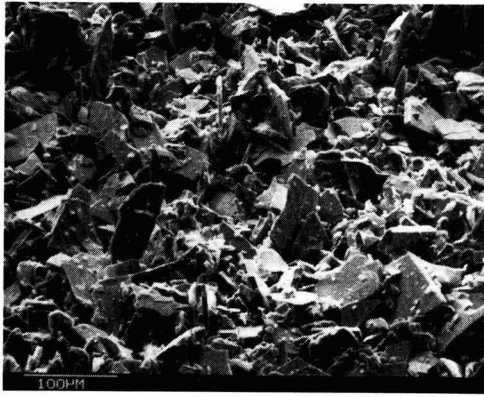
Granular pigments

These are typified by the samples of Spanish, South African, West Australian and Japanese pigments as shown in Figure 8, none of which possesses the typical lamellar structure associated with micaceous iron oxides (Figures 6 and 7).

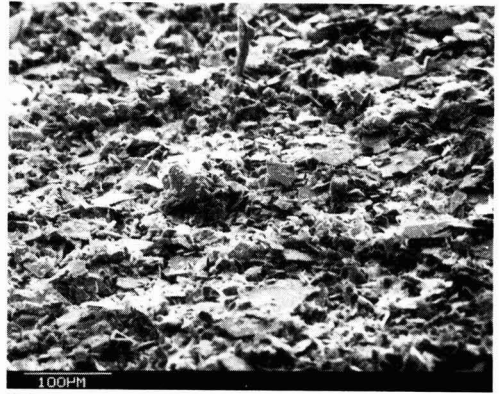
The two Spanish pigment samples, from Catalonia and Malaga, contain very little or no lamellar structure. The pigment particles are fairly uniform in size, being up to 100 microns in width and thickness but with no obvious difference between the reputed "coarse" and "fine" grades. Although the South African, Japanese and West Australian pigments contain varying proportions of micaceous iron oxide, about 50 to 75 per cent is non-micaceous with pigment particles up to 50 microns in width and thickness.

Small particle size pigments

Although the Indian and South Australian pigment samples contain some lamellar structure the bulk consists of "fines" (less than 5 microns) and cannot be considered as "micaceous" (Figures 6, 7 and 9). These pigments are comparable in size to the fine "free run" English grade but without its lamellar structure. A further sample of South Australian pigment indicated that although more lamellar structure was present, the bulk was still a mixture of granular pigments and "fines".



GRA grade

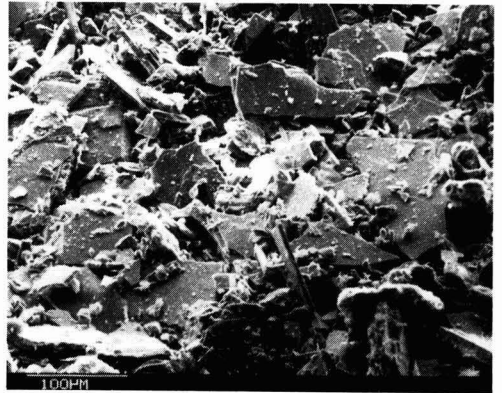


GRF grade

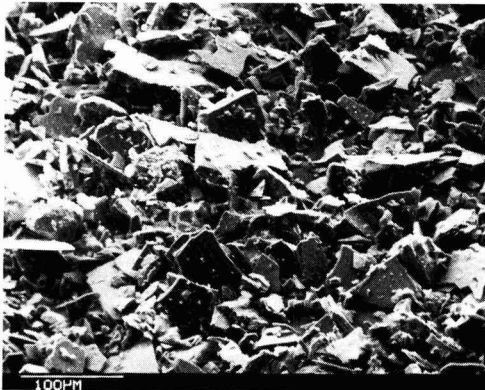
Figure 6. Scanning electron micrographs of micaceous iron oxide pigments from the Great Rock Mine, England



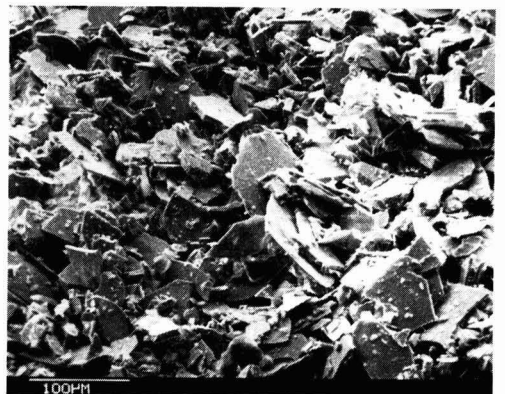
Original sample submitted in 1964



DB grade



Standard grade



Airless spray grade

Figure 7. Scanning electron micrographs of Austrian micaceous iron oxide pigments



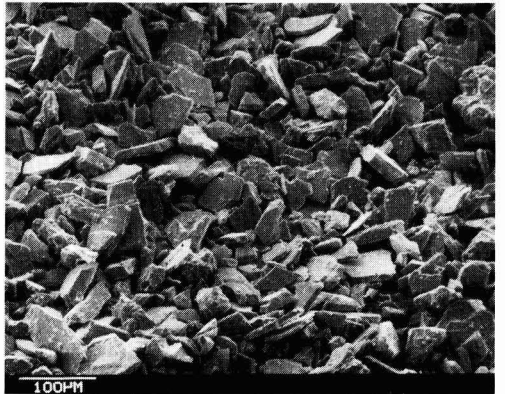
Spanish



West Australian



South African



Japanese

Figure 8. Scanning electron micrographs of granular pigments

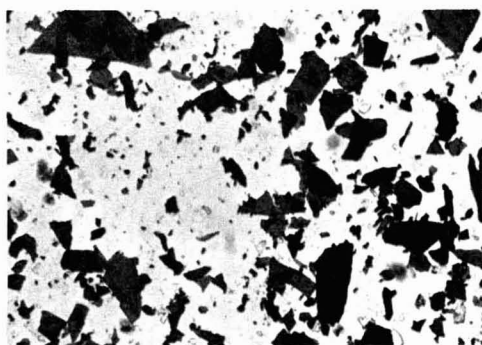


Indian



South Australian

Figure 9. Scanning electron micrographs of small particle size pigments



Austrian



Spanish



Japanese



Indian

Figure 10. Optical photomicrography of pigments viewed under transmitted light

Optical photomicrography

Typical photographs of pigments viewed under transmitted light, at a magnification of ca. $\times 200$, are shown in Figure 10. The pigments can be categorised according to the proportion of micaceous iron oxide particles present, as shown by the characteristic ruby-red colour of these lamellar pigments, and by pigment particle size.

Micaceous pigments

These consist almost exclusively of sharply defined angular ruby-red crystals, with the fracture planes clearly visible. All the English and Austrian grades of micaceous iron oxide, as well as the French, show these characteristics.

Non-micaceous pigments

Contain little or no micaceous iron oxide pigment as shown by the almost complete absence of any ruby red crystals and consist of the dark coloured crystals typical of non-lamellar pigments. The Spanish and West Australian pigments are typical examples.

Low micaceous content pigments

Contain varying proportions, and particle sizes, of micaceous iron oxide depending on the pigment source.

The South African and Japanese pigment samples are a

mixture of lamellar and granular pigments; the South African would appear to contain more granular than lamellar pigments whereas the Japanese is the opposite. The proportion of lamellar pigment was far below that present in true micaceous iron oxide pigments.

The Indian and South Australian samples contain pigment particles much smaller than those present in the other pigments, the Indian pigment has a high proportion of small lamellar pigments whereas that from South Australia contains more granular pigments.

Chemical characterisation of pigments

Refs. 16, 19, 22, 34-42, 47, 48

Micaceous iron oxide pigments were historically defined as containing 90-95 per cent w/w haematite^{16,19} ($\alpha\text{-Fe}_2\text{O}_3$) together with small quantities of mica, quartz, pyrites (FeS_2), goethite ($\text{FeO}\cdot\text{OH}$), etc. with which haematite is naturally associated^{34,37}. In recent years, the accepted proportion of Fe_2O_3 has been reduced to not less than 85 per cent w/w^{38,39}. The nature of the minor constituents will depend on the mine location, lode selection, mining and refining operations, quality control, etc. all of which are very important to ensure uniformity of product for the end user. The most undesirable contaminant is pyrites (FeS_2), which in a paint film is claimed can slowly oxidise to soluble sulphates and create active corrosion centres^{22,40}, but for which there is no direct chemical analysis.

Chemical analysis was carried out by instrumental and "wet" techniques:

1. X-ray powder diffraction
2. "Wet" analysis according to British Standard 3981: 1966 "Specification for iron oxide pigments in paints".
3. Mössbauer absorption spectroscopy.

X-ray fluorescence was also used to determine the inorganic elements present in each pigment and was a useful aid in determining the pigment constituents.

X-ray diffraction

X-ray diffraction⁴¹ is a technique for determining the crystalline forms present in materials and utilises the phenomenon whereby crystals diffract X-rays, the resulting diffraction pattern revealing the crystal structure. By comparing the resultant diffraction pattern with the data file of crystalline substances compiled by the Joint Committee for Powder Diffraction Standards⁴², which contains data for some 29,000 compounds, it is possible to identify the crystalline phases present by a computer search system. Materials that have no documented standard diffraction pattern or are present in an insufficient quantity to produce a good diffraction pattern cannot, however, be determined by this method.

Pigment analysis

X-ray diffraction traces of typical pigments are shown in Figures 11-16; the different crystal phases are indicated. It can be seen that each pigment has its own "fingerprint" due to significant differences in the minor crystalline phases present.

The majority of the peaks are due to the presence of haematite ($\alpha\text{-Fe}_2\text{O}_3$) and since it is the major component (see the section below under the heading "Pigment analysis to BS 3981 "Specification for iron oxide pigments

in paints: 1966") it produces the highest intensity peaks. The minor constituents, such as chlorite, quartz, etc. have their own characteristic peaks with the expected lower intensities, with the smallest produced by traces of muscovite [$\text{KAl}_2(\text{Si}_3\text{AlO}_{10})(\text{OHF})_2$]. The haematite peaks mask some from the minor constituents (which can be seen in Appendix 3), and unfortunately completely mask those from pyrites (FeS_2). Pyrites was expected to be present since it is often found in the presence of haematite but was identified by Mössbauer absorption spectroscopy (see the section under the heading "Mössbauer absorption spectroscopy", below).

The crystalline phases found in each pigment, together with a quantitative estimation are shown in Table I. The English and Austrian pigments have very similar "fingerprints" as can be seen by comparing figures 11 and 12 and both contain small amounts of chlorite and quartz and traces of muscovite. The "fingerprint" of the Austrian pigment submitted to this laboratory in 1964 is identical to that obtained from recent samples. The South African pigment, although containing small amounts of chlorite and quartz, would appear to contain traces of two forms of mica (muscovite $\text{KAl}_2(\text{Si}_3\text{AlO}_{10})(\text{OHF})_2$ and paragonite $\text{NaAl}_2(\text{Si}_3\text{AlO}_{10})(\text{OH})_2$), as shown by the double peak at just over 10 degrees in Figure 13. The Spanish pigments contain no detectable chlorite or mica but have small amounts of dolomitic material and calcite and a trace of quartz (Figure 14). The two Australian pigments are very similar in that they both contain haematite and a small amount of quartz, but the pigment from West Australia has a trace of goethite ($\text{FeO}\cdot\text{OH}$) as shown in Figure 15. Only the Japanese pigments contain detectable amounts of siderite FeCO_3 .

Pigment analysis to BS 3981 "Specification for iron oxide pigments in paints": 1966

The original Austrian pigment samples submitted to this laboratory were tested against the draft of this specification³⁸, which was first issued in 1966. For comparative purposes all samples were tested against this

Table I
Pigment analyses from X-ray diffraction data

Pigment	Crystal								
	Haematite	Chlorite	Quartz	Muscovite	Dolomitic	Calcite	Goethite (FeO.OH)	Paragonite	Siderite (FeCO ₃)
British	large	small	small	trace/ small					
Austrian	large	small	small	trace					
Spanish	large		trace		small	small			
Japanese	large	trace	small		small				small/ medium
South African	large	trace	small	small				trace	
South Australian	large		small						
Indian	large	small	medium	small		trace			
French	large	trace	small	trace	small				
West Australian	large		small				trace		

large = 80-90% w/w, medium = 10-20% w/w, small = 5-10% w/w, trace = 1-2% w/w

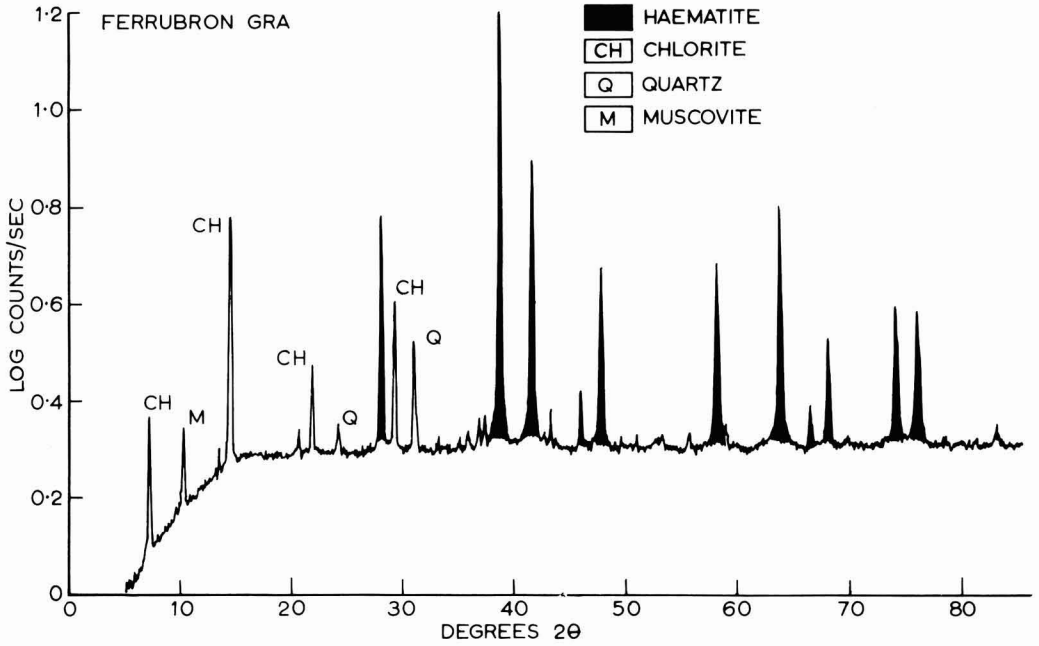


Figure 11. X-ray diffraction pattern of original British micaceous iron oxide pigment

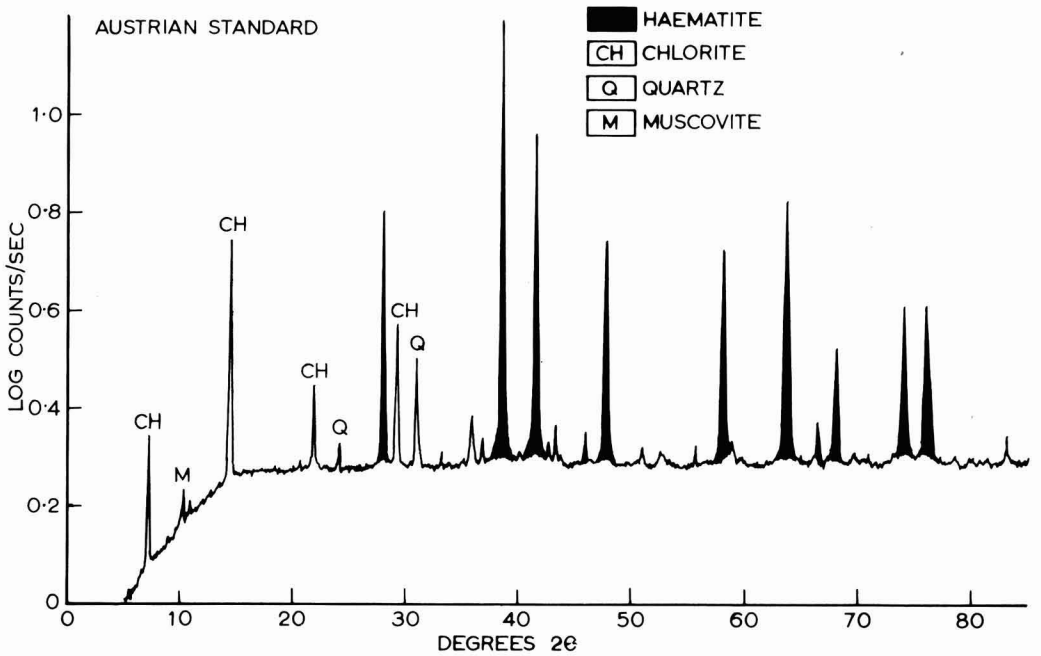


Figure 12. X-ray diffraction pattern of Austrian "Standard" pigment

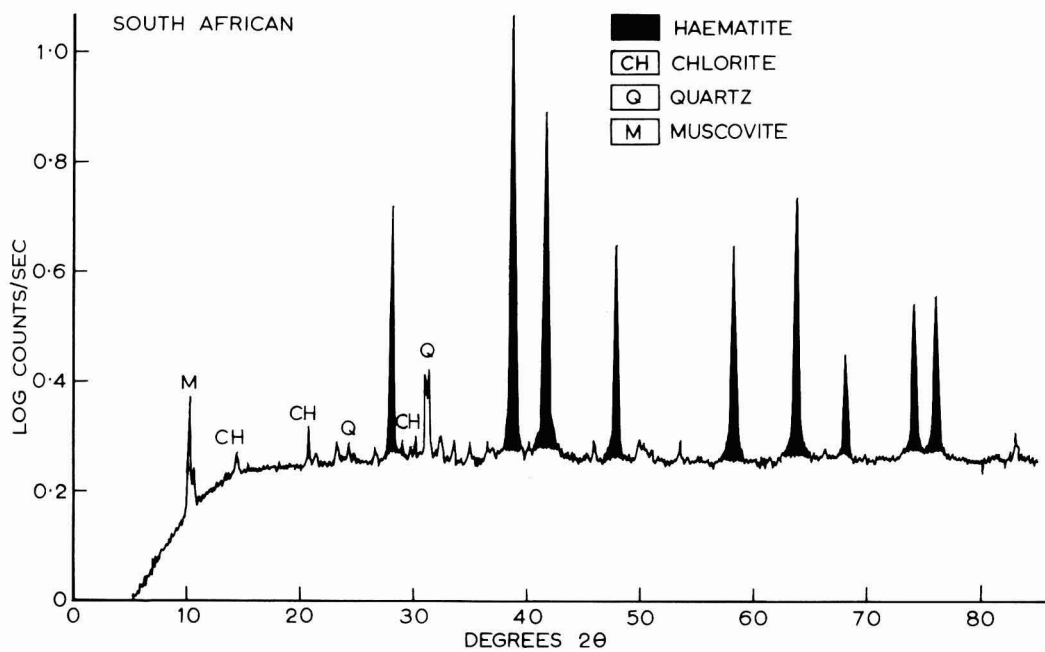


Figure 13. X-ray diffraction pattern of South African pigment sample

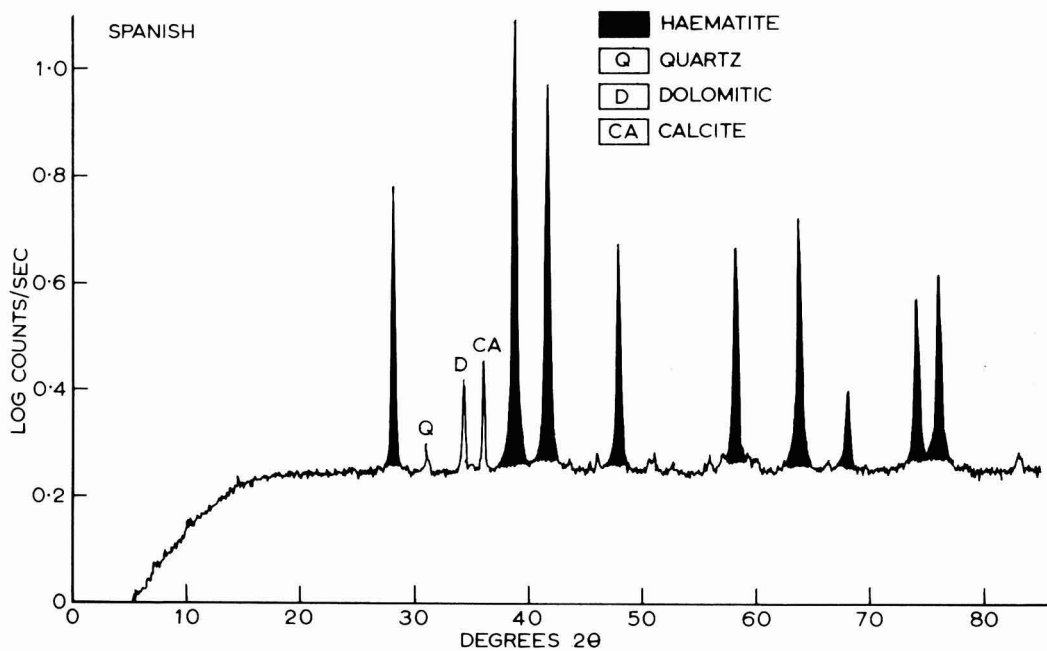


Figure 14. X-ray diffraction pattern of Spanish pigment sample

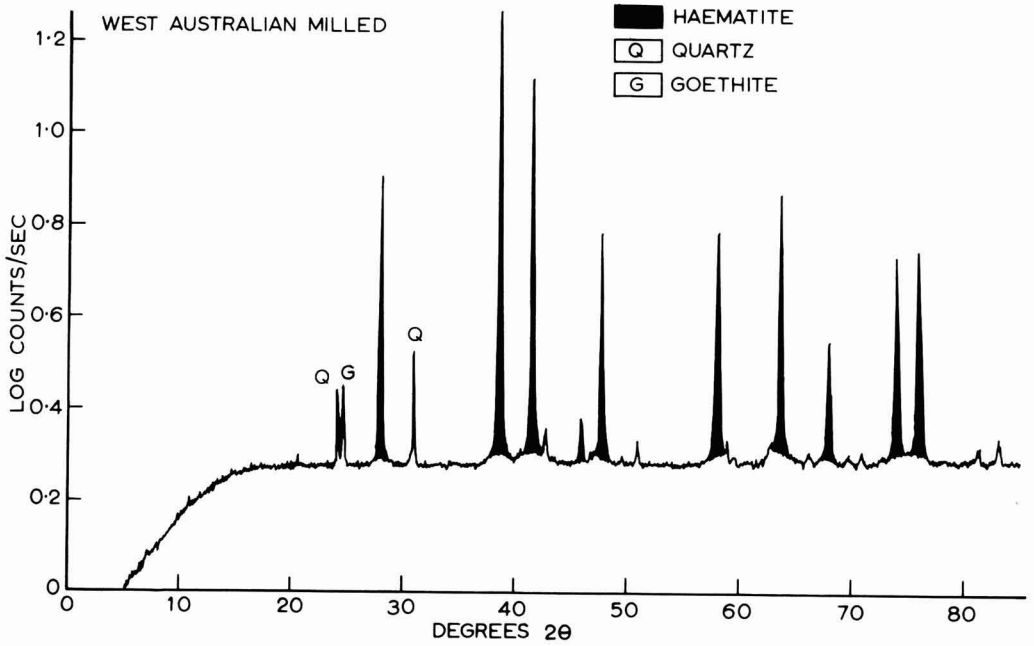


Figure 15. X-ray diffraction pattern of West Australian pigment sample

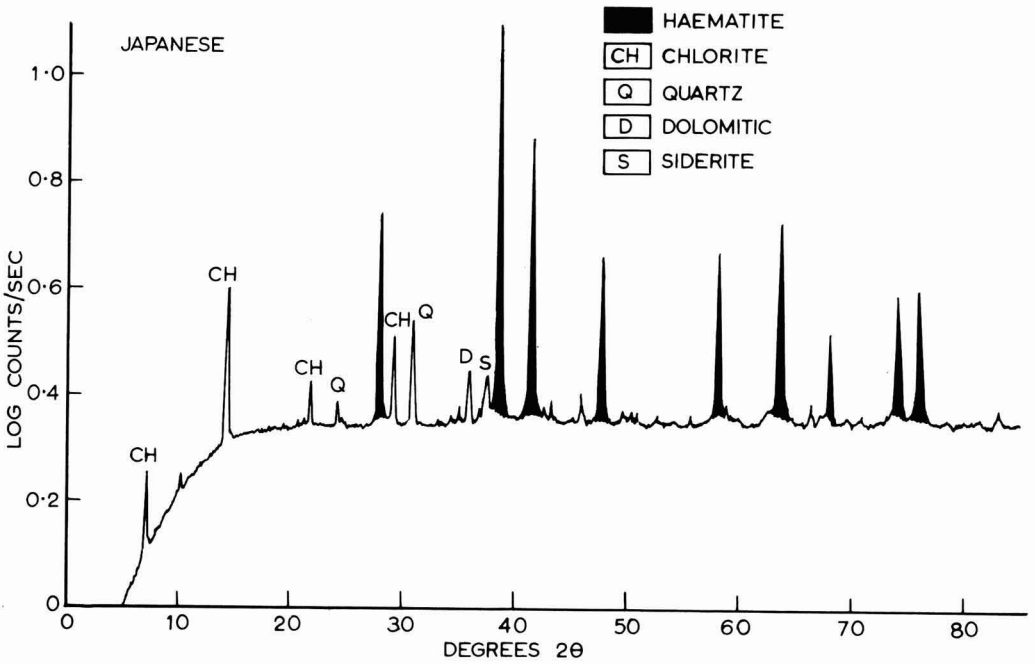


Figure 16. X-ray diffraction pattern of Japanese pigment sample

Table 2
Pigment analyses to BS 3981 "Iron oxide pigments in paints", 1966

Pigment	Test					
	Crystal structure	Iron as Fe ₂ O ₃ % (w/w)	pH of aqueous extract	Solubility in water (%)	S + sulphur compounds %	Oil absorption
Specification requirements	Must be lamellar	Minimum 85	Maximum 6	Maximum 0.5	Maximum 3.5	By agreement
British	yes	84	6.5	0.2	2.8	18
Austrian	yes	85	5.7	0.3	1.1	19
Spanish	no	61	7.2	0.1	0	16
Japanese	no	86				17
South African	no	83	6.2	0.02	0.1	23
South Australian	no	81	6.6	0.02	0	13
Indian	no	74	7.2	0.02	1.2	14
French	yes	86	6.8	0.02	0.6	19
West Australian	partly	83	7.2	0.2	0	16

specification, even though it has been superseded by the 1976 issue which has brought it into line with the International Organisation for Standardisation document, ISO 1248-1974. The latest specification differs from the original in that the tests for water soluble chlorides and total sulphur and sulphur compounds content have been eliminated for micaceous iron oxides, even though these contaminants are claimed to be corrosion accelerators^{22,40}, as well as that for pH of the aqueous solution. The pigment oil absorption requirements are now to be agreed between supplier and user, whereas in 1966 this was not required but was included in these tests. The results on all pigments are shown in Table 2.

Particle shape

The specification states that the micaceous iron oxide must be lamellar and the only commercially available pigment samples examined that meet this requirement are the Austrian and French (see the section under "Physical properties of pigments" above).

Iron content

The specification procedure had to be carefully followed if consistent results were to be obtained since some of the pigments are not easy to dissolve in hydrochloric acid and filtering and fusing may be necessary. Whether all the iron had been removed by acid treatment was determined by X-ray diffraction analysis on the residues from the acid treatment.

The Spanish samples were variable in their quality in that various samples had an Fe content (expressed as Fe₂O₃) of either 60 or 90 per cent compared with the specification requirement of 85 per cent w/w. The Indian samples contained only 74 per cent w/w Fe₂O₃ and the Australian and South African samples were slightly under the specification requirements. All other samples passed the specification requirement, as did the original British and Austrian pigments.

Oil absorption

Oil absorption values (defined as the weight of refined linseed oil to be added to 100g pigment to form a paste) ranged from 13g for the South Australian pigment to 23g for the South African. Oil absorption values are important since they affect the critical pigment volume concentration, which can be defined as the pigment concentration in the dried paint film were just sufficient binder is present to fill the voids between the pigment particles; the lower the oil absorption then the higher the critical pigment volume concentration.

The optimum performance regarding water permeability, rusting, blistering, etc. is obtained when a paint is formulated at or near the critical pigment volume concentration⁴³. Above the critical pigment volume concentration there is insufficient medium to fill the pigment voids and there is a rapid increase in water permeability through the film and a reduction in corrosion protection^{13,43,44}.

Micaceous iron oxides (English, Austrian or French) have oil absorptions of 18-19 and are formulated at pigment volume concentrations between 40-50 per cent in Britain which is higher than the 30-40 per cent for undercoats and 20-30 per cent for finishes that are generally used in Germany and Holland⁴⁵. Irrespective of the fact that all the other pigments examined were non-micaceous, they should not be used in anti-corrosion paints without full assessment by the specifier since the varying oil absorptions affect the critical pigment volume concentration which determines the corrosion protection, blistering, overcoating, etc. These non-micaceous pigments may also produce gelation effects due to interactions with the medium¹².

Sulphur and sulphur compounds

The determination was carried out according to BS 3981:1966 Appendix H which determines the sulphur

and sulphur compounds, other than insoluble sulphates, as per cent SO_3 (w/w), the results are shown in Table 2. The amount of SO_3 will largely be determined by the mine location (30-32) and it is highly significant that the English micaceous iron oxide has the highest SO_3 content (2.8 per cent w/w) followed by the Austrian (1.1 per cent w/w which has been reduced from 2.8 per cent w/w) although within the 3.5 per cent w/w limit of BS 3981 : 1964. The crystalline structures of the pigments (and hence the chemical composition) are greatly affected by the carrier rock²⁷. Norwegian and Spanish micaceous iron oxides, like the German ore mined in the Fichtel mountains, are characterised by an extraordinary hardness of the crude and unwashed ore, this makes the refining process difficult and results in non-micaceous pigments. The Austrian and English micaceous iron oxides, on the other hand, are found in softer rock, inevitably containing pyrites (FeS_2) which can be readily crushed (Appendix 1). The crystal structure and chemical composition are also determined by the size of the deposits, their purity, lode selection, mining techniques, processing and refining as well as geological factors.

Thus the presence of SO_3 produced by oxidation of sulphur and pyrites, must be expected in true micaceous iron oxides but its percentage must be kept to a minimum to prevent corrosion acceleration.

Mössbauer absorption spectroscopy

The principle of Mössbauer spectroscopy is the absorption and recoilless emission of gamma rays by the atomic nucleus. The method allows a more specific analysis to be made of the iron-bearing phases than is possible by X-ray diffraction methods. The effect does not depend on the crystallinity of the material, but on the resonating nucleus being bound in a solid. In recent years there has been considerable interest in Mössbauer analysis of iron-bearing minerals which showed that iron phases such as pyrite, carbonates (siderite and ankerite), ferrous silicates, and haematite exhibit different spectra^{30,47,48}. Since these minerals have been identified in micaceous iron oxides (see the section under the heading "X-ray diffraction", above) it was considered that this technique could be useful in analysing these pigments especially the identification and quantitative assessment of pyrites^{31,32,48}. The English, Austrian and Spanish micaceous iron oxide pigments were analysed for their iron bearing minerals and the Mössbauer spectra are shown in Figure 17. All three spectra have eight major peaks. In all three samples the outer six peaks occur essentially in the same positions and the Mössbauer parameters (isomer shift, quadrupole splitting, and hyperfine splitting) show them to be characteristic of $\alpha\text{-Fe}_2\text{O}_3$.

English and Austrian pigments

The samples produce very similar spectra both having the six peaks characteristic of $\alpha\text{-Fe}_2\text{O}_3$ and a central doublet. The Mössbauer parameters of the doublet are characteristic of pyrites.

Visual examination of the spectrum indicated that up to six extra small peaks were present but a complete analysis was not attempted. The position of these extra peaks indicated that the impurity was an iron mineral, and not a mineral containing interstitial iron.

Table 3
Quantitative analysis of pyrites (FeS_2) in
micaceous iron oxides from Mössbauer spectroscopy

Pigment	Iron content from pyrites %	Calculated pyrites content %	Pyrites content from wet analysis %
English "GRA"	4	8	6
Austrian "Standard"	4	8	6
Spanish	0	0	0

Spanish pigment

The Mössbauer parameters of the central doublet differ significantly from those in the spectra of the English and Austrian pigments, and do not correspond to any iron-sulphur compounds in the literature. This was in complete agreement with "wet analysis" (see the section under the heading "Sulphur and sulphur compounds", above) in which no sulphur was detected in the Spanish pigment.

Quantitative analysis of pyrites

The normalised intensities of the peaks due to pyrites showed that its iron content in the English GRA and the Austrian Standard grade pigments was as shown in Table 3, the corresponding pyrites contents were calculated and were in reasonable agreement with those calculated from the total sulphur from "wet analysis" (assuming all the sulphur is from pyrites, see the section under the heading "Sulphur and sulphur compounds" above).

Mössbauer spectroscopy has identified and quantified pyrites in micaceous iron oxides and could with further work provide a powerful technique for the identification/fingerprinting of these pigments.

Conclusions

This work has clearly shown that of the commercially available pigment samples examined only those from two sources, France and Austria are entitled to be called micaceous iron oxides. The other pigments are not considered to be micaceous iron oxides because:

1. the samples do not possess the lamellar structure of mica and are granular and/or "fines" with little or no lamellar structure.
2. the Fe_2O_3 content is below the accepted minimum of 85 per cent w/w; contents as low as 60 per cent have been determined.
3. the particle sizes are not comparable to the accepted standards of the pigments from Devon, England and Waldenstein, Austria. This affects the oil absorption, pigment packing, etc. which in turn affects the paint performance.

Modern techniques have shown the remarkable similarity in crystalline structure and chemical composition of the English and Austrian pigments (as well as "finger-printing" the pigment sources). This explains the

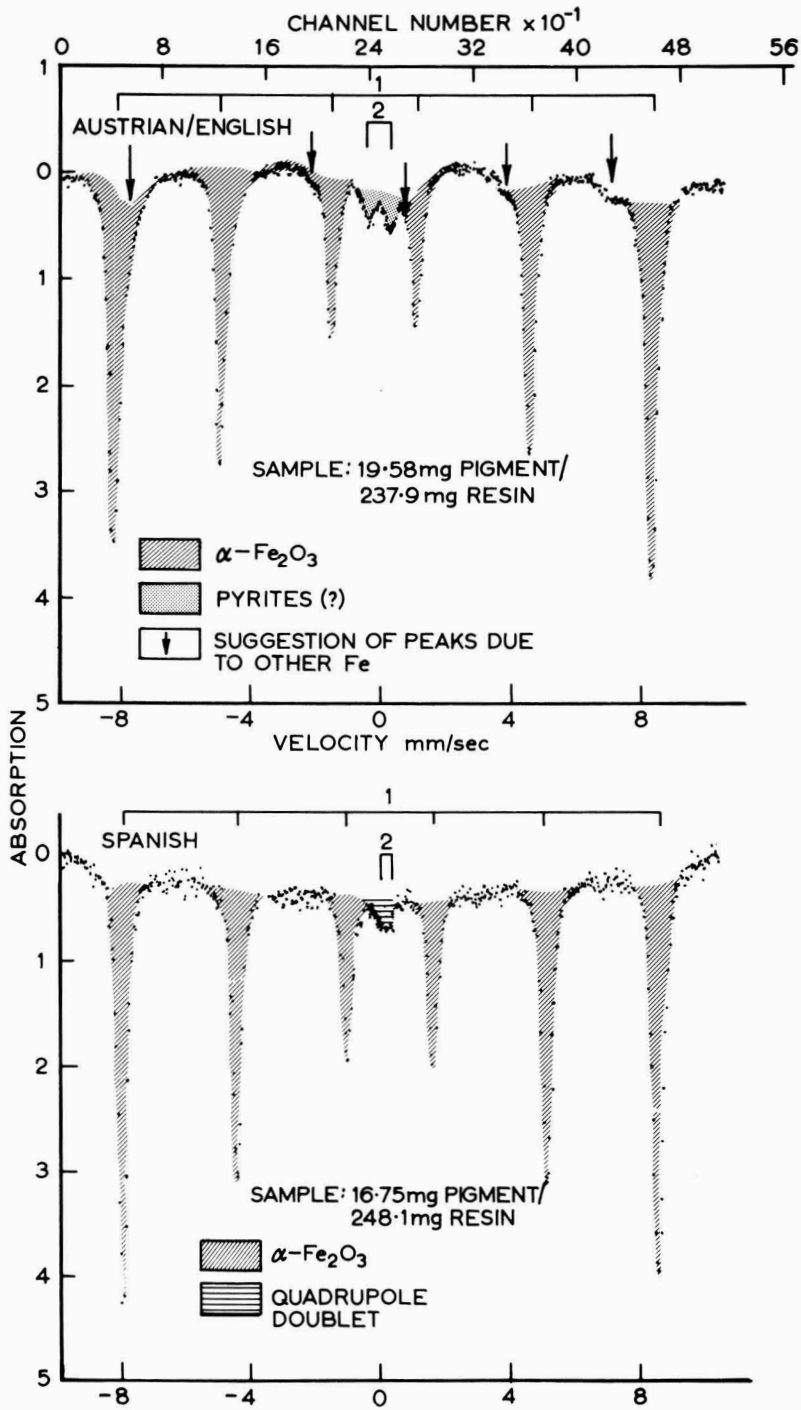


Figure 17. Mössbauer absorption of pigments

consistent level of protection given by both pigments in the civil engineering painting systems used for eighty years or so on the railways of Britain. The French pigment would also be expected to give good protection since it has the same lamellar structure.

It will be shown in a future paper¹² that micaceous iron oxides incorporated into protective paints give superior corrosion protection than paints based on granular and/or "fines".

Acknowledgements

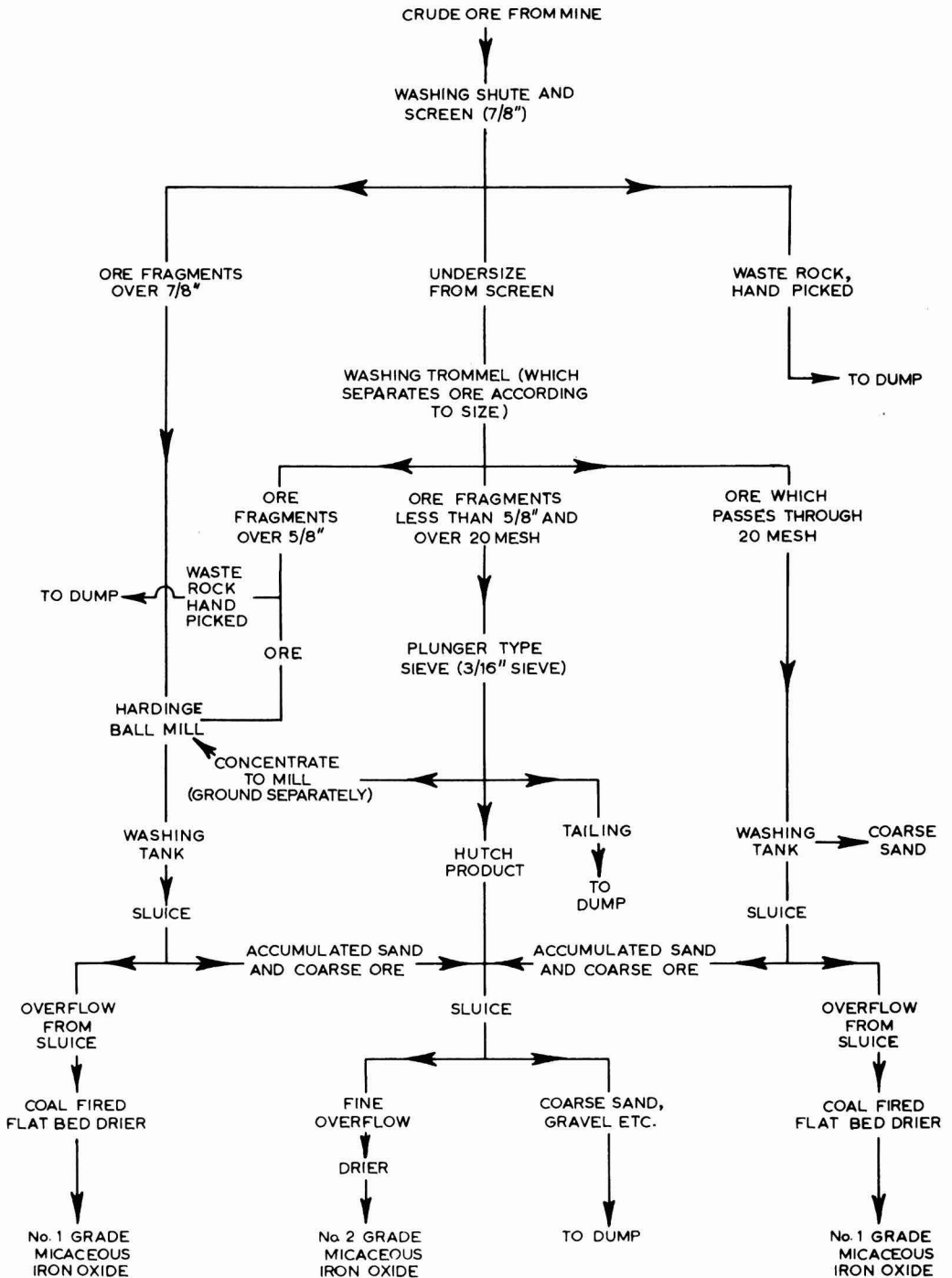
The Author would like to thank the Raw Material and Paint Industries for the assistance and information that was readily given, his analytical colleagues at the Railway Technical Centre, Derby especially Mrs S. E. Lovell/J. W. Harding and J. Jarvis/D. A. Williams for their X-ray diffraction/scanning electron microscope expertise respectively and Dr L. Guest of the Health and Safety Executive, Sheffield for the Mössbauer absorption spectroscopy analyses. The author acknowledges the permission of the Director of Research, British Railways Board to publish this paper.

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References

- Scheifele, B., *Paint and Varnish Production Manager*, 1935, July, **11**, 32.
- Hudson, J. C., *Journal of the Iron and Steel Institute*, 1951, October, **189**, 153.
- Claxton, A. E., *Official Digest*, 1964, **36**, (470), 268.
- Kirsch, A., *Korrosion und Metallschutz*, 1927, **3**, 227.
- Fancutt, F., *Corrosion Prevention and Control*, 1970, **18** April.
- Bayliss, D. A., *Paint, Oil and Colour Journal*, 1962, **28** December, 1493.
- Hudson, J. C., *JOCCA*, 1945, **28** (295), 27.
- Claxton, A. E. and Carter, E. V., *British Corrosion Journal*, 1969, **4**, 187.
- Claxton, A. E., *Journal of the Iron and Steel Institute*, 1962, July, **200**, 508.
- Wolff, H. and Zeidler, G., *Paint and Varnish Production Manager*, 1933, **9** (12), 18.
- Wiktorek, S. and Craig, C., *Corrosion Australasia*, 1977, **2** (3), 4.
- Bishop, D. M. and Zobel, F. G. R., to be published.
- Ferguson, P. J., *JOCCA*, 1976, **59** (7), 253.
- Bayliss, D. A., *JOCCA*, 1975, **58** (9), 325.
- Harrison, J. B., *JOCCA*, 1979, **62** (1), 18.
- Rabate, H., *Travaux de Peinture*, 1962, **17** (5), 151.
- Nassberg, B., *American Paint and Coatings Journal*, 1970, 22 June, **54**, 68.
- Treade, M., *American Paint and Coatings Journal*, 1974, 23 September.
- Griffiths Bros Co., "Photographs of some Recent Steel Structures Painted with Ferrodor Elastic Paint", Booklet, 1909, October.
- Thornbery, K., private communication.
- Lindermayer, O., *Zeitschrift des Vereines Deutscher Ingenieure*, 1933, 15 April, **77** (15), 385.
- Bennett, N. A., private communication.
- District Civil Engineer, Exeter Division, British Rail, private communication.
- Fancutt, F., private communication.
- Hartley, H., *Journal of the Institute of Transport*, 1932, **13**, 495.
- Schaper, G., *Bautechnik*, 1935, **1** (1), 35.
- Schaper, G., *Korrosion und Metallschutz*, 1937, **13**, 327.
- Fritsch, B., *Farbe und Lack*, 1950, **56** (2), 61.
- Pokorny, G., *Defazet*, 1973, **27** (12), 588.
- Huffman, G. P. and Huggins, F. E., *Fuel*, 1978, October, **57**, 592.
- Guest, L., *Annals of Occupational Hygiene*, 1976, **19**, 49.
- Guest, L., *Annals of Occupational Hygiene*, 1978, **21**, 151.
- Oatley, C. W., *New Scientist*, 1958, **5**, 153.
- Deer, W. A., Howie, R. A. and Zussman, J., "An Introduction to the Rock-forming Minerals", *Longmans*.
- Michell, F. B., *Mine and Quarry Engineering*, 1944, November, **9**, 227.
- Michell, F. B., *Mine and Quarry Engineering*, 1945, 9 January, **10**.
- Berliñg, T. C., *Official Digest*, 1930, No. 101, 287.
- British Standard Institution, "Specification for iron oxide pigments for paints", BS 3981 : 1966.
- German Railways Specification, Appendix to TL.918 300, 1976.
- Charrin, V., *Peintures Pigments-Vernis*, 1946, **22** (11), 357.
- Klug, H. P. and Alexander, L. E., "X-ray diffraction procedures", *John Wiley & Sons*.
- Powder Diffraction File: Alphabetical Index Inorganic Compounds, 1978, Published by JCPDS International Centre for Diffraction Data.
- Newton, D. S., *JOCCA*, 1962, 45.
- Asbeck, W. K. and Van Loo, M., *Industrial Engineering Chemistry*, 1949, **41** (7), 1470.
- Miox Ltd. "Pigmentation levels for micaceous iron oxide paints", Technical Literature No. TIL5.
- Miox Ltd, Technical Literature Nos. FG/1-FG/7.
- Coey, J. M. D., *Atomic Energy Review*, 1980, **18**, 1.
- Levinson, L. m. and Jacobs, I. S., *Fuel*, 1977, **56**, 453.

Appendix 1



Appendix 2

Micaceous iron oxide formulations

Extract from British Railways "Paint Specification No. 35 covering Materials for use on Bridges, Buildings and Structures", November 1958.

Item 61. Undercoating micaceous iron ore paint

1. Material supplied to this "item" shall be suitable for the purpose described in the title as an oleo-resin bound paint for use, without any adjustment, over priming, paints to items 7, 8, 9 and 10, and as an undercoating paint for items 62 and 63.

2. Material supplied to this "item" shall consist of a mixture of an *approved grade* of micaceous iron ore, leafing aluminium paste to BS 388, Part 2, and not more than 5 per cent by weight of china clay, Grade 1, or asbestine to BS 1795. The pigment shall be incorporated by suitable means in the medium specified in sectional clause 7/3, together with driers and white spirit to BS 245 to bring the resultant paint to a working consistency. Surface active suspending agents may also be incorporated but must not exceed 0.5 per cent by weight of the total pigment.

The following formulation produces a satisfactory paint:

micaceous iron ore	55-60 lbs.
china clay, Grade 1, to BS 1795	3 lbs.
leafing aluminium paste to BS 388 (Part 2)	0.5 lbs.
boiled linseed oil to BS 259	6 lbs.
stand oil (15 poise)	8-10 lbs.
medium oil length varnish	4-6 lbs.
white spirit to BS 245	4-10 lbs.
liquid driers	5-7 lbs.

Item 62. Finishing micaceous iron ore paint (natural)

1. Material supplied to this "item" shall be suitable for the purpose described in the title as an oleo-resin bound paint for use, without any adjustment, over undercoating micaceous iron ore paint to Item 61, and for self-overcoating.

2. Material supplied to this "item" shall consist of a mixture of an *approved grade* of micaceous iron ore, leafing aluminium paste to BS 388, Part 2, and not more than 5 per cent tinting pigment to the appropriate BS Specifications. The pigment shall be incorporated by suitable means in the medium specified in sectional clause 7/3, together with driers and white spirit to BS 245 to bring the resultant paint to a working consistency. Surface active suspending agents may also be incorporated but must not exceed 0.5 per cent by weight of the total pigment.

The following formulation produces a satisfactory paint:

micaceous iron ore	60-65 lbs.
leafing aluminium paste to BS 388, (Part 2)	2.5 lbs.
boiled linseed oil to BS 259	6 lbs.
stand oil (15 poise)	8-10 lbs.
medium oil length varnish	4-6 lbs.
white spirit to BS 245	2-3 lbs.
liquid driers	5-7 lbs.
aluminium stearate	0.5 lbs.

Suggested present-day paint formulation (46)

Micaceous iron oxide paints formulated to meet specifications such as "British Railways Specification No. 35" have over many years given excellent performance but had the disadvantage of poor through drying in generously applied coatings. Modern economic requirements of reduced numbers of paint coats (but maintaining overall dry film thickness), shorter overprinting times, faster application etc. necessitated formulation changes. A typical air-drying formulation to meet present-day requirements is shown below:

micaceous iron oxide	50 (parts by weight)
extender (i)	6
anti-settling agent (ii)	1
air drying medium (solids) (iii)	18
mineral spirits	24
driers and anti-skinning agent	1
	<hr/>
	100

volume solids = 50 per cent
pigment volume concentration = 40 per cent

- Many extenders are available (e.g. barytes, talc, asbestine, mica, china clay etc.), differing in chemical composition, particle size and shape. Water soluble salts must be kept to a minimum.
- Such as montmorillonite clay like mineral or hydrogenated castor oil.
- Air drying media such as:
 - Tung oil modified phenolic resin or tung oil/linseed modified phenolic resin. 60-70 per cent oil length.
 - Modified alkyls (i.e. urethane oil or vinyl modified).
 - Alkyls. 20-25 per cent phthalic anhydride 55-65 oil length.

Chemically curing or solvent evaporation coatings, such as two pack epoxies, two-pack polyurethanes, chlorinated rubbers etc. can be used but formulation changes, e.g. solvent balance, will be necessary in order to meet performance and application requirements.

Appendix 3

Computer "print-out" of crystal analysis from X-ray powder diffraction data. (See section under heading "X-ray diffraction" above.)

Sample: Ferrubron - GRA

Peak detection table of standard data

2 theta (1)	D(angs) (1)	Intens (1)	α -Fe ₂ O ₃ (2)	α -SiO ₂ (2)	Chlorite (2)	Muscovite (2)
7.32	13.9970	7			14.1 ₅₀	
10.36	9.9012	5				9.95 ₉₅
13.57	7.5653	2				
14.58	7.0481	31			7.05 ₁₀₀	
20.67	4.9827	7				4.97 ₃₀
21.92	4.7018	8			4.69 ₅₀	
24.32	4.2439	2		4.25 ₃₃		
28.18	3.6733	28	3.66 ₂₅			
29.38	3.5265	16			3.52 ₉₀	
31.13	3.3327	10		3.343 ₁₀₀		3.32 ₁₀₀
36.97	2.8200	3			2.81 ₄₀	
37.48	2.7829	3				
38.77	2.6935	100	2.69 ₁₀₀			
41.72	2.5112	45	2.51 ₅₀		2.51 ₅₀	
43.41	2.4175	3				
46.05	2.2861	4	2.285 ₂			
47.92	2.2016	22	2.20 ₁₃₀			
53.33	1.9926	1	2.070 ₂			1.993 ₄₅
58.22	1.8378	22	1.838 ₄₀			
63.81	1.6918	32	1.690 ₆₀			
66.47	1.6313	3	1.634 ₄			
68.13	1.5964	11	1.596 ₁₆			
68.30	1.5928	7	K			
74.10	1.4840	15	1.484 ₃₃			
74.30	1.4806	11	K			
76.05	1.4515	14	1.452 ₃₅			
76.28	1.4479	9	K			

(1) Data from X-ray powder diffractometer.

(2) Crystalline phases identified by computer search system.

The formulation of textured coatings for plywood

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Summary

Durable coatings for birch plywood can be produced from sand-textured, internally-aggregated or cast-aggregate systems, although the last type appears to be more difficult to formulate.

For all of these types of finish the maintenance of good coating

integrity during exterior weathering is dependent upon polymer type and, for the sand-textured and cast-aggregate types, upon the level of pigmentation adopted. The addition of sand or aggregate into textured paints also needs careful control to avoid poor coating performance on plywood.

La formulation des enduits décoratifs pour contreplaqué

Résumé

On peut obtenir des revêtements durables pour contreplaqué en bouleau à partir des produits contenant du sable ou des agrégats minéraux, et aussi par la projection de l'agrégat à la surface fraîche du revêtement, bien que ce genre de revêtement soit plus difficile à formuler.

A l'égard de tous ces types de finition, le maintien de la bonne

solidité du feuil lors de l'exposition aux intempéries se dépend du type de polymère, et du niveau de pigmentation dans le cas des revêtements contenant de sable, et de ceux où l'agrégat est appliqué ultérieurement. L'addition du sable ou de l'agrégat à telles peintures doit être contrôlée soigneusement afin d'éviter du mauvais rendement lorsque le revêtement est appliqué au contreplaqué.

Die Rezeptierung von Strukturbeschichtungsmitteln für Sperrholz

Zusammenfassung

Man kann dauerhafte Beschichtungsmittel für Birkensperrholz aus Porodukten herstellen, die Sand und andere Aggregate erhalten, oder durch das Werfen des Aggregate nach dem Aufbringen des Beschichtungsmittels, obwohl die Rezeptierung der letzten Type schwieriger scheint. Während der Freibewitterung hängt für alle dieser Systemen das Erhalten des Beschichtungs-

integrität von der Polymerentype und von dem Pigmentierungsgrad hinsichtlich der Sand erhaltenden und geworfene Aggregat-Typen. Man muss den Zusatz von Sand oder Aggregat zu den Strukturbeschichtungsmitteln sorgfältig kontrollieren um auf Birkensperrholz, geringe Beschichtungsleistung zu vermeiden.

Keywords

Types and classes of coatings and allied products

texture coating

Properties characteristics and conditions primarily associated with

dried or cured films

durability

water vapour transmission

Types and classes of structures or surfaces to be coated

plywood

Processes and methods primarily associated with service or utility

weathering

Introduction

Ref. 1

Plywood is widely used in the building industry for cladding. As a substrate however it is difficult to coat satisfactorily due mainly to the problems caused by surface checking (splitting) of the board which develops in response to fluctuations in atmospheric moisture content. Many types of coating systems including varnishes and conventional paints as well as textured finishes have been used on plywood. Textured finishes have been widely used in exterior situations because of their decorative appeal and also because they are considered to be more durable.

However, even when so coated plywood has still proved to be an especially difficult substrate with many reported instances of failure.

A programme of research at PRL on plywood coatings was designed to study the performance of various commercially available systems with special regard to their long-term effectiveness during exterior exposure. The checking tendencies of various board types and the modifying effects of preservative pre-treatment, as well as the effect of paper overlays on paint performance are also being evaluated¹.

The aim of the work reported here was to study the for-

mulation requirements necessary for plywood coatings in order to obtain long-term durability. Three types of coating were studied: sand-textured types intended for *in situ* application by brush, spray or roller, the aggregate-textured types normally applied by trowel, and the two-stage systems in which loose aggregate is cast onto a base coat whilst still wet. The latter is normally suited only for factory application. For both the sand-textured and cast-aggregate systems, the effect of polymer type, pigment volume concentration, and particle size of the texturing additive on subsequent performance was studied. A smaller study of the influence of polymer type on the performance of internally-aggregated coatings was carried out.

Testing of the formulations included a period of accelerated weathering to induce premature coating failure by checking of the plywood, followed by natural weathering to assess the general durability characteristics of the coatings. The permeability of some of the coatings to water vapour was also investigated.

Experimental

Refs. 2,4

Coating systems studied

Three types of coating systems were studied; sand-textured, cast-aggregate and internally-aggregated, Figure 1. Formulation variables examined within these systems were as follows.

Sand-textured paints: effect of polymer type
effect of pigment volume concentration (pvc)
effect of sand loading
effect of sand grading

Cast-aggregate systems: effect of polymer type
effect of pvc
effect of aggregate particle size

Internally-aggregated systems: effect of polymer type

Conventional formulation techniques were used throughout, although only a brief outline of the major ingredients is presented here.

Coating ingredients

Polymers

Five types were used.

Aqueous emulsions: a polyvinyl acetate – Versatate copolymer,
a “100 per cent” acrylic
a styrene-acrylic copolymer

Solvent-soluble resins: a long-oil length drying-oil modified alkyd,
a two-component epoxy-polyamide.

Pigment

A paint grade red oxide of iron was used throughout.

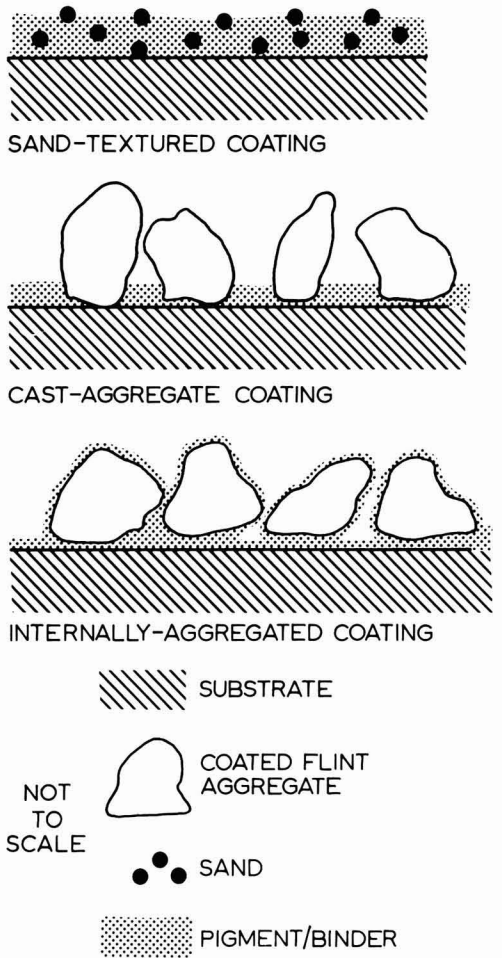


Figure 1. Coating types

Sand

Clean dried building sand was separated by sieving into two fractions, fine, 250–355 μm and coarse, 355–1000 μm. In some of the work a mixture at a ratio of 1.5:1.0 mass/mass of fine sand to coarse sand was used.

Aggregate

A natural flint of angular shape which was obtained pre-coated with two coats of a dark red coloured polyurethane paint. Three grades were used, of nominal particle size 1.6 mm, 3.2 mm and 6.4 mm.

Coating preparation

Base paints were prepared by addition of the iron oxide pigment to each of the five polymers. For each polymer, five pigment volume concentrations were used; 5, 15, 25, 35 and 45 per cent and coatings prepared as follows.

Sand-textured paints: effect of polymer and pvc

Paints were prepared from each of the pigmented bases by mixing in the fine and coarse sand combination to give a total sand addition of 25 per cent (parts by weight).

Sand-textured paints: effect of sand addition

The effects of sand loading at a constant grading and of varied sand gradings at a constant loading were studied using the styrene-acrylic and the alkyd binders pigmented at 25 per cent pvc.

The effect of sand loading was evaluated by including into base paints 0, 12.5, 25, 37.5 and 50 per cent of the sand mixture.

The effect of grading the sand was studied by incorporating in the paint bases 25 per cent of the fine and coarse fractions, and the sand mixture.

Cast-aggregate systems

All combinations of polymer and pvc were studied using the 1.6 mm aggregate. Details of how the finished systems were produced are presented under "Panel preparation".

The effect of aggregate particle size was studied in the styrene-acrylic and alkyd bases, pigmented to a level of 25 per cent pvc, using the three grades of the aggregate.

Internally-aggregated systems

Formulations were prepared using the 1.6 mm aggregate and each of the five polymers. The weight ratio for the two main ingredients was 8:1 aggregate to polymer, a level known to be appropriate for this type of finish. These systems, which were applied by trowel, had a high solids content of 88-90 per cent by weight. One per cent of pigment was incorporated during preparation to improve opacity.

Panel preparation

Duplicate birch plywood panels, 150 × 100 × 10 mm, were used for all exposure testing. All panel preparation was performed at 20°C and 65 per cent relative humidity. After application as detailed below, two coats of an aluminium wood primer were applied to the backs of the panels, and the edges were sealed with a two-component pitch-epoxy compound.

Sand-textured paints

Three coats of each system were brush applied to obtain a final dry coating thickness of ca.250 μm. A period of overnight drying was allowed between coats.

Cast-aggregate systems

One coat of each of the base paints was brush applied to the test panels to produce a dry film thickness of ca.50 μm. Whilst still wet, aggregate was cast onto the surface of the film. The panel was then lightly tapped to remove surplus material and then stored flat until the coating had dried.

Internally-aggregated coatings

Each of the internally-aggregated coatings was applied to

the test panels using a trowel. The films were all applied to produce a layer 1.5 to 2 mm thick.

Exposure testing

After conditioning for seven days at 20°C and 65 per cent relative humidity the panels were subjected to an accelerated weathering procedure developed by Smith²; designed to initiate dimensional movement in the substrate. A cycle comprised 250 hours artificial weathering³ to BS 3900:Part F3; followed by 8 hours soaking in water, 16 hours infrared drying (surface temperature ca.60-70°C), 8 hours soaking in water, 24 hours at ca.minus 18°C, and finally 16 hours infrared drying.

After two such cycles, the test panels received 12 months exposure mounted at 45° facing south on the PRL test site.

After the second period of accelerated testing and periodically during the natural exposure, the panels were assessed for either checking and flaking or checking and loss of aggregate; the respective modes of failure for the sand-textured and the two aggregated systems. Performance was assessed on a 5-point rating scale, 0, 1, 2, 3, 4, where 0 represents no failure and 4 indicates severe failure.

Permeability testing

The water vapour transmission rate of unweathered coatings was determined by the cup technique⁴ detailed in ISO/R 1195:1970, under conditions of 25°C and 90 per cent relative humidity. Standard grade fibre building board discs, 90 mm diameter and 3 mm thick, were used as support substrate, and finishes were applied by the techniques described previously to achieve the appropriate thicknesses.

Three replicates were used for each test. The water vapour transmission was expressed as grammes per square metre of film per 24 hours.

Results**Sand-textured paints – 1. Effect of polymer and pigment volume concentration***Exposure testing*

Within the emulsion based systems, Table 1 and Figure 2, the pva-Versatate formulations remained in good condition throughout the exposure testing only at the lowest (5 per cent) pvc studied. Failure progressively worsened as pvc increased. At 15 and 25 per cent pvc checking occurred, but for the 35 and 45 per cent formulations the films had flaked completely from the panels after just six months of natural exposure.

Similar trends were shown by the styrene-acrylic and acrylic systems although here failures became evident only in the paints formulated at 25 per cent pvc and higher. Failure was confined to checking, except in the 45 per cent pvc styrene-acrylic where severe flaking occurred.

The behaviour of both the alkyd and the epoxy-based systems was similar and performance was better, in general, than the emulsion systems. After 12 months natural weathering slight checking occurred with the paints formulated at 35 and 45 per cent pvc. In the 45 per

Table 1
Testing of sand-textured paints;
effects of polymer and pigment volume concentration

Polymer	pvc %	Exposure testing			Permeability $\text{g m}^{-2}(24\text{h})^{-1}$	SD
		Accelerated	Natural			
			6 m	12 m		
<i>Emulsions:</i>						
Pva-Versatate	5	0	0	0	64	1.7
	15	1	1	3	73	3.2
	25	2	2	3	111	6.2
	35	4	4	4	163	19.6
	45	4	4	4	147	9.4
Styrene-acrylic	5	0	0	0	20	2.8
	15	0	0	0	21	1.5
	25	1	1	2	56	2.1
	35	3	4	4	153	13.8
	45	3	4	4	166	25.9
Acrylic	5	0	0	0	82	2.3
	15	0	0	0	82	1.7
	25	1	1	1	111	5.1
	35	2	2	2	168	6.3
	45	2	2	2	194	17.7
<i>Solvent-soluble:</i>						
Alkyd	5	0	0	0	16	3.0
	15	0	0	0	14	1.8
	25	0	0	0	12	1.0
	35	0	0	1	58	5.3
	45	1	1	1	96	10.6
Two-pack epoxy	5	0	0	0	5	0.8
	15	0	0	0	5	0.4
	25	0	0	0	66	2.1
	35	0	0	1	86	3.3
	45	0	1	1	118	24.0

Table 2
Testing of sand-textured paints; effects of sand loading

System	Sand loading %	Exposure testing			Permeability $\text{g m}^{-2}(24\text{h})^{-1}$	SD
		Accelerated	Natural			
			6 m	12 m		
<i>Emulsion:</i>						
Styrene-acrylic 25% pvc	0	1	1	1	18	2.3
	12.5	1	1	1	24	2.3
	25	1	2	2	28	1.3
	37.5	2	2	3	55	12.4
	50	3	3	3	138	2.9
<i>Solvent-soluble:</i>						
Alkyd 25% pvc	0	0	0	0	9	0.6
	12.5	0	0	0	9	0.6
	25	0	0	0	9	0.3
	37.5	0	1	1	11	2.2
	50	1	1	1	14	0.3

cent pvc alkyd-based system, this limited failure was caused by the accelerated weathering.

Permeability

The permeabilities of the systems depended on both the polymer and pigment level, Table 1. Lowest permeabilities

occurred where formulations were based on the solvent-soluble polymers and the styrene-acrylic emulsion, although this was only evident at low pvc's. Paints formulated from the acrylic-emulsion polymer possessed the highest permeabilities.

Within each system, the permeability values of the 5

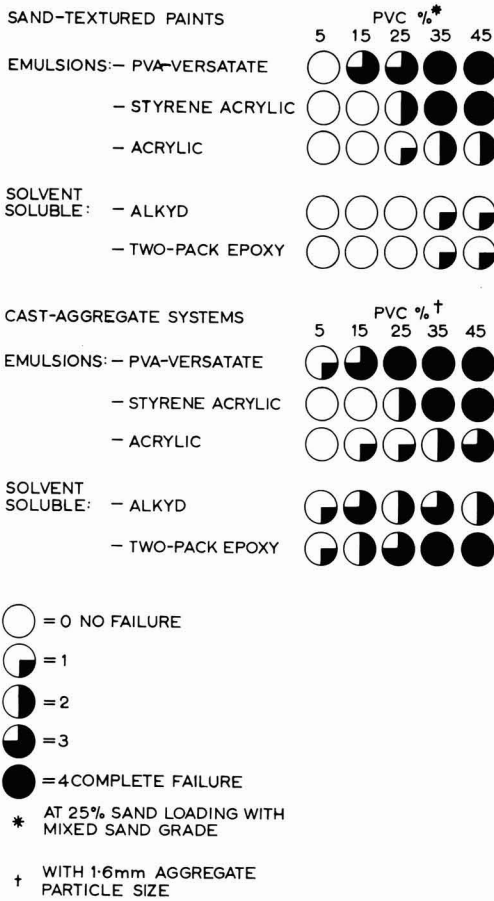


Figure 2. Effect of polymer and pigment volume concentration on performance; results after 12 months of exposure

and 15 per cent pvc formulations were similar; with increasing pvc producing progressively high permeabilities. With the alkyd system however, low permeabilities were exhibited up to the 25 per cent pvc level.

Sand-textured paints – 2. Effects of sand loading

Exposure testing

With the styrene-acrylic formulations, raising the sand loading resulted in failure by checking, which increased in severity with loading, Table 2.

For the alkyd formulation at the 50 per cent level, checking was caused by accelerated weathering. Some checking had also developed in the 37.5 per cent sand loading formulation during natural exposure.

Permeability

The water vapour permeabilities were relatively low, and constant, up to the 25 and 37.5 per cent sand loading for the styrene-acrylic and alkyd systems respectively, Table 2. Permeability increased with the higher sand additions, the effect being markedly more pronounced with the styrene acrylic than with the alkyd.

Sand-textured paints – 3. Effect of sand grading

Exposure testing

Only two systems were investigated and sand grading had a deleterious effect only with the styrene acrylic based paints, Table 3. After accelerated weathering, slight checking was evident which became somewhat more extensive during natural exposure.

Permeability

There was no well defined trend in permeability within the styrene-acrylic systems. The alkyd formulation containing the coarse sand however, had a somewhat higher permeability than paints containing the fine and mixed gradings. As a class the alkyd based paints had lower permeabilities than the styrene-acrylic systems, Table 3.

Table 3
Testing of sand-textured paints; effects of sand grading

System	Sand grading	Exposure testing			Permeability g m ⁻² (24h) ⁻¹	SD
		Accelerated	Natural			
			6 m	12 m		
Emulsion:						
Styrene-acrylic						
25% pvc						
25% sand loading	fine	0	0	0	21	1.7
	mixed	1	2	2	34	3.9
	coarse	1	2	2	29	3.1
Solvent-soluble:						
Alkyd						
25% pvc						
25% sand loading	fine	0	0	0	8	0
	mixed	0	0	0	8	0.7
	coarse	0	0	0	11	1.6

Cast-aggregate systems – 1. Effect of polymer and pigment volume concentration

Exposure testing

For all of the polymer systems there was a trend towards reduced performance with increasing pvc of the base coat, Table 4 and Figure 2, and after natural exposure only the low pvc acrylic and styrene-acrylic emulsion based systems were defect free.

Table 4
Testing of cast-aggregate systems;
effects of polymer and pigment volume concentration

Polymer	pvc %	Exposure testing			
		Accelerated	Natural		
			6 m	12 m	
<i>Emulsion:</i>					
Pva-Versatate	5	0	1	1	
	15	0	3	3	
	25	3	4	4	
	35	4	4	4	
	45	4	4	4	
Styrene-acrylic	5	0	0	0	
	15	0	0	0	
	25	1	1	2	
	35	4	4	4	
	45	4	4	4	
Acrylic	5	0	0	0	
	15	1	1	1	
	25	1	1	1	
	35	2	2	2	
	45	2	2	3	
<i>Solvent-soluble:</i>					
Alkyd	5	1	1	1	
	15	3	3	3	
	25	1	2	2	
	35	2	3	3	
	45	1	2	2	
Two-pack epoxy	5	0	0	1	
	15	0	0	2	
	25	1	2	3	
	35	3	4	4	
	45	4	4	4	

The mode of failure was similar for all systems; a progressive loss of aggregate from the base coat occurring, generally developing from areas of plywood checking. At pvc's of 35 and 45 per cent, aggregate loss was extensive, with flaking of the exposed base coat occurring. The colour retention of the exposed aggregate surface was not good, and after six months of exposure considerable fading of its red coating had occurred.

Cast-aggregate systems – 2. Effect of particle size

Exposure testing

The particle size of the cast aggregate had a marked effect on coating performance in both the styrene-acrylic and alkyd coatings, Table 5. In both systems, increasing the particle size resulted in a worsening in performance, again characterised by loss of aggregate around areas of checking.

Permeability

The permeability of the styrene-acrylic systems varied in a well defined manner with particle size, Table 5; higher values being obtained as the aggregate particle size was reduced. The permeability of the alkyd based coatings was not markedly influenced by aggregate particle size.

Internally-aggregated systems – 1. Effect of polymer

Exposure testing

Failure, by loss of small areas of coating from the panel edges, occurred for all except the system based on the acrylic emulsion, Table 6. During weathering the colour retention of the aggregate within the polymer matrix was good.

Permeability

The styrene-acrylic, alkyd and epoxy systems possessed low water vapour permeabilities, Table 6. The acrylic based formulation had the highest permeability.

Discussion

The results presented here confirm that the primary cause of coating failure on birch plywood is check propagation from the substrate. For the three types of coating studied;

Table 5
Testing of cast-aggregate systems;
effects of aggregate particle size

System	Particle size mm	Exposure testing				Permeability $\text{g m}^{-2}(24\text{h})^{-1}$	SD
		Accelerated	Natural				
			6 m	12 m			
<i>Emulsion:</i>							
Styrene-acrylic 25% pvc	1.6	0	1	1	144	2.1	
	3.2	2	2	2	130	6.8	
	6.4	3	3	3	94	14.1	
<i>Solvent-soluble:</i>							
Alkyd 25% pvc	1.6	1	1	2	59	8.2	
	3.2	1	2	2	72	21.6	
	6.4	2	2	3	52	4.8	

Table 6
Testing of internally-aggregated systems;
effects of polymer type

Polymer	Exposure testing		Permeability $\text{g m}^{-2}(24\text{h})^{-1}$	SD	
	Accelerated	Natural			
		6 m			12 m
<i>Emulsion:</i>					
Pva-Versatate	0	1	1	107	11.9
Styrene acrylic	0	0	1	63	6.9
Acrylic	0	0	0	143	24.2
<i>Solvent-soluble:</i>					
Alkyd	0	1	1	73	18.0
Two-pack epoxy	0	1	1	53	9.7

sand-textured, cast-aggregate, and internally-aggregated, the tendency toward film failure initiated in this manner is dependent upon certain formulation parameters which need to be closely controlled to achieve durable coatings.

Sand-textured paints

With the sand-textured paints (at a sand addition rate of 25 per cent by weight) the type of polymer used in the formulation does not seem as critical as the pigment volume concentration (pvc) adopted. For all of the paints, acceptable performance was only obtained when the pigment content was less than 25 per cent, although only the solvent-soluble systems gave durable coatings when formulated at this upper limit. The emulsion based paints required much lower pigment contents with, at the extreme, the pva-Versatate formulations only showing acceptable durability when formulated at 5 per cent pvc.

This clearly has important implications in the formulation of emulsion-based textured coatings which are designed primarily for masonry, but which are also used on other substrates including plywood. Invariably such products are formulated in the region of 35-40 per cent pvc, far higher than the level suggested in this work for reasonable performance on plywood.

The effect of an increasing sand addition rate is detrimental to coating durability in the two types of polymer-based formulations where this variable was studied; and this would appear to be related to a decreased film integrity through the "filling" effect of the sand particles. As found previously for pvc, the solvent-soluble polymer based systems could tolerate a greater sand loading than the emulsion-based system. In a similar manner, the emulsion-based system exhibited some sensitivity toward the effect of sand grading, with the introduction of coarser sands reducing coating performance. However, it should be remembered that the styrene-acrylic was formulated at 25 per cent pvc, a pigment level subsequently shown to be borderline for performance. In contrast, the alkyd at 25 per cent pvc was just within the range identified for reasonable performance. This suggests that a relationship between sand loading, its grading and the formulation pigment volume concentration exists, and provided the latter is within the range for acceptable performance for the type of polymer used, then sand addition can be varied within fairly wide limits. Performance projections based on the results obtained are shown in Figure 3.

The role of permeability in modifying coating perfor-

mance is not clear from this work, and there is no unequivocal correlation with water vapour permeability that can account for the observed performance of all the polymer systems studied. For two of the systems however, those based on the alkyd and the styrene-acrylic, the formulations that failed by checking during weathering had much greater permeabilities than comparable but lower pvc systems which gave acceptable performance. This suggests that although permeability is not the sole determinant of plywood coating performance in general, it may assume greater importance in certain formulations.

Cast-aggregate systems

The results obtained show that good performance in respect of aggregate retention is difficult to achieve in cast-aggregate coatings, and the type of polymer and the pigment loading of the basecoat, as well as the particle-size of the aggregate applied to it, need to be carefully matched.

The two acrylic containing emulsions were the only polymers that gave acceptable durability which may well indicate a specific material requirement for the polymer. The pigment loading of the basecoat formulations clearly need to be at a very low level; a figure in the region of five per cent pvc being suggested. This low level of pvc presumably maximises the ability of the basecoat to hold the aggregate; the inferior performance of the pva-Versatate may well reflect an inferior binding capability during weathering. The comparatively poor durability of solvent-soluble systems is however difficult to account for, it may be that thermoplasticity is a requirement for these cast-aggregate systems.

The effect of increased aggregate particle size in a basecoat of 50 μm dry thickness is detrimental to performance, with aggregate retention reducing as size increases. The best retention was obtained with the 1.6 mm particle size, and it seems likely that the size of the aggregate used in these cast systems needs to be matched to the film thickness of the base paint. If this is so then films thicker than those used here might have produced better aggregate retention.

The permeability data shows no well defined trends that can be related to performance. The basecoat formulated on the styrene-acrylic shows a clear trend toward lower water vapour permeability as the particle size of the aggregate is increased. This would seem to be a contact effect; that is the integrity of the base paint cast with the

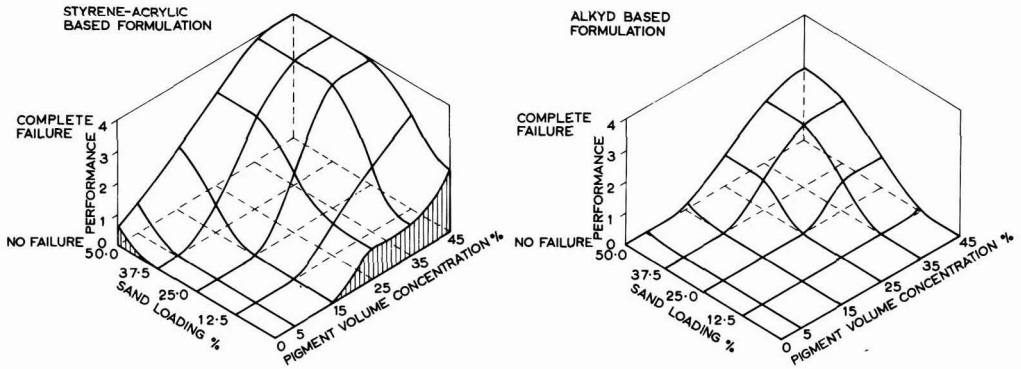


Figure 3. Sand-textured paints, effect of pigment volume concentration and sand loading; performance projections after 12 months of exposure

larger sized aggregate is less disrupted than that containing finer material.

Internally-aggregated systems

Only one formulation variable, that of polymer type, was evaluated in this study; factors such as aggregate to binder ratio and aggregate particle size being maintained at a constant, but typical level.

Binder type was found to be important however, and only the acrylic gave good performance over the exposure period. Coating failure in the other systems was from panel edge areas, and although this demonstrates a possible problem of adequate edge sealing with this type of textured finish, it might also signify superior adhesion of the acrylic system.

In general however, the durability of all of the internally aggregated systems can be considered reasonable, since failures where they have occurred have been minimal. This tends to suggest that the aggregate to binder ratio used here, i.e. 8 to 1, is satisfactory for the 1.6 mm particle size of aggregate used. It is to be expected however, that finer or coarser grades of aggregate would need different aggregate to binder ratios in order to obtain good coating performance.

It is interesting to contrast the excellent colour retention of the coloured aggregate in these systems with the much poorer performance found with the cast-aggregate type of finish. Undoubtedly this improvement can be attributed to the physical incorporation of the aggregate into the polymer, which was also lightly-pigmented, with consequent improved protection against weathering.

The scope of this particular aspect of the study was not wide enough to show any clear relation between permeability and formulation performance. However, the permeability values show a similar rank order by polymer type as found for the other types of textured coating studied.

Conclusions

It has been demonstrated that durable coatings for birch

plywood can be produced from sand-textured, internally-aggregated or cast-aggregate systems.

For the sand-textured coatings, satisfactory performance was obtained provided pigment volume concentration did not exceed a certain value, which varied with polymer. This maximum was found to be five per cent for the pva-Versatate and 15 per cent for the acrylic and styrene-acrylic emulsions. For both the solvent-soluble alkyd and epoxy based coatings the maximum pvc was 25 per cent. These results were applicable to coatings containing a loading of 25 per cent of a graded sand; performance worsened where high sand loadings and coarser gradings were used although the extent to which this occurred varied between formulations.

Cast-aggregate systems were more difficult to formulate and particle size was found to have a marked effect on performance. It would appear likely that the grading adopted needs to be closely matched to that of the thickness of the base coat into which it is cast. Aggregate of 1.6 mm particle size gave satisfactory results in acrylic and styrene-acrylic containing base coats of dry film thickness $50\mu\text{m}$, although poor results were obtained with pvc's in excess of five per cent and 15 per cent respectively.

For the internally-aggregated systems performance was reasonable with all polymers, although only the acrylic emulsion based formulation was completely satisfactory after weathering. The 8:1 aggregate to binder ratio used in this work might need modification to suit different aggregate gradings and polymers.

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References

1. Smith, G. A., *Building Trades Journal*, 1977, 2 December, 37.
2. Smith, G. A., unpublished work, PRL.
3. "British Standard 3900 Part F3:1966, Resistance to artificial weathering (enclosed carbon arc)", *British Standards Institute*, London.
4. "ISO Recommendation R1195, 1970, Determination of the water vapour transmission rate of plastics films and thin sheets. Dish method", *British Standards Institute*, London.

Electrochemical impedance on coated metal electrodes. Part 1: Polarization effects

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Summary

The electrochemical impedance techniques previously used to study organic coatings on mild steel, although suitable for intact films are shown to be unsatisfactory for thin or defective films.

The reasons for this are demonstrated and methods are shown which overcome the problem.

Keywords

Properties, characteristics and conditions primarily associated with

dried or cured films

film defect

Processes and methods primarily associated with analysis, measurement or testing

electrical impedance

L'impédance électrochimique des revêtements appliqués aux électrodes métalliques. 1 Les effets de polarisation

Résumé

On a démontré que les techniques pour déterminer l'impédance que l'on a utilisées antérieurement pour étudier le comportement de revêtements appliqués à l'acier doux, ne sont pas appropriées aux feuillets minces ou défectueux, bien qu'elles soient convenables

dans le cas des feuillets intacts. On démontre les raisons pour cette observation et on propose des méthodes pour surmonter le problème.

Die elektrochemische Impedanz der auf Metallelektroden aufgetragenen Beschichtungsmittel. 1 Polarisationswirkungen

Zusammenfassung

Obwohl die Impedanzverfahren, die man früher wendete um auf niedriggekohlten Stahl aufgetragene Beschichtungsmittel zu untersuchen, für intakte Filme geeignet sind, zeigen sie sich

unbefriedigend für dünne oder mangelhafte Filme. Die betreffenden Ursachen werden bewiesen und Methoden werden gezeigt, die das Problem überwinden.

Introduction

Refs. 1-5

Previous measurements¹⁻³ carried out using electrical impedance techniques on coated mild steel used a current to voltage converter and two dissimilar electrodes. This technique gave valid and reproducible results when studying intact films. The current to voltage converter was chosen in preference to other polarization techniques for two reasons. Firstly, the measurement of the specimen rest potential is not required. Secondly, it was thought that an organic coating would introduce a solely ohmic resistance into the polarization path which would have obscured other data. This latter reason has since proved groundless⁴. Furthermore, the first reason is also unfounded as shall be shown later in this paper.

The techniques outlined above result in low frequency behaviour with thin or defective films which is not readily explainable.

Examples of this type of behaviour are given in the first three figures. During these experiments, the mean (DC) potential was monitored and was found to change as the frequency response analyser reached frequencies below

100 mHz. This effect is possibly due to rectification originating from curvature about the rest potential as observed by Dévay and Mészáros⁵ and will be discussed in a later paper.

A further disadvantage of the current to voltage converter is that when used at gains greater than unity spontaneous self oscillation occurred. These various phenomena were further investigated and form the substance of the rest of this paper.

Results and discussion

Initially, the self oscillation was investigated. A dummy cell of 2.2 μ F in parallel with 11 k Ω with 1 k Ω as a series resistor was introduced between the frequency response analyser and the current to voltage converter. Self oscillation was not observed at any reasonable levels of gain. Thus, the source of instability was clearly an interaction between the electrochemical cell and the current to voltage converter. When the potential difference was "backed off" the impedance curve shown in Figure 4 was obtained. Thus the potential difference of ca.75 mV generated between the painted specimen and the platinum electrode was shown to have caused the spontaneous oscillation.

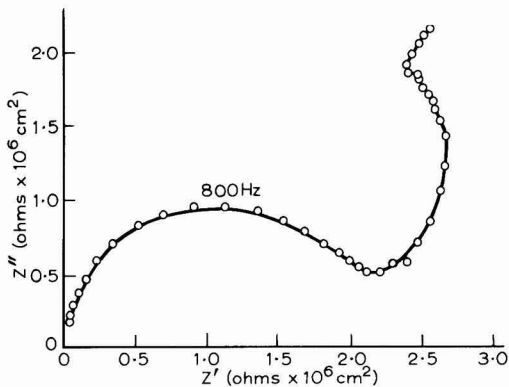


Figure 1. Impedance diagram for 50 μm acrylic lacquer on abraded mild steel in artificial sea water after 1 day

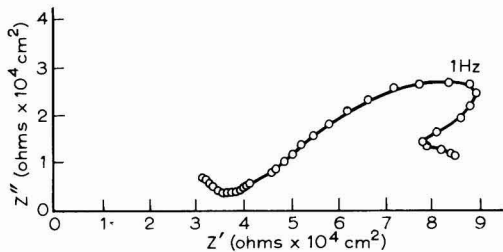


Figure 2. As Figure 1 after 4 days

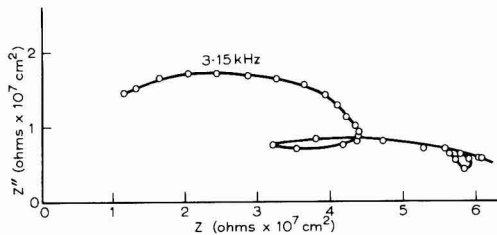


Figure 3. Impedance diagram for 45 μm plasticized chlorinated rubber on abraded mild steel in artificial sea water after 60 days.

As the drift in potential was obscuring the information on the corrosion processes that should be obtainable from the low frequency data, it was thought that polarization by constant current would help to eliminate potential drifts. To this end, a conventional potentiostat, Thompson Ministat 251, was employed in the configuration as shown in Figure 5. This arrangement has the effect of holding the voltage drop across R constant as the inverting input is referenced to this point. A constant current flows through R and hence through the cell. If 200 mV r.m.s. is applied to the non-inverting input (+), then 200 mV will appear at the top of the resistor R; if R is 1 k Ω then a current of 200 μA will flow through the cell. If 10 mV is applied, 10 μA will flow.

The constant current configuration was tested using the dummy cell, previously mentioned. Results obtained are

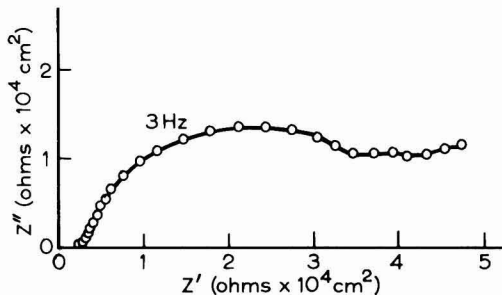


Figure 4. Impedance diagram for 50 μm acrylic lacquer on abraded mild steel in artificial sea water after 43 days, the potential difference between the working and counter electrode "backed off" to zero. Some rust spotting

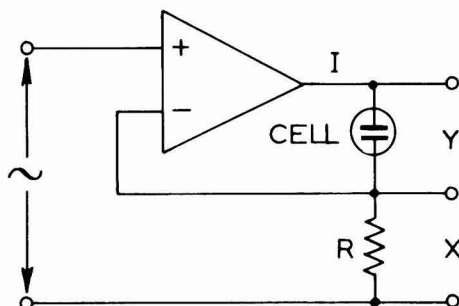


Figure 5. Circuit diagram for constant current configuration

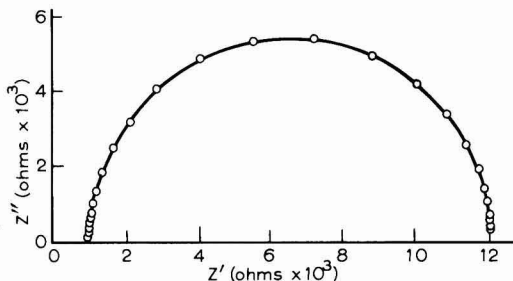


Figure 6. Impedance diagram from dummy cell

shown in Figure 6. The same specimen discussed previously, an acrylic, was employed in the new arrangement using currents of 200 μA and 10 μA . Results are shown in Figure 7. In the case of higher current perturbation, distortion occurred in the low frequency region. The shapes of the high frequency regions, Figure 8, are similar but the higher perturbing current has caused a shift towards the origin.

As both the above methods, namely current to voltage converter, and constant current gave so markedly different results, conventional three electrode potentiostatic measurements were carried out. In order that the potential between the working electrode, the coated mild steel, and the reference electrode could be sensed by the potentiostat,

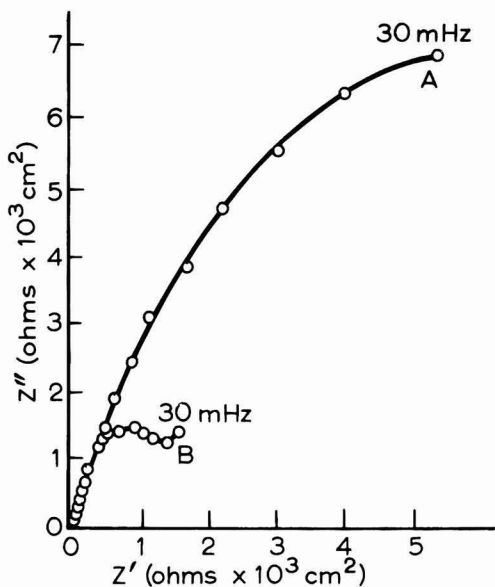


Figure 7. As Figure 4 polarized at constant current; A = 10 μ A, B = 200 μ A

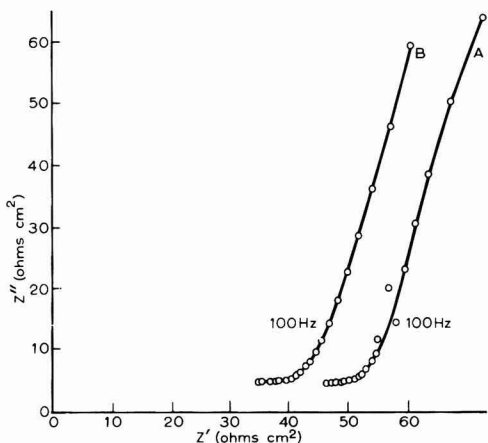


Figure 8. High frequency portion of Figure 7

it was necessary to wait until a stable potential was reached. For a typical vinyl acrylic specimen the potential took between 12 and 16 minutes to stabilise in artificial aerated sea water as shown in Figure 9. A Keithley 610 C electrometer was used for potential measurement. To demonstrate the effect of changing potential on the impedance response, a frequency sweep was made during the period shown by the dotted line on Figure 9. The specimen was maintained using a potentiostat at -520 mV SCE during the frequency sweep. After the end of the sweep the potential was found to be -610 mV SCE. The impedance curve is shown in Figure 10 and at low frequencies a "tail back" can be observed similar to that in Figure 2.

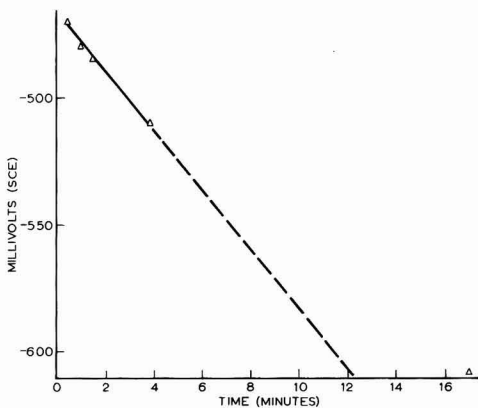


Figure 9. Potential time curve for 50 μ m vinyl acrylic lacquer in artificial sea water

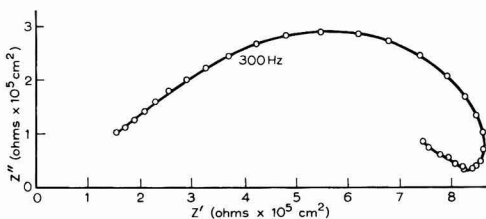


Figure 10. As Figure 9, impedance at -520 mV (SCE)

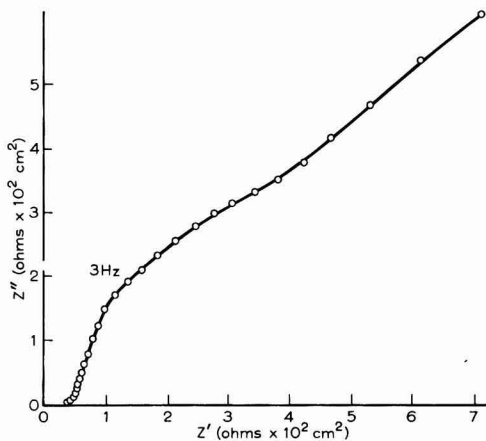


Figure 11. As Figure 9, impedance diagram at -600 mV (SCE)

For comparison, a potentiostatic frequency sweep was made using the acrylic specimen described earlier. The impedance curve obtained at the potential, -600 mV is shown in Figure 11.

The scale of Figure 11 corresponds reasonably with the data obtained using the current to voltage converter, Figure 12; the actual shape is intermediate between those curves obtained by the other two methods comparing

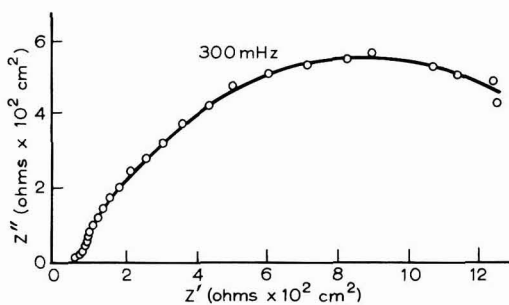


Figure 12. As Figure 9, impedance diagram using current to voltage converter

Figure 11 with figures 12 and 7(A). The shape of the high frequency portion Figure 13 is nearly identical with both the curves obtained using the constant current method.

The impedance curves obtained using the three methods described above differed markedly in their low frequency characteristics. As it has been demonstrated that spurious low frequency behaviour can arise from potential drift, low frequency information derived from non-potentiostatic methods must be thought of as suspect.

Conclusions

1. The current to voltage converter is an unsatisfactory device for polarizing defective coated metals since potential drift can take place and this influences the shape and magnitude of the impedance curve so obtained especially at low frequencies.
2. The constant current mode is an improvement on the current to voltage converter.
3. Potentiostatic three electrode measurements can be made on defective paint films provided a stable rest potential is measurable.
4. Superfluous polarization and galvanic effects are eliminated using the potentiostatic method since the potential may be set at the stable rest potential of the coated electrode.

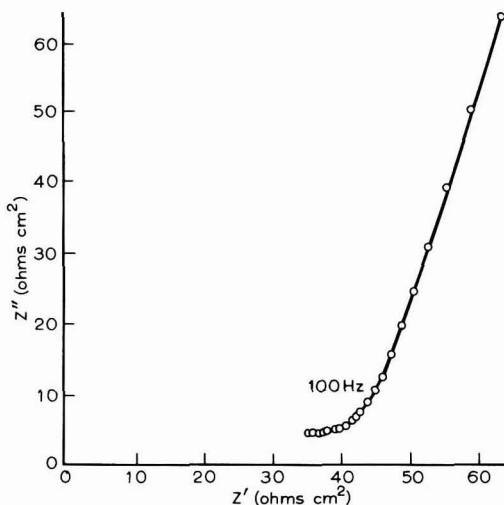


Figure 13. High frequency portion of Figure 12

Acknowledgements

The authors wish to thank Dr W. W. Harpur, Dr. P. D. Philpot and Dr C. G. Googan, of International Paint Marine Coatings for their encouragement and financial support without which this work could not have been carried out.

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References

1. Scantlebury, J. D. and Ho, K. N., *JOCCA*, 1979, **62**, 89.
2. Scantlebury, J. D., Eden, D. A. and Ho, K. N., "Proc. Symp. on Electrochemical Corrosion Testing", San Francisco, 1978, to be published by ASTM.
3. Piens, M. and Verbist, M., "Proc. XV FATIPEC Cong.", Amsterdam, 1980.
4. Scantlebury, J. D. and Sussex, G. A. M., "Proc. Conf. on Corrosion Control by Organic Coatings", Lehigh, 1980, to be published by NACE.
5. Dévay, J. and Mészáros, L., *Acta Chim. Acad. Sci. Hung.*, 1979, **100**, 183.

Next month's issue

The Honorary Editor has accepted the following papers for publication. They are expected to appear in the March issue of the *Journal*:

Influence of the type and content of soluble corrosion-inhibitive pigments on the behaviour of shop-primers by B. del Amo, J. J. Caprari, M. J. Chiesa and R. D. Ingeniero

Phosphate pretreatments for mild steel by G. W. Kapse and L. K. Aggarwal

Electrochemical impedance on coated metal electrodes. Part 2: Effects of time and potential by J. D. Scantlebury and L. M. Callow

OCCA meetings

Auckland

Abrasive products

On 27 May 1980, 45 members were present to hear Mr P. Woodcock, Sales Manager of Carborundum NZ Ltd, give a talk on "Abrasive products".

Starting with the naturally occurring abrasives diamond, emery, sandstone and corundum, Mr Woodcock then described the manufacture of silicon carbide from sand and coke, and aluminium oxide from bauxite, coke and iron, in electric furnaces, and the crushing and treatment which takes place to produce the desired size and shape of the particles. Many different sizes and shapes are produced to suit the various demands. Aluminium oxide is a tough sharp grained abrasive used for grinding or cutting high tensile strength materials, its main use being the manufacture of bonded and coated abrasive products. Silicon carbide is a very hard, sharp abrasive used for grinding or cutting low tensile strength materials and used in several forms for cutting, abrading and polishing.

Coated abrasives were then described, from early materials to the modern flexible backing with adhesive holding the abrasive grains. Details were given of the many different backings, adhesives and abrasives used, with their methods of manufacture.

Mr Woodcock gave a very detailed and informative talk on this aspect of our industry, as was shown by the questions at the conclusion.

Hazardous chemicals

Fifty-five members and visitors were at the July meeting when Mr G. Hodson, Group Safety and Environment Officer for ICI gave a talk on the "Effects of new acts and regulations on the transportation and use in industry of hazardous chemicals". His talk was directly relevant to the New Zealand scene where paint is a significant part of the chemical industry. Mr Hodson showed how we are regulated, for example, by the Toxic Substances Act, Noxious Substances Act, Factory and Commercial Premises Bill, Isocyanate Bill etc, and how these relate with overseas requirements.

A. Macdonald

Irish

Prohesion - the key to metal protection

An evening Meeting of the Irish Section was held on 24 October at the Clarence Hotel, Dublin, where Mr F. D. Timmons discussed his paper "Prohesion - the key to metal protection" and some aspects of BS5493:1977.

Mr Timmons described "prohesion" as meaning protection by adhesion, and it implies that adhesion failure precedes corrosion and not the reverse.

Mr Timmons outlined his experiences of long-term exposure tests, giving significantly different results to those

obtained on initial laboratory accelerated tests. Details were given of a more realistic salt spray procedure, BR277, carried out in a relatively cheap "prohesion cabinet" and of a modified impact resistance test. Using both tests, Mr Timmons stated that reliable correlation between accelerated and actual long-term exposure can be achieved. These procedures can expose inadequately formulated paint systems and predict long life durability.

After a most interesting, thought-provoking lecture, followed by a lively discussion, a vote of thanks was proposed to Mr Timmons on behalf of the audience by Mr Noel Morrish.

P. McCrudden

Hull

Marketing in the paint industry

The second ordinary meeting of the Hull Section was held on 3 November 1980, at the Queens Hotel, George Street, Hull. The speaker was Mr D. J. Lockham, a Marketing Executive of Blundell - Permoglaze Ltd, who spoke on the general aspects of "Marketing in the paint industry".

The speaker quoted the total UK market for all paints, giving a breakdown into trade, retail, high performance paints and industrials. The annual growth rates from 1974 to 1980 indicated high growth in 1974 followed by a rapid decline up to 1977, with a revival in 1978, but the subsequent growth has been minimal. The outlook for 1981 was not encouraging, but as he pointed out, the present cut-back in maintenance would have to be made good sometime in the future. An overall growth of 2-4 per cent was postulated for the next few years.

After discussing the product split into the various categories of paint types he made comments on the expected trends in surface coatings. Firstly, water based products are in the ascendance. Heavy textured coatings are now developing sales mainly in the retail market. Wood stains are appearing, also microporous coatings to reduce blistering and flaking problems.

On pack sizes his comments were that the smaller sizes were falling in favour of larger sizes. There was also the possibility of a move towards plastic containers in certain areas.

On application, rollers were taking over from brush application. Formulation of painting for roller application was towards non-foaming on the roller. Coating by spraying has remained constant over the last eight years.

The distribution of paint through established selling outlets has been effected by increases in supermarket sales. Their entry into the market has dominated the price structure. Their lower selling price may mean supplying

OCCA meetings

paint at or below cost. Market managers plan the balance between these customers and the conventional outlets to maximise efficient production.

In summary the main points of his lecture were as follows:

1. The UK market is substantial.
2. Despite intermittent setbacks an increase in paint volume is expected.
3. There will be a volume increase in retail sales.
4. A movement from solvent to water based paint is taking place.
5. Fall in the small volume pack (250 ml), to larger size taking place, with possibility of tin cans being replaced by plastics.
6. Increase in application by roller at the expense of brush application.
7. Sales through supermarkets on the increase. Merchants maintaining the sales to the trade.

A very lively and sustained question time reflected the quality of the lecture and the enthusiastic interest of all the members present in the marketing aspects of surface coatings. Mr A. Pipes proposed the vote of thanks on behalf of the eighteen members and guests who were present.

F. D. Robinson

Bristol

The present state of water dilutable Resins

The first two lectures of the present session were given to special audiences since the first was the joint Bristol Section and the Birmingham Paint, Varnish and Lacquer Club, at which the Bristol Section entertained their Birmingham friends and the second was the Ladies' Evening Lecture.

On the occasion of the first lecture due to the unavoidable absence of the Chairman, Mr Les Brooks, the Chairman Elect, Mr Fowkes opened the meeting.

The lecture was given by Mr G. Keith of Rohm and Haas Ltd, on the subject of "The present state of water dilutable resins in the surface coatings industry" and dealt with their use in paints and printing inks covering their introduction and their present standing. In the printing ink industry the speaker covered flexographic and gravure inks for craft paper, corrugated paper board and flat carton board. Their third use was stated to be for tissue and non-woven fabrics and cigarette boxes. The questions asked by the audience present clearly indicated their interest in the subject. The vote of thanks was proposed by the President of the Birmingham Paint Varnish and Lacquer Club.

The second lecture in the series with Mr Brooks in the

chair was the Ladies' Evening Lecture and the subject was "Traffic control" by Chief Inspector R. Stone of the Avon and Somerset Constabulary. The speaker covered the organisation of the national and local police forces with particular reference to the Traffic Division.

The subject of traffic management and the many requests that his department received for assistance from both the motorway police and other branches for tuition for driving lessons. Correct motorway driving was highlighted by the showing of a film on the "do's and don'ts" of driving under these conditions.

A colleague of the speaker who was in charge of the Avon Driving Courses indicated the great value to civilians of the courses available from the Institute of Advanced Motorists. The use of the book on the subject "Advanced Motor Craft" was highly recommended for reading by the motoring public who were keen to increase their standard of driving.

The evening was both enjoyable and instructive and the vote of thanks was given by Mrs Fowkes and was well received. Finally a dinner had been arranged for the speakers, members and their ladies and concluded a pleasant evening.

J. R. Taylor

Midlands

Polyester based powder coatings

A technical meeting of the Midlands Section was held on 16 October 1980 at the County Cricket Ground, Edgbaston, Birmingham. Members and guests heard Mr L. Whitfield of BIP Ltd give a talk entitled "Polyester based powder coatings".

Mr Whitfield, who is a member of the Midlands section, opened his talk by saying that polyester powders can be generally classified into two categories, namely, hydroxy or carboxy terminated materials. In use these materials require crosslinking agents to effect curing. The hydroxy type polyesters can be crosslinked with such materials as anhydrides which give good film properties but require high stoving schedules, polyisocyanate types, which have hazardous by-products or amino resins, which can cause problems in processing and storage due to low melting points. With the carboxyl type polyesters the most used crosslinking agents are epoxies which give good films but require high stoving schedules or TGIC which is very reactive but very expensive.

Mr Whitfield continued his talk by considering a typical epoxy/polyester system and how, by the inclusion of a catalyst such as zinc oxide, the reverse impact of the coating can be substantially improved, while other properties remain the same. When comparing epoxy/polyester with an epoxy system for humidity, staining, corrosion, heat and detergent resistance, the epoxy/polyester was always equal or a little better than the epoxy system. Throughout his talk Mr Whitfield showed numerous slides to illustrate various examples of the chemical type of crosslinking agents and the reactions that take place when polyester films cure, also some of the equipment that can be used to produce laboratory samples of powder.

In conclusion, Mr Whitfield described two methods that can be used to determine the amount of free trimellitic

anhydride in a powder coating. This is important because in America exposure limits of 0.005 ppm have been set as a safe working concentration.

A lively question time followed the talk and Mr Whitfield's colleague, Mr J. Sreeves, helped to answer some of the members' questions.

The meeting was finally brought to a close with a vote of thanks proposed by Mr D. A. Wallington and warmly endorsed by the audience.

B. E. Myatt

London

A one-eyed view of the last half century of paint

The second evening meeting of the session was held at the Rubens Hotel SW1 on 23 October 1980. Following on his previous successful appearance before the London Section two years ago Mr J. J. Froggatt returned to present another talk, this time on his own experiences of the paint industry. Once again his audience was not disappointed. Ably assisted by his wife, who had also prepared the visual aids, Josh Froggatt entertained the elder and educated the younger members with recollections of paint formulation, manufacture and use over the last fifty years.

Within the course of an hour Mr Froggatt managed to include the Socialist Sunday School, granite triple roll mills, rabbit skin glue, gum fumes, trade unions, the stack process for manufacturing white lead, accountants and architects in his talk and kept the audience enthralled the whole time.

The vote of thanks was proposed by Mr A. Saxby and was warmly echoed by the audience.

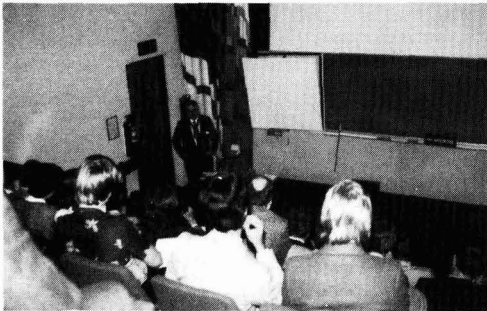
A. J. Newbould

Manchester

Students seminar "Industrial finishes - the present and the future"

Attended by 42 members and visitors this inaugural student function of the 1980-81 session was held at the Manchester Polytechnic, All Saints, on Friday 19 October 1980.

The Manchester Section Chairman, Tony Jolly,



The Section Chairman, Tony Jolly, welcoming delegates to the student seminar

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delivered the Official Welcome to the audience which included the President of OCCA, Dr Francis Smith. His remarks included reference to the relatively satisfactory audience numbers in relation to the prevailing economic climate, and was obviously a reflectance of the seminar content and the expertise of the respective lecturers. The first of the four papers was entitled thus:

Overprint varnishes in packaging

Mr J. R. Delafield is Product Manager of the Paper/UV Curing Division of Donald McPherson & Co. Ltd, Bury, and his lecture, "Overprint varnish in packaging", made reference to the following subjects in chronological order:

- Roller coating machines
- Cellulose nitrate overprint varnishes and their modifications
- 2 component PU lacquers
- Acid catalysed finishes and shellac based types
- UV cured finishes
- Machine design
- New products and future trends

A discussion period followed the presentation.

The second paper delivered was:

Wood finishes and their application

Alan de S. Wilson has had considerable experience in the formulation of wood finishes and his comprehensive paper made reference to:

- Wood finish technology allied to paint technology
- Substrate variation
- Service conditions
- Woodfillers and stains
- Lacquers - shellac - cellulose nitrate and its plasticization
- Acid catalysed lacquers - pre and post catalysed types
- Polyurethanes
- Polyesters
- UV cured finishes
- Water borne wood finishes

Application methods including spraying, dipping, roller and curtain coating, barrel coating.

Cure methods included reference to UV, electron beam, IR, gamma rays and impulse curing.

Applied film test methods were comprehensively covered.

A discussion period followed which was terminated by the call to lunch. The afternoon session opened with a paper presented by Mr M. J. Foot of Berger Paints entitled "Can and coil coatings". The lecturer, who is Technical Service Manager of the Industrial Can Coating Division, made reference to the following subjects during his 60 minute lecture:

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Part 1 Can coatings

History, Contents and end-uses
Lacquer types – internal and external
Construction – seam types
Construction – two-piece, DWI, DRD
Coating application – types of coatings

Part 2 Coil coatings

A BSC film of 15 minutes duration was shown which proved to be an excellent introduction to this part of the lecture which included reference to substrate types:

Coil coating lines
Coating types included alkyds, thermosetting acrylics, saturated polyesters
Silicone modification
PVC pastisols
PVF and PVDF

The final paper of the seminar was entitled "General industrial paints, present and future" and was given by Mr R. G. J. Toms of International Paints – Industrial Coatings. The lecturer has spent 27 years in the industry and his detailed paper made reference to definition, methods of application, substrate types, major users of industrial paints, current technologies – a comprehensive review, formulation, current and future trends.

An interesting discussion period followed and Mr G. T. Flood our Hon. Student Activities Secretary made the closing remarks in which he acknowledged the excellence of content and presentation of the four papers, the audience agreed in the usual manner. The Manchester Section intend to submit the four papers and their respective discussion details for publication in *JOCCA*.

Plastics for buildings – 13 years on

This was the first senior lecture of 1980/81 session, presented to an audience of 27 members and guests, at the Manchester Polytechnic, All Saints on Friday 10 October 1980. The Lecturer Mr Brian Wade is currently working at Leeds Polytechnic, School of Architecture and Landscape, and he has a practical background in the use of plastics in the building industry.

The title of this lecture became of increasing relevance as Brian Wade described, with the use of many slides, case histories of plastic usage in building, covering a period 1966-1979, i.e. the "significant" 13 years.

A further connection with the Manchester Section was the previous technical association between Tony Jolly, our section Chairman, and Brian Wade in relation to the polyester resin type in the GRP and surface coatings based on polyurethane resins. For the record, the definition of plastic in the lecture title referred solely to glass reinforced polyester.

Proof of the maxim "A picture is worth a thousand

words", Brian showed many colour slides, duplicated with a time gap of 13 years. Allowing for difference in angle, vagaries of colour photography etc. the general results portrayed were those of minimal degradation of product both structurally and appearance-wise.

The various applications and comments could be itemised thus:

1. GRP lap panels, housing, white
Combustible substrate
No painting or delamination (i.e. painting = yellowing?)
Lightweight
Surface fixed, screens and domes

2. Cladding panels, polyester laminate
Foam core
Polyurethane finish with exposed aggregate
Aggregate consisted of seashells, Norwegian quartz bonded with polyurethane resin.

3. Pigmentation
White satisfactory
Other GRP coloured panels have faded
i.e. wattle green + blue – blue only

4. Canopies
Housing
White
GRP
Over front door
Will support two workmen if necessary
Some dirt accumulation
No structural faults

5. GRP
Soffit
Fascias
Gutter ends

6. Future trends
Increased usage of plastic has resulted in reduction of paint consumption. There is still evidence of prejudice existing against use of plastics, especially in relation to fire hazards.

The lecture was followed by a lively question period during which it was established that considerable areas of BS476 class "O" gel coat are coated with long life, two-pack aliphatic isocyanate cured urethane resins but conversely, the urethane system used in the aggregate finish had been crosslinked with an aromatic isocyanate.

The vote of thanks proposed by Geoff Flood was unanimously supported by the members and visitors present.

Replacement of lead containing pigments in paints

Herr Wolfgang Kelch of the Technical Service Division – Market Group – Paints, BASF Stuttgart, delivered his lecture to 58 members and guests on Monday 10 November 1980 at the Manchester Polytechnic, All Saints.

The lecturer commenced by defining his subject which was basically the use of titanium/nickel/antimony and titanium/chromium/antimony oxides in rutile form as lead-free pigments. He listed their development and present properties thus:

1. Cleaner shades than iron oxides
2. Used in conjunction with organic pigments
3. Originally low colour strength
4. Originally low gloss – due to particle size distribution
5. Nickel titanate – greenish yellow – lower opacity SG 4.4-4.6
6. Chrome titanate – reddish yellow – higher opacity SG 4.4-4.6
7. Low PVC – good mechanical properties/good gloss stability/good elasticity
8. PVC of 15 per cent is optimum level

Florida results based on 18 months exposure in an alkyd/melamine binder claimed a durability superior to an established rutile titanium dioxide. The problems of discolouration caused by excessive abrasion in triple roll mills and high speed mixers was discussed.

Herr Kelch then introduced a significant topic into his lecture, that of the modification of the nickel and chromium titanates with organic based pigments. A specific product described was Paliotan Yellow SF7360 – a chrome titanate yellow/organic co-finish – with a claimed higher gloss than a pigment mixture prepared by a paint manufacturer. He then went on to compare SF7360 with Chrome Yellow L2130 S and ended his lecture on the sad note that the price of replacing lead chromes was going to be high.

The comprehensive question period that followed can be summarised as follows:

- Q. Brightness compared with chromes?
 A. Co-finish was the answer to the West German requirements for a Post Office Yellow.
- Q. Relative Costs?
 A. 6 Marks/Kg for red paint based on chrome pigmentation
 12 Marks/Kg for red paint based on lead free or low lead.
- Q. Define co-finish?
 A. Not a physical mixture but a co-flocculation, no bleeding problems – coating of the inorganic by the organic pigment.

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

Unichema catalyst production

Unichema Chemie GmbH is replacing its production facilities for dry-reduced nickel catalysts with a new plant which will have slightly higher capacity amounting to 4,000 tons per annum. Production will start in 1982. A second extension will become operative in 1983. Unichema Chemie GmbH is part of a group of Unilever companies which sell fatty acids, glycerine, derivatives and nickel catalysts through the marketing organisation of Unichema International.

The reason for setting up a new catalyst production unit is the growing world demand for this range of nickel catalysts. These products are used in over fifty countries for the hardening of oils, fats, fatty acids, and for other hydrogenation reactions.

Reader Enquiry Service No. 31

Substitute for stainless steel vessels

Loyne Limited are introducing their P3066 applicator service to chemical engineers. P3066 is an American made phenolic which Loyne consider from their experience to be equal to any other phenolic available in the world.

Its big advantage for the chemical engineer and user of chemical handling and storage equipment is that it allows the substitution of mild steel vessels coated with P3066 for the more costly stainless steel. The coatings are also extremely durable, easy to clean and the purity of surface and non-toxic composition allows their use in solid and liquid food and drinks manufacture and processing.

Reader Enquiry Service No. 32

occa meetings

- Q. Ratio of inorganic : organic?
 A. Equal parts by weight.
- Q. Relative tinting strength?
 A. Stronger than chromes but 40 per cent lower than organics.
- Q. Price stability?
 A. Excellent prognosis – titanium stable, chromium and nickel relatively low.
- Q. Health and safety aspects?
 A. Solubility of chromium and antimony lower than current toy regulations.

Chromium and nickel titanate yellows have received approval from the French Authorities for contact with foodstuffs. It was claimed that the antimony was "locked into the molecule" but will dissolve in boiling sulfuric acid! Further proof of stability is the manufacturing temperature of 1000°C.

Wolfgang Kelch predicted that the future might produce a red type chrome titanate, the present has produced a lead free pigmentation choice based on a compromise combination of high performance inorganic and organic types of yellow pigments.

R. Stott delivered the vote of thanks which was warmly applauded.

F. B. Windsor

news

Constant rate feeder

Avery Parsons has announced its new microprocessor based constant rate feeder designed for extraction of bulk materials at a fixed feed rate. The feed conveyor features simple belt changing and automatic belt tracking, with a simplified low profile load cell weighing station. The electronic controller, mounted on a 19 inch rack cubicle, is suitable for local or remote setpoint initiation. The processor also incorporates a push button initiated automatic zero correction.

Reader Enquiry Service No. 33

Computer controlled dyeing process

Instrumental Colour Systems, whose computer controlled colour match prediction and formulation systems offer high savings in dyestuff usage, have signed an agreement with Bayer AG for worldwide introduction of a number of Bayer developed computer programs.

ICS are one of only six firms in the world producing instrumental colour systems. One of the most dramatic benefits of installing the system is its ability to reduce pigment and dyestuff usage by between 10 and 20 per cent. Incorporation of the new Bayer programs will allow further dyeing process savings, taking into account such aspects as the rate of temperature increase, process run time and second stage additions.

Reader Enquiry Service No. 34

Acquisition

The Board of Perchem S.p.A., Rome, Italy have announced that they have acquired, with effect from 10 December 1980, the whole of the manufacturing plant, technology and related business of the organophillic gellant Sedapol from Supercolori S.p.A., Milan.

Perchem S.p.A. is part of an international Group in association with Perchem Limited, London.

Supercolori S.p.A. is one of the well-known Italian suppliers of speciality additives to the paint industry.

Reader Enquiry Service No. 35

Cheap thinner is false economy

As many as 30 per cent of vehicle refinishing specialists are in danger of losing their profits by adding cheap thinners to high gloss top coats.

This is the finding of an informal study made by Britain's leading vehicle refinishes producer, Berger.

Berger Vehicle Refinishes found that this surprisingly large number of car and commercial vehicle cosmetic and accident damage refinishers were using low-priced equipment-cleansing thinners in top coats, too.

"The economy is quite false", according to Vince Vallely, marketing manager of Berger Vehicle Refinishes.

Reader Enquiry Service No. 36

Space heating

The Dravo Heating Division of Covrad have announced a three-part package in industrial space heating aimed at maximum efficiency with utmost energy conservation.

1. The Dravo Counterflo Mark III, oil and gas fired space heaters in four sizes ranging from 200,000 B.t.u. (60 kW) to 500,000 B.t.u. (150 kW) output.

Further models from 600,000 to 1,250,000 B.t.u. will be introduced during 1981.

2. The Dravo Energymiser a tamperproof remote control station incorporating day and frost thermostats; summer, winter, overtime, holiday and normal mode switching.

3. The Dravo Econofan, a thermostatically controlled fan which reclaims wasteful high temperature air in factory roof space and benefits the economical cutting in and out of prime heater thermostats.

Reader Enquiry Service No. 37

Burrell acquires chrome factory from receiver

A new company, Stratford Colour Company Limited has made a successful bid to the receiver of Burrell Colours Limited for the lead chrome pigment factory at Stratford, London E.15. Manufacture of the existing ranges will continue and a very high proportion of the employees at that location have been retained.

Stratford Colour Company was formed by Leo Liebster, formerly Finance Director of Burrell. He is to be Managing Director of the new Company supported by Jeff Cox, Technical Director, and John Stooke of Wengain Ltd, Non-executive Marketing Director. A small, but enthusiastic group of production and technical managers completes the very experienced management team.

The successful acquisition has been made possible by the involvement of Development Capital Ltd. After a very detailed feasibility study they have arranged substantial capital funding from the National Coal Board Pension Funds. Bob Gollman of Development Capital joins the Stratford Colour Co. Board as a non-executive Director.

Reader Enquiry Service No. 38

Powder blending and mixing

Powder blending and mixing are the latest activities to be added to the expanding range of chemical industry services undertaken by Beta Chemicals Limited.

Beta, a member of the Ellis & Everard Group, already specialises in formulating, blending, packaging and labelling chemicals in liquid and tablet form.

Reader Enquiry Service No. 39

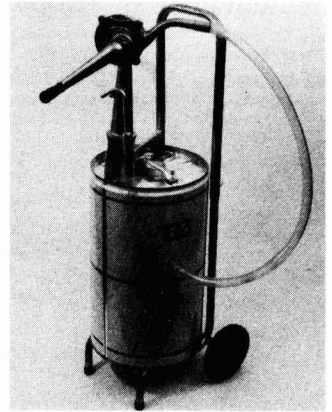
new products

New fluids dispensers

Bowser has introduced two new mobile dispensers, with a reversible rotary action pump. Both emptying and filling are thus made spill-proof and easier, even in inaccessible locations.

Handling a wide range of fluids both models are also light and highly manoeuvrable. With adjustable clamps, so both round and rectangular 25 litre drums can be handled, specification includes wide 150 mm wheels, 2 metres of hose and non-drip nozzle.

Reader Enquiry Service No. 40



Mobile fluid dispenser

Air pump runaway valve

A safety valve for air-powered pumps that automatically cuts off the air supply to the motor in the event of pump runaway, has been introduced by Graco.

Over-run may occur with an air-powered pump when the material supply runs out or is interrupted, when cavitation occurs in viscous materials or when an outlet line ruptures. Possible damage includes cylinder scoring and heat warpage and destruction of seals and packings. There is also a potential fire hazard from the pump overheating.

Graco's new Runaway valve mounts on the pump air inlet where it monitors the flow of air to the air motor. As soon as the pump starts to over-run, the valve senses the increased flow of air and shuts off the air supply within a few strokes. It will also detect a totally ruptured delivery line downstream from the pump. But it is not designed to respond to slow leakage from pinholed or porous hoses.

The Graco Runaway valve is unusual in that it can be used with either large or small pumps. It is easily set to match the pump and material in use and is reset after shutdown by simply pressing a button.

Reader Enquiry Service No. 41

Pressure control for corrosive fluids

Techmatron announce a new compact (2.2 x 4.5 inch) regulator which combines low flow capability with corrosion resistant construction.

The Tescom 26-1300 Series is a direct-acting, spring-loaded regulator which is capable of reducing primary pressures up to 6,000 psi down to six secondary pressure ranges.

All parts of the regulator which are exposed to the flowing media are stainless steel, Teflon, Viton-A, and Kel-F. An integral self-relieving vent valve is a standard feature.

Small size makes the regulator suitable for mounting in-line, on panels or cylinders making it ideal for use in a wide number of manufacturing processes or research work where corrosive fluids require repeatable control.

Reader Enquiry Service No. 44

literature

Flame retardant study

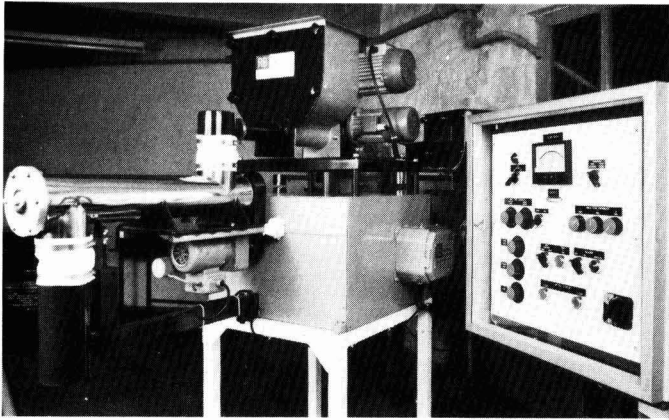
A new major review "The UK Market for Flame Retardants" is now available from the specialist consultancy IAL - Industrial Aids Limited at a price of £600.

The total UK Market for flame retardant additives is estimated to be around 14,900 tonnes p.a. and it is forecast that by 1983 demand will have grown by 3-4 per cent to 15,400-15,500 tonnes p.a.

The major traditional applications for flame retardants are plastics, rubber, surface coatings, timber impregnation, fibres and textiles. A new application promising major growth is the impregnation of paper for use as thermal insulation in domestic roof space.

Hitherto, the largest application for flame retardants has been plastics, estimated to have consumed about 4,230 tonnes in 1979. Only a modest growth in consumption in 1983 by about 1.5 per cent to 4,300 tonnes is forecast. The fibres and textiles sector is expected to show the largest growth; consumption of fire retardants is forecast to rise by up to 50 per cent from 1,200 tonnes in 1979 to 1,500-1,700 tonnes in 1983.

Reader Enquiry Service No. 45



Particulate matter controller/detector

Controller/detector for particulate matter

R.B. Engineering Ltd have developed a new type of particulate matter controller/detector.

Called Sodec the unit is an important advance in this area of materials handling, combining three normally separate functions in one machine.

As a flow detector, Sodec measures any change in flow rate or material characteristics and gives an audible alarm if the pre-set parameters fluctuate.

Operating as a flow meter, Sodec measures the flow rate of differing materials passing through the unit and its flow rate signal can be used to control the rate of infeed of solids or liquids from dependent but remote equipment.

Finally Sodec is a constant weight feeder accurately monitoring and controlling weight of product, continuously, into any process.

Apart from its operational versatility Sodec is unique in the main features of its design. It eliminates the need for knife edges or pivoting beams normally associated with any comparable system. The feed output is self-supporting giving all round clearance which allows Sodec to integrate directly into a process or feed from above into a hopper.

Sodec is light in weight and small in size, but with capacities of 50 kg/hr to 1400 kg/hr and has all solid state controls, one of the features virtually eliminating the need for maintenance.

Reader Enquiry Service No. 42

Clamp wattmeter

As an aid to energy conservation, Channel Electronics Ltd has introduced the model PK220 Clamp Wattmeter for measuring electricity usage. The circuit to be measured need not be disconnected during measurement as the conductor is

encompassed by the jaws of the clip-on transformer. The conductor can be insulated and enclosed in a metal conduit; maximum conductor size is 54 mm (2.15 inches). Measurement can be carried out even in inaccessible places where reading is difficult as needle deflection can be arrested at any point on the scale by a slide switch on the side of the instrument. Readings as low as 0.3 KW and as high as 300 KW can be taken; range selection and jaw opening can be effected with one hand.

Complimentary to the PK220 and similar to it in size and appearance, the Model PK230 Clamp Phase Meter allows true consumption readings to be taken from capacitive and inductive loads by indicating the true vector, θ .

Both instruments have an accuracy of ± 5 per cent and are supplied with lined carrying case, shoulder strap and special test leads. Dimensions (excluding case) are 290 x 102 x 56 mm (11.4 x 4 x 2.3 inches).

Reader Enquiry Service No. 43



Clamp wattmeter

news

Chemical industry data

Chemical Data Services have published two new books entitled "Chemical plant contractor profiles 1980" in which major companies are surveyed in detail and "Chemical industry yearbook 1980-1981" which contains information from 50 countries.

Reader Enquiry Service No. 46

Turbospray equipment

A four page full colour brochure has been published by Volumair (UK) Ltd describing and illustrating its full range of Turbospray equipment and accessories.

Reader Enquiry Service No. 47

Blast cleaning cabinets

Guyson have produced a 12-page full colour brochure which illustrates a series of hand operated blast cleaning cabinets based upon either the suction feed or pressure feed blasting method.

Reader Enquiry Service No. 48

Specialised silicas

A comprehensive new booklet issued by the Applied Silicas Division of Joseph Crosfield & Sons Ltd, describes applications and products in the range of Crosfield specialised silicas.

Reader Enquiry Service No. 49

Powder coating production machinery

Barker Perkins have made available a leaflet on the Barker Perkins MPC/V Mark III series continuous compounder

which offers outstanding versatility controllability and economy at the vital melt mixing stage of the powder coatings production process.

Reader Enquiry Service No. 50

Protecting pipelines

BSI has published a revision of "BS 4164 Coal-tar-based hot-applied coating materials for protecting iron and steel, including suitable primers where required". The new edition takes account of technical advances made in this field since the original version appeared in 1967, particularly in connection with extensive installations of steel pipelines for the transmission of oil, water and gas.

BS 4164 specifies requirements for hot-applied coal-tar-based materials, unfilled or reinforced with inert non-fibrous fillers, which are used to protect iron and steel against corrosion. Requirements are also given for the primers on which the performance of such protective coatings ultimately depends. Various types and grades of material are used for different substrates, conditions of application and service. The standard therefore provides guidance on the commonly accepted applications for individual types and grades and indicates the factors to be considered when selecting material for a particular use.

Reader Enquiry Service No. 51

meetings, etc.

Corrosion control

The Institution of Corrosion Science and Technology will be holding a one-day symposium entitled "Corrosion control in the chemical and process industry" in Runcorn, Cheshire on 26 March 1981. For further information, contact Mr L. Woolf, Metrotect Ltd, Whitechapel Road, Cleckheaton, W. Yorks.

Colour difference measurement

The Society of Dyers and Colourists will be running a one-day conference on Tuesday 12 May 1981 at the University

of Bradford entitled "Colour-difference measurement - A reliable basis for quality control". For further information contact The Society of Dyers and Colourists, PO Box No 244, Bradford 1, Yorkshire.

Colour technology courses

Instrumental Colour Systems will be running residential courses in 1981 on colour measurement. The first of these is to take place on 30 March-3 April. For further information, contact Instrumental Colour Systems Limited, 13 Bone Lane, Newbury, Berkshire RG14 5TE.

appointments

Mr Robin Millard former director of Spencer and Halstead Ltd, a subsidiary of Carborundum Co., USA has been appointed to the board of Morgan Fairest Ltd, as Managing Director.

Graham Broadbent has been appointed President of BP Chemicals Americas, succeeding Harry Burnham who has returned to a UK appointment.

Mr Fred Morpeth has been appointed to the position of Managing Director of Foscolor with effect from 1 January 1981.

Mr Morpeth joined Foscolor as an ink chemist early in 1967 and served as Chief Chemist and Works Manager until his election to the board as Technical Director in 1973.

He is a Fellow of the Royal Society of Chemistry and actively involved in the British Plastics Federation, the Plastics and Rubber Institute and his local section of the Oil and Colour Chemists' Association.

The appointment is confirmation of the Company's determination to remain in the forefront of developments in pigment dispersion and masterbatches, and to maintain the high reputation for service built up since its formation in 1966.

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

OCCA news

London

Ladies' Night

The London Section Ladies' Night was held on 7 November at the Selsdon Park Hotel, Sanderstead. Reflecting the current

economic situation, numbers attending were down on last year's, but this in no way diminished the success of the occasion. Amongst the guests were the Director and Secretary, Mr R. H. Hamblin and the chairmen of the Manchester, Midlands, Newcastle and Thames Valley Sections with their wives. Mr Bentley of West Riding Section was unable to be present due to flu, and although Dr F. Smith was in South Africa he added his presence to the evening with a good wishes telegram. The principle guests of the evening were Mr Tom Humphrey, Chairman of the

Scottish Section and his wife. Mr Humphrey responded to Dr Tom Banfield's toast to the ladies and guests in a way that appealed to all - it was short and understandable!

After an excellent four-course meal, dancing continued to midnight. During the evening a raffle was held for the first time for a number of years. The success of the raffle was in no small way due to the persuasive powers of the organiser, Mrs Stephanie Gilliam.

A. J. Newbould



From left to right: Mr H. Glover, Mrs Glover, Tony Jolly, Mrs Jolly, Francis Smith and Mrs Smith

Manchester Section

Annual Dinner Dance 1980

A grand total of 339 members and their guests attended the Manchester Section Dinner Dance on Friday 17 October 1980. Held, as in previous years, in the Peacock Suite of the Hotel Piccadilly. Section Committee members assisted the Chairman, Tony Jolly, in entertaining the official guests on the balcony during a reception period.

The official guest list comprised the following accompanied by their wives.

Mr H. Glover, CB, Ex. Controller of HMSO, Ex. Deputy of The Royal Mint.
 Dr Francis Smith, President of OCCA.
 Gordon Bentley, Chairman, West Riding Section
 John Clark, Chairman, Newcastle Section
 Dr Tom Banfield, Chairman, London Section

T. L. M. Humphries, Chairman, Scottish Section

An excellent dinner served at 7.45 p.m. was followed by the Loyal Toast, and "The Manchester Section of OCCA" was proposed by Harold Glover whose speech covered his Merseyside origins followed by details of his long and distinguished career in Her Majesty's Stationary Office.

Tony Jolly responded with a welcome to the guests and was followed by contributions from Dr Francis Smith and Frank Redman the Section Vice-Chairman.

Dancing was to the music of Satin Brass accompanied by an excellent female vocalist and the evening's activities became early morning ones till the bewitching hour of 2.00 a.m. terminating yet another successful Manchester Dinner Dance organised by our Hon. Social Secretary, David Wilcox who also arranged the supply of the very popular Ladies' Gifts.

F. B. Windsor

OCCA news

Wax Chandlers' Hall

Those members of the Association who have had the privilege of visiting the Wax Chandlers' Hall, which was used for many occasions during the Association's tenancy of office at the Hall from 1959 to 1972 for such functions as the Council Reunion Dinner, Council and Committee meetings and the Receptions at the 50th Anniversary, will be interested to know that an exhibition on "Beekeeping and uses of wax" was held in the Hall on 9 and 10 July, as part of the City of London Festival. It is thought that members will be interested to see a photograph of one of the exhibits - beeswax chessmen - shown below.



Beeswax chessmen

OCCA-33 ANNUAL EXHIBITION

First list of exhibitors

28-30 April 1981



The Exhibition Committee announces that the first allocation of space for the OCCA-33 Exhibition has now taken place.

It is particularly pleasing to note the return to the Exhibition of many companies who have not been able to participate for a number of years, as well as companies new to this Exhibition.

The OCCA Exhibition, which is known as the international focal point for the surface coatings industries, is the most important annual event of its kind in the industries, and it offers an unparalleled opportunity for personnel in the manufacturing industries to meet and

discuss their requirements with their counterparts in the supplying industries.

In recent years, the OCCA Exhibition has regularly attracted thousands of visitors from between 40 and 50 countries who travel to London each year to view the latest developments affecting the industry and to contact companies for their needs.

The aim of the Exhibition is the presentation of technical and commercial information relating to raw materials, plant and equipment used in the paint, polymer, printing ink, colour, adhesive and allied industries, both in manufacture, processing and application.

The thirty-third annual OCCA Exhibition, a three day event, will be open as follows:

Tuesday 28 April	09.30 - 17.30
Wednesday 29 April	09.30 - 17.30
Thursday 30 April	09.30 - 17.30

The venue for the 1981 Exhibition will be the same as for OCCA-32, i.e. the Cunard International Hotel, Hammersmith, London, W6 and the Exhibition will be in two sections: on the ground floor, forming the entrance to the Exhibition, and in the rooms on the third floor of the hotel. A fully licensed bar and seating area will be installed in the New Hall.

OCCA news

The hotel has a selection of restaurants, shopping facilities and bars. The hotel is situated near Hammersmith Station on the Piccadilly Underground Line between Heathrow Airport and the centre of London. Hammersmith Station is also served by the Metropolitan and District Underground Lines (the latter of which connects to Victoria Station for those arriving at Gatwick Airport). Car parking at the hotel is limited, but there is a large NCP car park close by in King's Mall off King Street.

Admission to the Exhibition will be free, and visitors will be asked to complete registration cards which will be available in advance from the Association's offices with copies of the

Official Guide. Copies of the official Guide will be charged at £1.50 each, and both registration cards and copies of the Official Guide will also be available at the entrance to the Exhibition.

First list of exhibitors

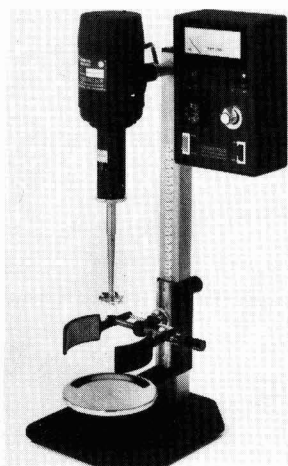
New Hall Exhibitors

Baird & Tatlock (London) Ltd
Beta-Tech Equipment Ltd
BOC Ltd Chemicals Division
BOC Automation
Cappelle Freres
Capricorn Chemicals Ltd
Chemolimpex
Contraves Industrial Products Ltd
Eiger Engineering Ltd
Elcometer Instruments Ltd
FMK International
GAF (Great Britain) Ltd
Glen Creston Machinery Ltd
Godrich, John
Grace, W. R. & Co. Ltd
Industrial Colours
Industrial Dispersions Ltd
Institution of Corrosion Science & Technology
Instrumental Colour Systems
International Tin Research Institute
ISC Alloys Ltd
K & K Greeff Chemicals Ltd

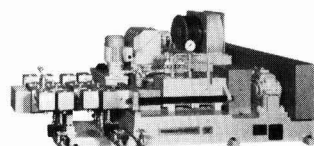
Mason & Morton (Engineering) Ltd
Micro Products Co
MSE Scientific Instruments
Netzsch (UK) Ltd
Norwegian Talc A/S
OBS Machines Ltd
Paintmakers Association of GB Ltd
Paint Research Association
Polymers Paint & Colour Journal
Q-Panel Co
Roban Engineering
Sartorius Instruments
Sheen Instruments Ltd
Silberline Ltd
Society of British Printing Ink Manufacturers
Society of Dyers & Colourists
Stratford Colour Co. Ltd
Werner & Pfeleider (UK) Ltd
Westlairs Ltd
Victor Wolf Ltd
G.M. Langer
Macbeth

Syndicate Room Exhibitors

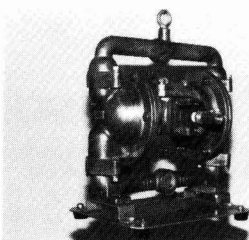
BOC Ltd Chemicals Division
Hercules Ltd
Kirklees Chemicals
NL Chemicals
Schering Chemicals Ltd
Sun Chemicals
Victor Wolf Ltd



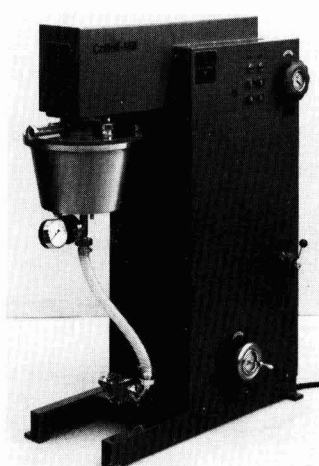
The John Godrich Chemcol MS O-G laboratory machine with built-in processing timer will be on show for the first time



Werner & Pfeleider will be showing the ZSK 30, a twin-screw compounding extruder for powder coatings



Roban will demonstrate a new double diaphragm air operated pump for handling a very wide range of liquids



The CoBall-Mill from Mason and Morton which can grind pigments paints etc down to 10-0.1 microns

new members

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

CAPPS, ALAN PAUL, BSc, 22 Wolsey Drive, Kingston-upon-Thames, Surrey
(London)

NDHLOVU, BOND FRADREDK SILENJE, c/o Vitretex Paints Ltd, PO Box 70207, Ndola, Zambia
(General Overseas)

PERKINS, CHRISTOPHER, BSc, c/o A I Davis & Co. (PVT) Ltd, PO Box 66021 Kopje, Zimbabwe
(Zimbabwe - General Overseas)

Ordinary Members

BARNES, CHRISTOPHER PAUL, James Halstead Ltd, PO Box 3, Whitefield, Manchester
(Manchester)

PYLE, WILLIAM JOHN, Hermetite Products Ltd, Tavistock Road, West Drayton, Middlesex UB7 7RA

(Thames Valley)

RATHI, KISHOR L, BSc, Sudarshan Chemical Ind. Ltd, 162 Wellesley Road, Pune 411001, India (General Overseas)

RAYMOND, PETER, BSc, 72 Grasmere Road, Gatley, Cheshire (Manchester)

TRAPMAN, PETER B, BSc, MCIC, 2179 Adair Crescent, Oakville, Ontario, L6J 5J6 (Ontario)

VAN der BORGHT, XAVIER Dr Chem. Sc., Mader Benelux, Groot Bijgaardenstraat 147, B- 1610 Ruisbroek, Belgium (General Overseas)

VESTUTO, MARIU, Eden Colours Ltd, Station Road, Edenbridge, Kent TN8 6ED (London)

WILLIAMS, MALCOLM CHARLES, 8 Latham Avenue, Runcorn, Cheshire (Manchester)

WISEMAN, KENNETH EDWARDS, Box AY 210, PO Amby, Salisbury (Zimbabwe - General Overseas)

WILSON, PHILLIP JOHN, P.Bag 6630, Kopje, Salisbury, Zimbabwe (Zimbabwe - General Overseas)

WOODHEAD, CHRISTOPHER, BSc, 173 Moorhouse Road, Wold Road, Hull HU5 5PT (Hull)

Associate Members

BOULTER, VERNON RODNEY, 18 Torchacre Rise, Dursley, Gloucestershire GL11 4LW (Bristol)

new members

HASS, DIETRICH JURGEN, 32 The Avenue, Loughton, Essex (London)

MCGINN BRIAN, Bayer (Ireland) Ltd, Kill O'The Grange, Dun. Laoghaire, Co. Dublin (Irish)

PARKER, MICHAEL ANTHONY, Lewis & Everitt (Pty) Ltd, PO Box 1255, Cape Town 8000, South Africa (Cape)

VORSTER, S. W., T & C Chemicals (Pty) Ltd, PO Box 3067, Port Elizabeth, 6000 South Africa (Cape)

Registered Students

STANTON, PETER ROY, 11 Great Meadows, High Crompton, Shaw, Oldham, Lancashire OL2 7PU (Manchester)

VRIDEE, JATINDER, 13 Lancaster Road, Southall, Middlesex UB1 1NP (London)

YATES, KEVIN ROBIN, MCIF (MIDS) Ltd, Middlemore Lane, Aldridge, Walsall, West Midlands (Midland)

Details are given of Association meetings in the United Kingdom and Ireland up to the end of the third month following publication.

February

Monday 2 February

Hull Section: "The Maintenance and protection of North Sea Structures" by F. M. Small of Berger (UK) Ltd, at the Queens Hotel, George Street, Hull, commencing at 6.45 p.m.

Tuesday 3 February

West Riding Section: Lecture on "Some Aspects of Micro Processors". Details to be announced.

Thursday 12 February

Midland Section - Trent Valley Branch: "Dispersants-Theory and Practice" by Dr R. D. Harding of Bevaloid Ltd, at the Derby Crest Motel, Pasture Hill, Littleover, Derby, commencing at 7.15 p.m.

Scottish Section: "Water-Borne Systems" (a) Industrial Finishes by Tioxide International, (b) Wood Finishes by Hill Son & Wallace, at the Albany Hotel, Glasgow, commencing at 6.00 p.m.

Friday 13 February

Manchester Section: Lecture "Computer Match Prediction" by Dr I. Bridgman of Ciba-Geigy Ltd, at the Manchester Polytechnic, New Administration Building, All Saints, commencing at 6.30 p.m.

Scottish Section - Eastern Branch: Annual "Burns Supper" at the Commodore Hotel, Marine Drive, Edinburgh. Details to be announced.

Tuesday 17 February

London Section: "Surface Character & Performance of Organic Pigments" by Dr R. R. Mather of Ciba-Geigy Pigments & Additives Co. Joint meeting with the Society of Chemical Industry at the S.C.I. 14 Belgrave Square, London SW1 commencing at 6.00 p.m.

Midlands Section: "Pretreatment for Paint" by M. Danks of W. Cannings Materials Ltd, at the Calthorpe Suite, County Cricket Ground, Edgbaston, Birmingham, commencing at 6.30 p.m.

Thames Valley Section: "Truflex coat-

occa diary

ings for tennis court surfacing" by B. R. Wynne of R. J. Hamer & Sons Ltd, at the Beaconsfield Crest Motel (White Hart), Aylesbury End, Beaconsfield, Bucks, commencing at 6.30 p.m. for 7.00 p.m.

Wednesday 18 February

Manchester Section: Student Lecture "Woodpriming Paints" by Messrs F. Redman and W. Phillips of Crown Paints Ltd, at the Manchester Polytechnic, New Administration Building, All Saints, commencing at 4.30 p.m.

Friday 20 February

Irish Section: Ladies' Evening. Details to be announced.

Newcastle Section: Ladies' Night at the Five Bridges Hotel, Gateshead. Details to be announced.

OCCA diary

March

Manchester Section: Student Works Visit. *Details to be announced.*
Informal Buffet Dance. *Details to be announced.*

Monday 2 March

Hull Section: Ladies' Evening. *Details to be announced.*

Tuesday 3 March

West Riding Section: "Colour Systems" by G. Pakvis and L. Wehrens of Tenneco Colotrend BV, at the Mansion Hotel, Roundhay Park Leeds 8, commencing at 7.30 p.m.

Thursday 5 March

Newcastle Section: "A Hundred Years of Colour Chemistry" by Prof. Rattee, Colour Chemistry Dept, University of Leeds, at the Students Common Room, St. Mary's College, Elvet Hill Road, Durham, commencing at 6.30 p.m.

Friday 6 March

Scottish Section: Lecture "The Scottish colour manufacturing and using industries within the framework of the EEC", by Mrs W. Ewing (Scottish Euro MP), at the Central Hotel, Glasgow, commencing at 7.30 p.m. Ticket holders only, closing date for applications 16 February. Apply - Mr T. L. Humphrey, Scottish Chairman.

Monday 9 March

Manchester Section: Lecture "Medials" by Manchem Ltd at the Crest Motel, Bolton, commencing at 6.30 p.m.

Wednesday 11 March

Scottish Section - Eastern Branch: "Line Measurement of Colour" by Dr Ferguson of Instrumental Colour Systems. This is organised by BP and BIF Scottish District, and will be held in the King Malcolms Hotel, Dunfermline, at 7.30 p.m. to which all interested persons are invited.

Thursday 12 March

Scottish Section: "Pigments" Film and

Lecture - Lecturer from BASF Ltd, at the Albany Hotel, Glasgow, commencing at 6.00 p.m.

Trent Valley Branch: "British Rail Specifications - What, Why and How" by Dr F. G. R. Zobel, Head of Surface Coatings Laboratories British Rail, at the Derby Crest Motel, Pasture Hill, Littleover, Derby, commencing at 7.15 p.m.

Wednesday 18 March

London Section: "Applications of Colour". Joint one-day symposium with the Society of Dyers and Colourists, London Region at the Thames Polytechnic, Woolwich, SE18, commencing at 10.00 a.m.

Ontario Section: Meeting at the York Suite of the Cambridge Motor Hotel, Ontario, commencing at 6.00 p.m.

Thursday 19 March

Midlands Section: Newton Friend Ladies' Invitation at Chamber of Commerce and Industry, Birmingham. "National Trust" by Mr Harrison of the National Trust.

Thames Valley Section: "Developments in building chemicals and compositions" by Dr Maurice Wilkinson of Blundell Permolglaze Ltd, at the Beaconsfield Crest Motel (White Hart), Aylesbury End, Beaconsfield, Bucks, commencing at 6.30 p.m. for 7.00 p.m.

Friday 20 March

Bristol Section: "Evaporation and Solvent Power" by Mr Barry Hudson, BP Chemicals Ltd, at the Post House, Cardiff.

Irish Section: "Timber Preservation" by E. A. Hilditch, Technical Director, Cuprinol Ltd, at the Clarence Hotel, Dublin, commencing at 8.00 p.m.

Friday 27 March

Bristol Section: Ladies' Night. *Details to be announced.*

April

Thursday 2 April

Newcastle Section: Annual General Meeting. *Details to be announced.*

Monday 6 April

Hull Section: Annual General Meeting at the Queens Hotel, George Street, Hull, commencing at 6.45 p.m.

Tuesday 7 April

West Riding Section: Annual General Meeting at the Mansion Hotel, Roundhay Park, Leeds 8, commencing at 7.30 p.m.

Thursday 9 April

Thames Valley Section: Annual General Meeting, talk "Tourism around the Thames" by Thames & Chiltern Tourist Board at the Beaconsfield Crest Motel (White Hart), Aylesbury End, Beaconsfield, Bucks, commencing at 6.30 p.m. for 7.00 p.m.

Scottish Section: "Glasgow theatres - behind the scenes" by D. Smith of Ault & Wiborg Ltd at the Albany Hotel, Glasgow. *Details to be announced.*

Friday 10 April

Midlands Section - Trent Valley Branch: Annual General Meeting followed by Buffet Dance at the Cross Keys Inn, Turnditch. *Details to be announced.*

Manchester Section: Annual General Meeting at LCC in the Library, Lancaster and Jubilee Suite. *Details to be announced.*

Wednesday 15 April

Scottish Section - Eastern Branch: Annual General Meeting followed by "Innovations in Wallcovering" by George Niven, Development Manager, Nairn Coated Products at the Murrayfield Hotel, 18 Corstorphine Road, Edinburgh, commencing at 7.30 p.m.

Friday 17 April

Irish Section: Annual General Meeting. *Details to be announced.*

Wednesday 22 April

Ontario Section: Annual General Meeting at the York Suite of the Cambridge Motor Hotel, 600 Dixon Road, Rexdale (Toronto), Ontario, Canada, commencing at 6.00 p.m.

Thursday 23 April

London Section: Annual General Meeting at the Rubens Hotel, Buckingham Palace Road, London SW1, commencing at 6.30 p.m. followed by a lecture of general interest to which members' ladies are invited. *Details to be announced.*

Friday 24 April

Bristol Section: Annual General Meeting. *Details to be announced.*

Saturday 25 April

Midlands Section: Annual General Meeting. *Details to be announced.*

Tuesday 28 April-Thursday 30 April

OCCA-33 Exhibition at the Cunard International Hotel, Shortlands, Hammersmith, London W6. 9.30-17.30 each day. For further details see page 95.

OCCA CONFERENCE 1981



BATH

17-20 JUNE 1981

ALTERNATIVE TECHNOLOGIES IN COATINGS

Closing date for Registrations, 1 April 1981

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To: The Director & Secretary, Oil & Colour Chemists' Association,
 Priors House, 967 Harrow Road, Wembley, Middlesex, England, HA0 2SF

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FORMULA 81 THE MULTI- COLOURED TRADE FAIR

2nd international trade fair for the paint, paint products and printing-ink industries

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* The report on a survey among visitors to Formula 80 will be sent on request.

Programme of the exhibition:

- raw and auxiliary materials, equipment, including measuring and control equipment as well as computer systems, tools, mechanical aids, patent products and processes for the paint, varnish, lacquer, printing-ink and allied industries;
- raw and auxiliary materials, equipment, including measuring and control equipment, tools, mechanical aids, patent products and processes for the treatment and regeneration of water, air and waste matter, in relation to the manufacture of paint, varnish, printing-ink and allied products;
- information in these fields.

Formula 81 is organized by RAI Gebouw B.V., in close cooperation with an exhibition committee, composed of representatives of the relevant trade and industry.

All correspondence to:
RAI Gebouw B.V., 8 Europaplein,
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Tel. 020 - 5 411 411, telex 16017.

13-16 October, 1981

10 a.m. – 5 p.m.

International Exhibition and Congress Centre RAI Amsterdam

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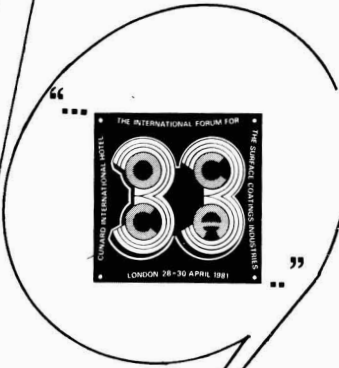
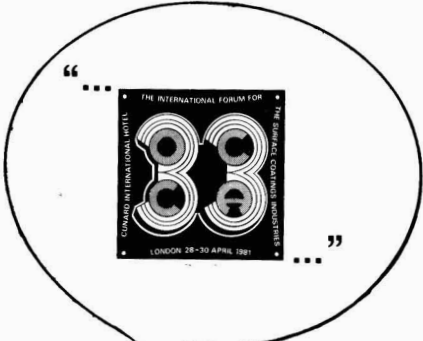
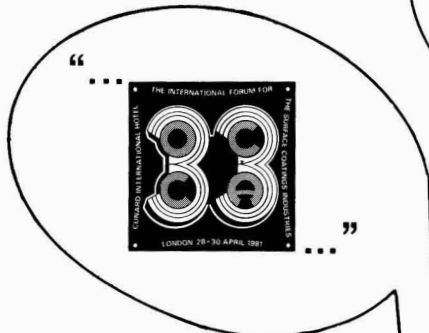
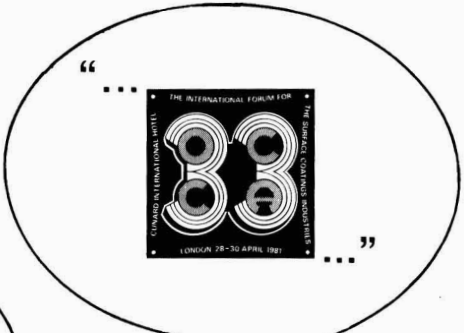
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