ISSN 0030-1337

Vol. 72, No. 3
March 1989
pp 79-122

JOURNAL OF THE OIL AND COLOUR CHEMISTS' ASSOCIATION

JOCCA

■ Pigments

JOURNAL OF THE OIL AND COLOUR CHEMISTS' ASSOCIATION

JOCCA

Editorial correspondence should be addressed to the Hon Editor, *JOCCA*, and general correspondence addressed to the General Secretary at the Association Headquarters.

General Secretary:
C. Pacey-Day

Assistant Editor:
P. J. Fyne, MA, DPhil

Advertisement Manager:
F. Craik

Tel: 01-908 1086
Fax: 01-908 1219
Telex: 922670 (OCCA G)

Annual subscription to non-members: £80.00 ($160), post free by surface mail, payable in advance.

Single copies £8.00 ($18), post free by surface mail, payable in advance.

Member of the Audit Bureau of Circulations

An Official Journal of the Paintmakers' Association of Great Britain Ltd.

Contents

Vol. 72 No. 3 **MARCH 1989**

Feature: Pigments

Transactions and Communications

Cover: The colourful world of pigments (Photo by courtesy of Hays Chemical Distribution, Gomersal, Cleckheaton, W.Yorkshire).

Forthcoming Features: April – Automotive/Industrial Coatings, May – Fire Retardant Coatings, June – Paint and the Environment. Contributions are welcomed at least five weeks prior to publication date.

Oil and Colour Chemists' Association
Priory House, 967 Harrow Road, Wembley, Middlesex HA0 2SF England

Printed by The Herald Press, Stratford-upon-Avon and 112 Bermondsey Street, London SE1 3TX. Tel: 01-378 1579.

Chester Conference Column

You will by now, certainly, have had a copy of the Official Brochure and hopefully have had time to look through it at your leisure.

We decided that by sending it to your home address as a special item, not simply inserted in the latest edition of *JOCCA*, it would draw your attention to a greater degree and, if left at home, allow your partner to peruse it. In fact this idea (call it a hope!) was certainly realised as, within forty-eight hours of the despatch of the Brochure and covering letter from me, we had our first registration! Then, within a further twenty-four hours the same chap came back to us and booked his wife in as she had taken a distinct liking to the Social Programme and both had realised how little extra was called for to do so. (A very cheap way to see that the "old man" is behaving himself!!!).

Simon Lawrence reports that the complete Papers are now coming in and he is delighted with the standard they exhibit. It seems that we are in for a rewarding event both from a purely technical and techno-commercial standpoint. The Preprints and Conference material will be contained in an attractive folder paid for by Shell Chemicals (UK) Ltd.

A. C. Jolly ■

Below further summaries of the papers and biographies of the authors are presented.

New crosslinking reactions in organic coatings

(Presented on behalf of SLF)

S. Göthe

Summary

Acid Curable Coatings have a dominating position in the woodfinishing field in Scandinavia. The formaldehyde emission from these coating types is today of great environmental concern.

New developments during recent years have increased the general knowledge of the chemistry behind formaldehyde emission.

New resin concepts, which utilize the normal and new crosslinking reactions, in acid curable coatings are described.

Biography

S. Göthe

Dr Sven Göthe is currently R & D Director at AB Wilh. Becker. Dr Göthe has an MSc and PhD from the Department of Polymer Technology, Royal Institute of Technology, Stockholm, and his doctoral research was concerned with the "Photocuring of organic coatings". In 1980, Dr Göthe joined AB Wilh. Becker as Project leader in the Department for Technical Co-ordination. Dr Göthe has since then held a variety of positions and responsibilities within the company – Internal education in different business areas (83-85), Planning and building up the R & D department (85-86), R & D Director and member of A B Wilh. Becker management group (86-), member of the Industrial Coatings Divisions, Senior Management Group (88-). Dr Göthe is currently President of the SLF (Federation of Scandinavian Paint and Varnish Technologists) and is a member of the Royal Swedish Academy of Engineering Science, the American Chemical Society and OCCA.

Preservation of a quality image: Development of an alternative method of can decoration

J. B. Emerson

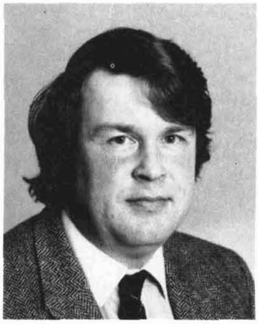
Summary

The last 10-15 years has seen major technical changes in the Packaging Industry. One of the most significant developments of the era was the introduction of a beverage can without a side-wall seam. This is lighter in construction and cheaper than is traditionally possible with the standard method of forming a can from a flat blank and welding or soldering the join.

However, because of the method of manufacture, decoration of the new container is carried out after can construction which limits the quality of the graphics achievable. The traditional method of printing flat sheets which gave very high quality graphics was no longer appropriate and a new process had to be developed to satisfy certain market demands.

This paper outlines the development of a thermal dye diffusion process which enables the production of high quality designs on seamless beverage containers. The critical factors in the production application of the process are considered and the relevance of the development to the demands of the market place is reviewed.

Biography



J. B. Emerson

Mr Emerson joined MB Group in 1976 in the Research and Development Department, after graduating in Chemistry at Oxford University. He was initially involved in the development of ink and varnish systems which could be dried by ultra-violet radiation and applied direct to metal containers.

In 1979 the Company relocated to R & D staff to a purpose built facility in Wantage, Oxfordshire. Subsequently, he has widened his role to encompass the range of MB Group development activities in Metal Decorating. More recently he has assumed responsibility for four groups working on Metal Decorating, Plastics Printing, Colour and Printing Science, and Capital Projects respectively.

Developments in the field of industrial solvents

E. M. van Acker and C. L. M. Vrouwenvelder

Summary

The chemical industry is continuously adapting to change. This also holds true for the solvents industry, which has long been considered a "mature" industry with few new developments. New and modified products are needed to fulfil changing demands in applications, due to the development of new technologies, and to meet increasingly stringent environmental requirements.

In this presentation two areas involving new developments will be discussed:

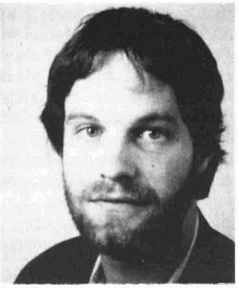
1. Development of improved or completely new solvents, which are more suited to the complex demands on technical, toxicological and environmental performance.
2. Support to the industry with the application of new products.

Both aspects will be illustrated by examples.

Biographies

E. M. van Acker

Following graduation from the Technical University, Eindhoven, The Netherlands, in 1964, Mr van Acker joined the "Koninklijke/Shell-Laboratorium, Amsterdam" (KSLA) in 1966. Initially, he was involved in R&D on thermoplastics and epoxy resins as a group leader. After a period in Marketing in Germany, his present position is Head of Solvents Research, Development and Customer Technical service at KSLA.



C. L. M. Vrouwenvelder

Mr C. M. L. Vrouwenvelder joined KSLA in 1978, specialising in thermodynamics after graduating from the University of Amsterdam in Chemistry. Since 1988 Mr Vrouwenvelder has been active in Solvents research at KSLA as group leader.

Computer modelling of solvent blends

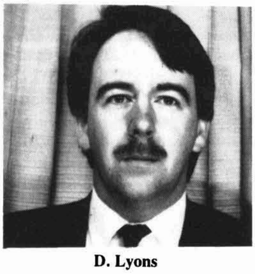
D. Lyons and A. D. Sheen

Summary

As customers sought to reformulate long established solvent systems on environmental or cost grounds, BPCI as a major supplier of solvents to the coatings industry was asked for assistance. Evaporation performance is the key to a successful formulation, but in the early 1980s no satisfactory prediction technique existed.

The development of BP Solve will be described. BP Solve is an accurate computer model for the prediction of solvent evaporation which is now widely used in the coatings industry.

Biography



D. Lyons

David Lyons joined BP Chemicals in 1984, after obtaining a PhD from Imperial College London. During the last two years he has been involved in the development, use and launch of BP Solve. David is now responsible for the support and the future technical development of the BP Solve software package.

Finishes and furniture research

M. Charity

Summary

Finishes and furniture have both to be fit for the purpose and suitable for the fashion and market place of the home. FIRA (Furniture Industry Research Association) has worked with paintmakers and furniture manufacturers for over a quarter of a century. The Association's work in testing, research and consultancy will be described and the state of the art commented upon.

Biography

M. Charity

Michael Charity, MA, is Director of the Cabinet Group of FIRA, which covers production, quality, standards, testing, contract research, management and industrial consultancy, operational research and systems. Mr Charity has wide technical experience and was formerly Technical Manager of NRDC (now BTG).

New products — new problems?

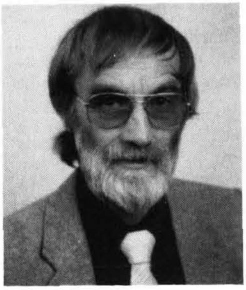
L Banks

Summary

PDQ Testing is a company involved on a day to day basis with the building and construction industries, both as a testing organisation and providing a materials and specification service. As a consequence of these activities bemused operatives are often encountered on site who are attempting to use products which are no doubt superb in a laboratory environment but pose sometimes insurmountable difficulties during application under site conditions. The paper will attempt to show how improved products can be developed more effectively by considering the application conditions and consulting the end user.

Chester 89 Conference

Biography



L. Banks

Les Banks started his career as an apprentice Carpenter and Joiner with a firm of timber boat builders. Following a successful final examination Mr Banks joined a national Contract Building Company as General Foreman gaining an ONC and HNC in Building. In 1969 Mr Banks was appointed a Lecturer at the C & CA (Cement and Concrete Association) Fulmer Grange Training Centre to teach mature students the use of concrete technology within the Building and Civil Engineering Industry. This course included laboratory testing requirements of various building materials. From 1978-83 Mr Banks was appointed Director of Index Finishes and was responsible for founding and running the Materials Testing Division called Index Concrete Testing Ltd. In 1982 Mr Banks formed a testing laboratory, PDQ Ltd, in partnership with industrial coating chemist, Harry Hosgood ■

NEXT MONTH

Details of Keynote Lecture

News

Prime Minister opens new Trimite factory

The Prime Minister, the Rt. Hon. Margaret Thatcher recently opened a new one million litre paint distribution centre at the Trimite paint manufacturing complex at Uxbridge, Middlesex.

Mrs Thatcher accompanied by Managing Director, Michael Brent was making an official visit to Trimite — Britain's largest private manufacturer of paint.

The multi-million pound distribution centre has been established to meet the changing needs of industry. An increasing number of customers now adopt a policy of holding just enough production stock for each manufacturing process — and therefore need suppliers like Trimite who can deliver materials "Just in Time".

During a visit lasting more than an hour, the Prime Minister toured the laboratories where Trimite is developing new products to stay at the forefront of technological change.

Advanced computerised colour analysis and matching — a part of Trimite's Technical Service

The Prime Minister with Michael Brent (right), Managing Director of Trimite being shown examples of low smoke emission coatings developed for London Underground

The Prime Minister said, "Trimite has an excellent formula for success — a good product, great attention to customer needs, a loyal and efficient workforce. I wish you continued prosperity in the years ahead."

Mrs Thatcher was shown examples of low smoke emission coatings which have been specially developed for the London Underground System, to minimise smoke and toxic emissions in the event of fire. In another part of the laboratory, she saw how coatings for children's toys will be made even safer — by greatly reducing lead and cadmium.

Mrs Thatcher also saw how Trimite coatings are used on a wide variety of products. Including eye liner pencils, computer casings, sports equipment, toys and NATO military helmets.

Trimite celebrates its 50th anniversary in 1990 and has over 500 employees. In addition to the Uxbridge plant, Trimite has manufacturing and regional centres at Bristol, Leeds, Rochester (Kent), Glasgow and Naas, County Kildare in Ireland.

Eiger acquires Torrance

Stothert & Pitt Fluid Engineering Ltd, a subsidiary of Hollis Industries plc, has reached an agreement to sell its Torrance Division located at Bitton near Bristol to Eiger Engineering Ltd of Warrington, Cheshire.

Alan Taylor, sales director of Eiger Engineering Ltd, commenting on the acquisition, said, "Eiger will continue to support the Torrance product lines which have an excellent reputation for performance and reliability both in the UK and throughout the world."

Manders to acquire Johnson & Bloy Liquid Inks

Manders (Holdings) plc has announced the proposed acquisitions of the UK liquid ink assets of Johnson & Bloy Ltd and the whole of Johnson & Bloy Inc based in Canada and the US. The agreement is expected to be completed in March 1989.

The maximum consideration for the acquisitions is expected to be £5.4m. The acquisitions will complement QC Colours Ltd, recently acquired by Manders for £9.1m.

Manders will continue with the J & B name for which they will acquire exclusive rights and will continue to operate from the manufacturing locations in Runcorn, Bristol, Canada and the US, with J & B's existing personnel.

Pearl Paints management buy-out

Pearl Paints Ltd of Pontypridd, Wales, has become a privately owned company following a management buy-out from Macphersons. Ellis Pruchnie (who joined Pearl in 1963) becomes the new Chairman and Michael Pruchnie the new Managing Director. The current Pearl Paints organisation will continue to manufacture Vacuum Metallising Lacquers and other products within its portfolio, with the exception of Mirror Backing Paints which are being retained by Macpherson Paints Ltd.

BRITE partners meet at PRA

On 23-24 January 1989 PRA hosted the first meeting of all Partners in the Self-Stratifying Coatings Project under the EEC's BRITE (Basic Research in Industrial Technologies in Europe) Programme.

The four-year collaborative undertaking, with a total budget of ECU 2.1m and half-funding by the EEC, oficially began on 1 January 1989. Its aims are two-fold: to develop a model of the scientific principles governing stratification, while formulating experimental one-coat systems with self-layering functional properties. It is the first such large-scale European research project in the coatings field.

The meeting served to finalise technical and administrative details, set targets and confirm work strategies. It also offered an opportunity for exploring ideas for future collaboration.

The venture involves Europe's leading institutes in the coatings field, with PRA as main contractor. Visitors at the meeting included Michel Joly of CERIPEC (France), André Toussaint of CoRI (Belgium), Philip Thornton and Marie O'Dowd of EOLAS (Ireland), Ulrich Zorll of FPL (Germany), Ove Säberg of NIF and Finn Folkerman of TIC (both in Denmark) as well as Fred de la Court and Tom Mooy of TNO (Netherlands). The overall Project Manager, John Bernie, was assisted by a small team from PRA headed by Derek Walbridge, who will be responsible for the scientific direction of the research.

This was the first of many more such events over the next four years. The next full Steering Committee will gather in Copenhagen on 19 May, and a smaller Working Party in Amsterdam on 17 March. Separate meetings will be held for industrial Sponsors; PRA has attracted financial support from 19 companies to date.

Akzo symposium and opening of new R & D laboratories

The Hon Editor attended the opening of the new R & D Laboratories of Sikkens (Akzo) at Sassenheim, Holland and was impressed by the size and quality of the buildings and equipment at Sassenheim. It is encouraging to note that Surface Coating Companies are willing to invest in the future of the Industry. The symposium "Coatings through Science" was held at Noordwijk and was most informative. The speakers included Dr Groot who introduced the audience to the composition of paint and its chemistry and the interaction between paint and the substrate.

Messrs Juffermans and Noomenn surveyed the problems involved in the formulation of high solid topcoats and the rheology of these paints whilst Mr Noormans discussed the routes available for the formulation of water based two pack coatings. Dr Williams discussed the composition of materials used in car refinishing paints whilst Mr Akkerman spoke on "Special Effect Coatings" which may have vivid colours and the effect of design and texture in decorative coatings.

At the end of the symposium and the official opening of the laboratories, conducted tours of the laboratories were arranged.

J. R. Taylor

Colour back in Colorgen

Colorgen Inc, the USM traded colour system specialist, returned to profit at the half-way stage with net income of $1,418 for the six months ending 31 December 1988, compared with a loss of $226,788 for the same period in 1987. Commenting on the interim results, Chairman John O'Brien said: "We made our first one million dollar plus sale to a leading US DIY chain. This is a significant breakthrough firmly establishing our colour matching systems for retailers. At the same time, in Europe we have launched a major ink program with a leading international chemical company."

BS 5750 drum reconditioning

Blagden's Reconditioned Drum

Division's Manchester plant has received approval of their Company Manual of Manufacturing Procedures to BS 5750 Part II. This is a first in the UK Drum reconditioning industry to achieve approval.

Products

New urethane coating

Supershield II® is a new two-component acrylic resin, isocyanate-free urethane coating system from Guertin Bros (Canada) which is designed for industrial finishes over metal, plastics and wood. The advantages of this two-component isocyanate-free urethane system include: excellent chemical resistance (>100 MEK rubs), excellent hardness (H), high application solids (38% + by volume) and VOC <4.5 lbs/US gal.

For further information Enter C101

Equipment

New plastic diaphragm pump

Graco UK has introduced a major new addition to their range of air-powered fluid transfer pumps, the Husky 715.

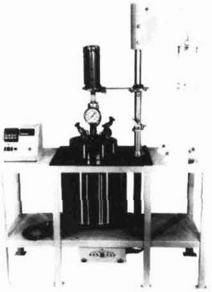
The Husky 715 is a compact (3/4 in) air-powered fluid transfer pump, ruggedly constructed from Acetal plastic, designed to handle hundreds of fluids from any pail, drum, tank or vessel. Extremely powerful for its size and weight, it is submersible and has a suction lift of up to 25 ft (7.6 metres) and will deliver up to 16 Gpm.

Graco's Husky 715 lightweight pump

Inherently safe, the Graco Husky 715 can be allowed to run dry without damage or fear of sparking, and is therefore safe with solvents and in other hazardous environments.

For further information Enter C102

New pressure reactor



Scientific and Medical has available the new 5 gallon stirred pressure reactor (Model 4555) from Parr providing enhanced ease of operation in pilot plant and small-scale production. This reactor is suitable for pressures up to 1,900 psig and temperatures up to 350°C. It is a seamless one-piece pressure vessel with no welds, which will greatly reduce any possibility of corrosion. The full opening head incorporates a confined Teflon seal and split ring type of closure and makes removal of the vessel head easier. A high torque magnetic drive unit gives the advantages of a sealed system together with powerful high-efficiency stirring.

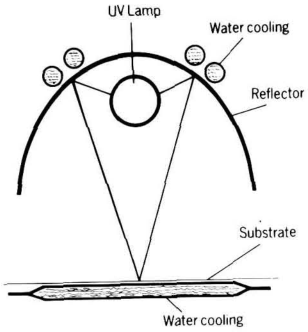
For further information Enter C103

UV cooling system

An alternative cooling method for its "Sheetcure" and other types of ultra violet dryers has been developed by Wallace Knight Ltd. This is designed for use with heat sensitive substrates and for intercolour drying where cooling of equipment by conventional methods is difficult. The system employs special double-skinned extruded lamp reflector housings through which water is circulated. Where the position of the dryer within the press permits, a heatsink


DCC

beneath the path of the substrate can be added.



For further information Enter C104

Reed's new six-colour printing facility

Reed Plastic Containers has introduced a six-colour offset printing machine (£0.32m) for decoration of its "S Type" tapered polypropylene containers and "Paintainer" all-plastic lever-lid cans. The new machine will enable the reproduction of full-colour photographs and precisely registered line/tone drawings.

For further information Enter C105

Literature

Literature miscellaneous

Macbeth colour brochure (8pp) on the 1500/Plus Colour Measurement System, "Consistent Colour Quality Management".

For further information Enter C106

Philips Industrial Automation. "Weighing in Hazardous Areas" (8pp, colour).

For further information Enter C107

Lawrence Industries. "High Bulk Filler for thickening & reinforcing" 12pp brochure and "Attagel 50 Thickener" booklet.

For further information Enter C108

HSE Consultative Document, "Proposals for draft Lifting Plant and Equipment (Certificates of Test and Examinations etc) Regulations" Tel: 051-709 1354.

Meetings

Applied rheology for paints and coatings

Three-day seminar in English, 10-12 April 1989, Science Park Idéon, Lund, Sweden. Organisers include Bohlin Reologi AB, NIF and NIFAB. For further information contact Gunlog Tange on Sweden 4646 1503 60.

Pakex 89

Pakex 89, the international packaging exhibition, will be held on 17-21 April 1989 at the National Exhibition Centre, Birmingham, with 350 companies from 23 countries. For pre-registration tickets call 021-705 4380.

OCCAA Convention

OCCA Australia's 31st Annual Convention will be held on 3-6 August 1989 at the Fairmont Resort in the heart of the Blue Mountains to the west of Sydney in New South Wales. The Convention theme is "Excellence Through Technology — Novel Approaches to Coatings". The combination of international technical experts and leading Australian R&D workers ensures a particularly high standard. For further information contact Convention Chairman: Mr Peter Parsons, C/- Tioxide Aust. P/L, 2a/6 Tooronga Terrace, Beverly Hills, NSW 2209, Australia.

People

BASF ink sales restructure

BASF Coatings + Inks has restructured its UK sales operation for oil-based inks and ancillary products.

The move is away from regional sales teams responsible for all lines, to four specialist groups which will promote specific products on a national basis.

The new group, headed in each case by a national sales manager (brackets) are: Heatset (Jim Scott); News Ink (Tony Downs); Carton (Martin Lewington); and Commercial (John Collins).

New Wengain area manager

Bryan Clementson

Wengain Ltd, specialist distributors of raw materials for the surface coatings industries, have strengthened their management team by the appointment of **Bryan Clementson** as area manager. He will be responsible for sales promotion in Scotland and the north of England and will be based at the company head office in Cheadle.

Mr Clementson, originally from Hartlepool, is a chemistry graduate from Newcastle University and has technical and selling experience in coatings additives and in titanium pigments. He is a member of OCCA and keeps up his Midlands connection by membership of the Birmingham Paint, Varnish & Lacquer Club.

New Macpherson marketing post

Elizabeth Parkin has joined Macpherson Paints Ltd as Market Development Manager with specific responsibility for merchants.

The new post has been created to reflect Macpherson's strong commitment to its core trade business and particularly to small painting and decorating companies through merchant outlets.

Elizabeth was previously with a leading Cambridge-based consultancy. ■

The COLOUR INDEX International

by A. G. Abel, Colour Index Editorial Board, The Society of Dyers and Colourists, Perkin House, 82 Grattan Road, Bradford, West Yorkshire, UK

The Colour Index International is becoming increasingly recognised as an indispensable work of reference for all who have any connection with colorants, including those in the fields of plastics, printing inks and paints. These specialised fields of use have been recognised by the Society of Dyers and Colourists and their joint publishers in the United States, the American Association of Textile Chemists and Colorists, by the publication of a Pigments and Solvent Dyes edition. Thus one book (now updated with a Supplement) contains all the information about pigments and solvent dyes which previously was scattered among the five volumes of the 1971 Colour Index and its 1975 and 1982 updates.

The Colour Index is proving valuable not only to chemists, but also to purchasing managers, safety experts and even legislators. Several countries have included Colour Index designations in legislation, e.g. France for food packaging, UK for the coloration of Gas Oil, and the EEC for its directive on the pigments and dyes that can be used in cosmetics. The United States classifies imports by Colour Index Generic Names and Japan has included them on a positive list for food contact. Therefore, it is clear that the Colour Index really is international, a factor becoming increasingly important as safety legislation is demanding internationally accepted nomenclature for labelling purposes.

The contents can be considered to be in four sections:

Section 1 lists the application properties of the pigments and dyes in order of their Colour Index Generic Name.

The CI Generic Name is defined as '*A classification name and serial number which when allocated to a commercial product allows that product to be uniquely identified within any Colour Index Application Class. This enables the particular commercial product to be classified along with other products whose essential colorant is of the same chemical constitution and in which the said essential colorant results from a single chemical reaction or series of reactions. Products obtained by physical admixture of essential colorants are excluded*'.

This section (example Box 1) describes the hue, gives an indication of the main application areas and lists such properties as light fastness, chemical resistance, solubility in various solvents and resistance to migration. This information is provided by the pigment or dye manufacturer, but as the information applies to the first product registered it can only be taken as an indication. Light fastness in particular can vary enormously, particularly in the

Box 1

C.I. Pigment Yellow 1—15

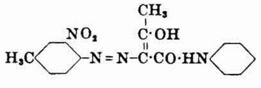
				FASTNESS									
				ORGANIC SOLVENTS								Heat	
C.I. Pigment Yellow	C.I. Constitution No.	Chemical Class	Hue	Aliphatic petroleum	'Cellosolve'	Esters	Ethanol	Ketones	NC solvents	Xylene	Light	m.p. °C	Stability °C
1	**11680**	Monoazo (Pigment)	Bright Yellow	3	3	2	1	2	2	2	V. good	256	Stable to 150 (20 min)

FASTNESS									
Water	Na_2CO_3 5%	HCl 5%	Linseed oil	Oleic acid	Plasticisers	PVC migration	Soap gel bleeding	MAJOR USAGE ADDITIONAL INFORMATION	**C.I. Pigment Yellow**
Insol	4–5	5	5	5	4–5	—	5	Paints and printing inks, emulsion paints and distempers; paper coating and wallpaper; mass coloration of viscose and in linoleum. Use in lacquers limited by solvent solubility and in rubber although its solubility is a disadvantage. Also used in textile printing, leather finishes and in P/F, U/F and vinyl plastics although some migration occurs on heating	**1**

Standard
BS 3599/1-5: 1963 (Arylamide Yellow G)

Box 2

11680 **C.I. Pigment Yellow 1** (*Bright yellow*)



2-Nitro-*p*-toluidine → Acetoacetanilide

H_2SO_4 conc. — golden yellow; on dilution — yellow ppt.
HNO_3 conc. — no change
HCl conc. — reddish solution
NaOH dil. — no change

Discoverer — H. Wagner 1909
M.L.B., *BP* 9633/10; *USP* 1082719; *GP* 257488 (*Fr.* **11**, 452)
Bayer Co., *GP ap.* F33190 (*Fr.* **11**, 455), *BP* 9252/14; *GP* 287569, 293429, (*Fr.* **12**, 382, 382)
BIOS 1661, 49 *et seq.*
FIAT 764 — Hansagelb A, G, GA, GGR, GN, GT Plv.
Rowe, Burr & Corbishley, *JSDC*, **42** (1926), 80
Fierz-David & Ziegler, *Helv. Chim. Acta*, **11** (1928), 777
Clark & Newburger, *J. Assoc. Off. Agric. Chem.* **27** (1944), 576

Standard
BS 3599/2 C.I. Pigment Yellow 1 (Arylamide Yellow G)

Slightly soluble in ethanol, acetone and benzene
M.p. 256°C (from glacial acetic acid)

pigment field, where particle size plays an important role. Much effort is being put into ensuring that the figures used for fastness data are obtained by recognised standard test methods.

Section 2 (example Box 2) provides structural information about the colorant. Many people find it surprising that manufacturers are so ready to part with structural information about their products, but compared with the production methods, in particular the finishing and surface preparation involved, the chemical structure is relatively easy to ascertain by modern analytical techniques. In addition to the structural information, which is listed in order of the five-figure Colour Index Constitution Number, this section includes a description of the hue, details of the inventor, specific references and where appropriate the route of manufacture.

Section 3 (example Box 3) is an index of the products set out in order of Colour Index Generic Name, listing the commercial names and their manufacturers. It is preceded by a list of manufacturers' names and addresses. Again it must be stressed that products containing the chemically identical essential colorant do not necessarily have the same application and fastness properties, so it is essential that the colorant user checks the products carefully under his own conditions of use. Nevertheless, knowing all the manufacturers of a pigment or dye is most useful and can save the purchasing manager or formulation chemist much time.

Section 4 lists all the products in alphabetical order of their commercial name, giving the manufacturer, the CI Generic Name and the CI Constitution Number. Finally a new index of range names is included.

From a single commercial name it is possible to ascertain the manufacturer, the chemical structure and all the manufacturers who produce a chemically identical colorant, and even obtain some idea of the coloristic and fastness properties of the product.

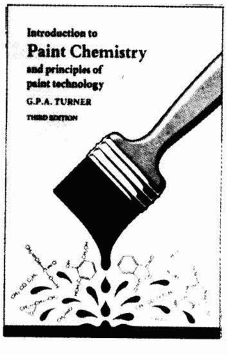
A tremendous amount of work goes into compiling the Colour Index International not only by the publishers but also at the dye and pigment manufacturers who supply the information. There is little wonder that the effort is becoming increasingly valued by those who work in colour, as it can save hours of painstaking research.

Box 3

CI PIGMENT YELLOW 1 (11680)

Eljon Yellow DG	EJ
Eljon Yellow DH1	EJ
Fanchon Yellow YH-5707	MBY
Fast Yellow G	CNC, KKK
Flexidrol Yellow GM	IOS
Forthfast Yellow GG	CRD
Hansa Yellow G	HOE
Helio Fast Yellow GN	BAY
Hispalit Yellow HG	RBM
Irgalite Paper Yellow GNS	CGY
Irgalite Yellow G	CGY
Irgalite Yellow GKO	CGY
Irgalite Yellow PDS8	CGY
Isol Aryl Yellow GX	KVK
Korfil Yellow G	Pol
Lithol Fast Yellow FK1420	BASF
Lithol Fast Yellow FK1460	BASF
Luconyl Yellow 1250	BASF
Luconyl Yellow FK142	BASF
Lutetia Yellow J	ICI
Lutetia Yellow 2JR	ICI(O)
Mono Fast Yellow G	KON
Monofast Yellow G	KON
Monolite Yellow GN	ICI, ICI(O)
Monolite Yellow GN HD	ICI
Monolite Yellow GN V	ICI(O)
Monolite Yellow GNA	ICI(A)

■



Control of the application performance of classical organic pigments

by R. B. McKay, Ciba-Geigy Pigments, Hawkhead Road, Paisley, Renfrewshire PA2 7BG, UK

Summary

From any given chemical type of organic pigment it is possible to prepare a multitude of organic pigments, each with distinctive application behaviour. The key is control of the physico-chemical character, in particular crystallographic and surface properties and state of aggregation of crystals. This is exemplified in relation to dispersibility, and optical properties, flocculation resistance and rheology of dispersions in ink and paint media.

Introduction

The chemical types of classical organic pigments have been established now for many decades, on the basis of colour, general fastness properties and cost. Nevertheless a multitude of pigments of distinctive application properties can be prepared from any given chemical type by modification of crystallographic and surface properties. The key factors are the size and shape of crystals, crystal lattice type, surface character of crystals and their state of aggregation. Ability to control these factors leads to a steady supply of new pigments in response to changing market requirements.

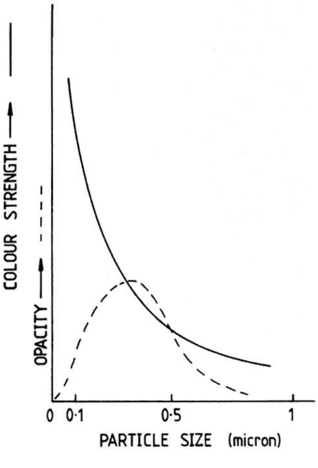
This paper gives some examples of the key influence of physical properties on the performance of organic pigments in inks and paints.

Optical performance

Although the characteristic colour of an organic pigment is determined primarily by its chemical constitution, the effectiveness of a given chemical type of pigment in imparting colour is dependent upon its particle size in dispersion. Figure 1 provides a schematic illustration. Colour strength increases with decrease in particle size in the sub-micron region. This is firmly established by theory, experiment and usage[1-3]. The dependence is most marked at the smallest particle sizes of the order of 0.1 micron in size. In cases where the particles are elongated it is the minor dimension that matters[4].

Figure 1

Effect of particle size on colour strength and opacity.



Opacity/transparency also depends on particle size. The opacity of a dispersion depends on the ability of the particles to scatter light. Scattering is at a maximum at particle sizes about half the wavelength of light. Therefore opacity passes through a maximum at a particle size in the region of 0.2 to 0.5 micron. Dispersions become progressively more transparent at lower and higher sizes. High colour strength and transparency go hand-in-hand. This is ideal for multicolour process inks where successive layers of ink are superimposed. Opacity on the other hand is achieved at the expense of colour strength.

Obviously the key to controlling the optical performance of a given type of organic pigment is control of particle size. So an important question to ask is — what is a particle?

Nature of organic pigment particles

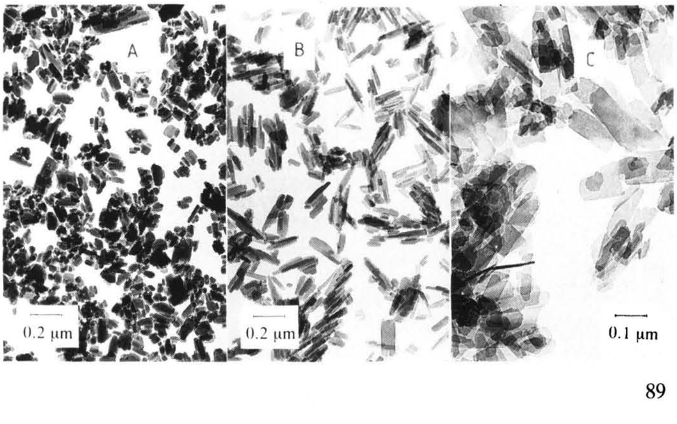
The primary particles of organic pigments are molecular crystals. These can be seen by electron microscopy. Figure 2 shows some examples. Crystallinity is shown by characteristic X-ray diffraction patterns, and in some cases by resolution of the crystal lattice planes by high resolution electron microscopy (Figure 3).

The crystals are typically brick-, rod- or plate-shaped. In pigments for printing inks the average minor dimension is usually in the range from 0.02 to 0.05 micron. In mono-azo pigments for paints it is often in excess of 0.1 micron.

Ideally the pigment particles in dispersion in application media should be individual crystals. In a few cases, such as calcium 4B toners in litho inks (Figure 4), inherent colour strength correlates fairly well with crystal size, suggesting that the crystals are

Figure 2

Transmission electron micrographs of two β-copper phthalocyanine pigments (A and B, brick- and rod-shaped, respectively) and a calcium 4B toner (C, rectangular plates).



substantially individually dispersed (note that inherent strength is observed strength corrected for colourless resin content). Generally, however, such simple correlations with crystal size do not occur. The particles in dispersion tend to be a mixture of individual crystals, small aggregates of a few crystals and a few larger aggregates sometimes detectible in the optical microscope. Thus in order to control particle size in the ink it is necessary to control both crystal size and the state of aggregation of crystals.

Figure 3

High resolution transmission electron micrographs of a β-copper phthalocyanine pigment (A) and a calcium 4B toner (B) showing crystal lattice planes.

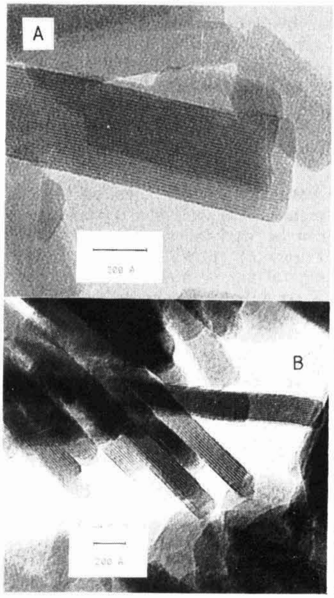
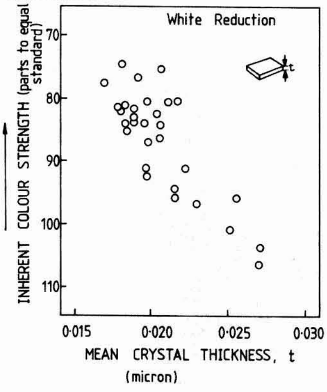


Figure 4

Relationship between inherent colour strength and mean crystal thickness of calcium 4B toner crystals in white reductions of lithographic inks, all of same pigment concentration.



Control of aggregate structure and dispersibility

Classical organic pigments are manufactured by grinding (copper phthalocyanines) or precipitation processes (azos, α -copper phthalocyanine), followed usually by controlled crystal growth. Crystal size can be obtained within desired limits by control of process variables and by the use of certain additives that inhibit crystal growth at key stages. Unfortunately the smaller crystals are made, the more prone they become to immediate and strongly coherent aggregation, which increases particle size. Unless steps are taken to control this aggregation then the benefits of small crystal size tend to be lost.

Furthermore when the pigment is isolated from the preparative medium to form a powder (or granules), the crystals have to be aggregated in a controlled way — so that the pigment can be obtained in conveniently handleable form, yet capable of being redispersed easily and as completely as possible into the application medium. Ease and completeness (quality) of dispersion are embraced in the term dispersibility.

Wettability of the pigment by the application medium is a prerequisite for dispersion, but is easy to achieve, especially in pigments for organic media. In practice the factor that tends to control dispersibility is the strength of cohesion of the aggregate structure.

The strength of cohesion is determined primarily by two factors. The first is the area of contact between crystals. This is dependent on the mode of packing, face-to-face packing giving stronger cohesion than edge-to-face, edge-to-edge, etc. The second factor is the strength of interaction per unit area of contact. This increases with increase in surface polarity.

The extent of face-to-face packing of crystals is indicated by the ratio S_{BET}/S, where S_{BET} is the specific surface area of the pigment **powder** determined by nitrogen gas adsorption, and S is the specific surface area of the **crystals** determined from electron micrographs and/or X-ray diffraction[5,7]. Nitrogen molecules do not penetrate between crystals in face-to-face contact under the conditions used in the determination of S_{BET}. $S_{BET}/S << 1$ indicates a compact structure with predominant face-to-face packing; $S_{BET}/S \rightarrow 1$ indicates an open structure with predominance of edge or point contact of crystals.

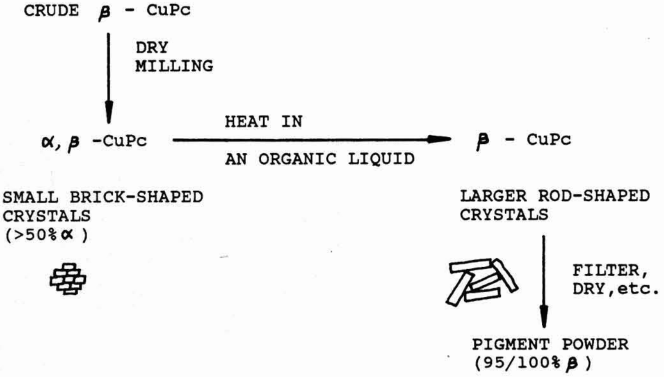
Clearly minimisation of direct face-to-face contact of crystals is required for good dispersibility.

β-copper phthalocyanine pigments provide an example. These pigments are commonly produced (Figure 5) by grinding non-pigmentary "crude" copper phthalocyanine as a dry powder to produce an α-,β-form mixture. This mixture consists of tiny brick-shaped crystals (mean thickness ca. 0.02 micron) that are compactly aggregated face-to-face ($S_{BET}/S < 0.1$). It has extremely poor dispersibility in ink or paint media. Treatment with a suitable organic liquid induces crystal growth and phase change by a recrystallisation mechanism. The β-form pigment produced consists of rod-shaped crystals (mean minor dimension 0.02 to 0.04 micron; 0.15 to 0.25 micron long) with an open aggregate structure ($S_{BET}/S \rightarrow 1$). Table 1 gives an example.

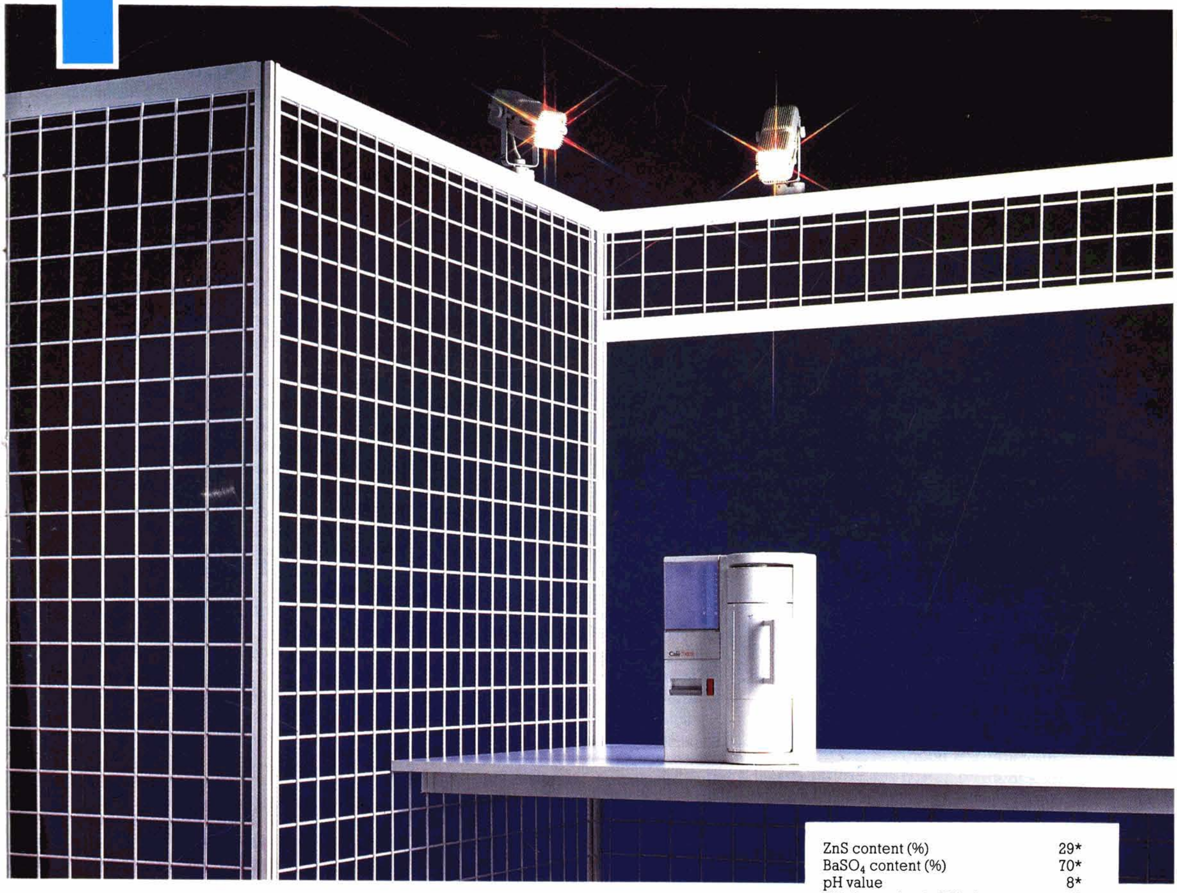
Optimisation of this type of process gives pigments with excellent dispersibility[6]. Care has to be taken to

Figure 5

Preparative scheme for a β-copper phthalocyanine pigment.



We didn't make the stand or the coffee maker. But it's still a great display of our products.



ZnS content (%)	29*
$BaSO_4$ content (%)	70*
pH value	8*
Oil absorption (g/100g)	8*
Sieve residue – 45 μm (%)	0.005*
Average particle size – ZnS (μm)	0.003*
– $BaSO_4$ (μm)	0.007*

*Approx

Zinc Sulphide Pigments

These days the standards for powder paints have got a lot tougher. Environmental factors now have to be considered along with performance and economy. At Sachtleben we've developed zinc sulphide pigments with all these qualities, plus they deliver all the whiteness and brightness you need. But they do it without the need for solvents. Which is why they are ideal, for example, in paints for display stand systems. Couple this with the brilliant range of TiO_2 pigments we make for plastics, and you can see why our products really stand out at exhibitions. Even when we're not there.

Having the world's most comprehensive range of white pigments and extenders proves invaluable to industries from plastics, paints and paper, to textiles, water treatment and pharmaceuticals. But just because we're ahead doesn't mean we stand still. Continuous R & D programmes find cost-effective solutions to the many unusual problems our customers face. Chances are, if you have a problem, we may have already solved it.
Call us now. And call us first.

Commitment: It's our formula for success.

»SACHTLEBEN«

Sachtleben Chemie GmbH, PO Box 17 04 54, D-4100 Duisburg 17, W. Germany.
UK: 56 High Street, Edenbridge, Kent TN8 5AJ. Tel: 0732 863694. Fax: 0732 866320. Tx: 95297. 38A Bury Old Road, Manchester M25 5TL. Tel: 061-773 2000. Tx: 668838.

Enter C203 on Reader Reply Card

avoid overgrowing the crystals. Once the α- to β-form conversion has been completed further growth by side-by-side fusion of crystals becomes important[7]. This produces fatter crystals and is detrimental to colour strength.

Table 1

$$\alpha,\beta\text{-CuPc} \xrightarrow[50^\circ C]{\text{organic liquid}} \beta\text{-CuPc}$$

S	(m^2g^{-1})	130	71
S_{BET}	(m^2g^{-1})	2	72
S_{BET}/S		0.02	1

Further improvement in dispersibility can be achieved by treating the surfaces of pigment crystals with additives such as abietyl resins. Calcium 4B toners for lithographic inks provide a good example. The rectangular plate-shaped crystals (Figure 1) are arranged in a fairly open aggregate structure, even in untreated pigments ($S_{BET}/S \approx 0.8$). Edge and point contacts predominate. The crystal surfaces, however, are polar[6] and so the cohesive strength of interaction at the contacts between crystals is substantial. The structure although open is strongly coherent and dispersibility of untreated toners in the ink varnish is poor.

Adsorbing abietyl resin to the crystal surfaces during pigment manufacture lowers the surface polarity and hence the strength of cohesion of the aggregate structure per unit area of contact. Dispersibility in the ink varnish is enhanced, and indeed within a series of related pigments increases with an increase in the surface concentration of resin[6].

It should be appreciated that adding an essentially colourless material, such as abietyl resin, to a pigment will have a diluent effect on colour strength. This is offset in calcium 4B toners by the fact that the presence of resin at key stages in their manufacturing processes results in smaller crystal size. Abietyl resin is a potent crystal growth inhibitor with these pigments[5].

Flocculation resistance and rheological behaviour in gravure inks and paints

Pigment particles dispersed in liquid media tend to flocculate. This leads to three-dimensional structure formation which enmeshes and immobilises the liquid phase. If the pigment concentration is sufficiently high, then all the liquid is immobilised and the dispersion becomes a gel. The structure, however, can be broken down on shearing, but recovers when shearing is removed. Breakdown and recovery is quantitatively reversible in a mechanical sense[8] and the flocculation is of the weak or secondary minimum type in colloid chemical terminology. Such structure is highly undesirable during manufacture of inks and paints. It limits the concentration of pigment that can be used in the dispersion process, and hence limits throughput.

Flocculation is best controlled by the pigment manufacturer. During key stages of the pigment manufacturing process the crystal surfaces can be accessed and modified by treatment with certain types of additive. This technology is well developed for copper phthalocyanine pigments, additives being applied usually at 5 to 10% of pigment weight.

One of the most common types of additive is $CuPc\text{-}(CH_2NRR')_n$, where R and R' are small aliphatic residues, and $2<n<4$. These are effective in pigments for low polarity media, such as phenolic/toluene gravure inks and hydrocarbon based paints. The additives adsorb to the pigment crystal surfaces, thereby effectively modifying the surface character. Flocculation resistance results from interaction of the substituent groups in the additive on the pigment surface with binder resin in the ink or paint medium[9-11]. In this way an adsorbed layer conferring steric stabilisation is induced to form. Electrical charge stabilisation can be discounted in low polarity media.

Nevertheless binder resin can be shown to adsorb to unmodified pigment surfaces from low polarity media[8,12] and yet the pigment flocculates badly. This fact indicates that the composition of the adsorbed layer is different when additive is present on the pigment surfaces. It can be inferred that the additive induces preferential adsorption of specific fractions of the resin that would not normally occur. These are most likely to be the more soluble fractions capable of giving a layer with sufficient thickness and solvation density for steric stabilisation.

Also important are additives of type $CuPc - (S\bar{O_3}\overset{+}{N}HRR'R'')_n$ where R, R', and R'' are aliphatic, and $2<n<3$. They are used in pigments for media of low to moderate polarity, utility and effectiveness depending upon the constitution of R,R' and R''.

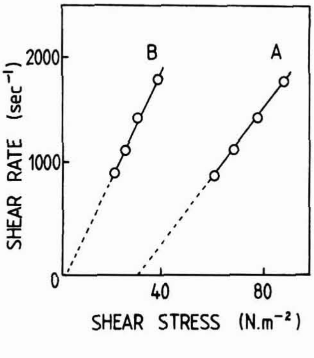
Additives are also known that are capable of conferring flocculation resistance in their own right, without necessarily involving the binder resin of the ink or paint medium. An example is $CuPc\text{-}(CH_2OOC$⬡$OC_{16}H_{33})_{2.5}$ which is effective in gravure inks and paints based on aromatic solvents[13]. The additive is soluble in aromatic hydrocarbons, thus indicating good solvation of the substituent groups in the (insoluble) copper phthalocyanine residue. It adsorbs to the surface of the pigment crystals with the copper phthalocyanine residue adjacent to the surface and the solvated side chains extending into the liquid phase. In this way an adsorbed layer is formed with sufficient thickness and well enough solvated to give steric stabilisation. In phenolic/toluene inks, for example, it competes successfully with the (ineffective) resin fractions for adsorption sites at the pigment surface and greatly enhances flocculation resistance[13].

Additives that confer flocculation resistance in their own right offer some potential technical advantages over conventional additives. They are effective to higher pigment concentrations and are less dependent on the nature of the binder resin. Nevertheless they have not featured prominently in commercially available pigments because they tend to be too expensive.

Enhanced resistance to flocculation in this context means reduction in the residual attraction between particles. This causes marked change in the rheological behaviour (Figure 6). The intercept on the shear stress axis (an indicator of strength of structure[8,13]) is greatly reduced, ideally to zero. Care, however, must be taken in interpreting such rheological data, for similar changes can also be caused by additives that inhibit dispersion of the pigment (resulting in fewer particles)[8,13]. Centrifugal hindered settling of the

Figure 6

Rheological data for phenolic/toluene gravure inks containing a β-copper phthalocyanine pigment (A) without additive and (B) with $CuPc\text{-}(CH_2NRR')_n$ at 10% w/w. Obtained using a rotational viscometer.



dispersions is useful for distinguishing between these mechanisms. In routine practice, however, observation of colour strength is often good enough and more convenient. Improved flocculation resistance reduces strength of structure without loss in colour strength; there may even be a gain. Inhibition of dispersion reduces colour strength.

Other factors influencing the rheology of concentrated pigment dispersions

Under conditions where flocculation has been broken down or eliminated, the viscosity of a concentrated dispersion increases markedly with an increase in pigment volume concentration[8]. Not all pigments, however, give the same viscosity when dispersed at the same concentration in a given medium. This is a result of the very small size of the pigment particles. They have a huge surface capacity to adsorb medium. As a result a substantial fraction of the liquid medium becomes immobilised at the particle surfaces in adsorbed or boundary layers. The immobilised liquid becomes in effect part of the solid phase, and so the effective pigment volume concentration is substantially higher than the nominal volume concentration[8,12]. Obviously the maximum concentration achievable in concentrated dispersions is greatly influenced by this effect. Consequently pigments with very small particles and too thick adsorbed layers are not advantageous in this context.

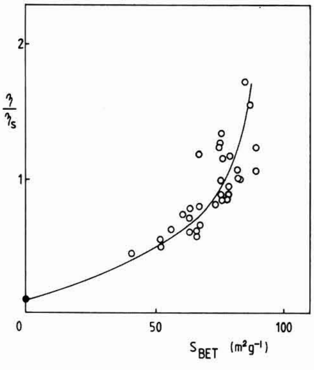
Particle shape can be an important factor. As a broad generality pigments with rod-shaped crystals of high axial ratio tend to give unsatisfactory rheology in concentrated dispersions. This can be explained at least in part by considering the spacial properties of random assemblies of rods. In such assemblies the void volume fraction within the structure increases with an increase in the axial ratio of the rods[14]. This implies that the concentration at which gel formation occurs in flocculated dispersions should tend to decrease with an increase in the axial ratio of the particles.

This is borne out in practice and has important implications, for example, with β-copper phthalocyanine pigments in lithographic inks. Well grown crystals are required for good dispersibility; thin crystals are required for high colour strength. A pigment with long thin rod-shaped crystals meets these requirements, but unfortunately gives acceptable rheology only at low pigment concentrations. Good rheology at high pigment concentrations requires pigments with low axial ratio. This means sacrificing either some colour strength (fatter crystals) or dispersibility (shorter crystals) or both. Consequently it is necessary to manufacture a range of β-copper phthalocyanine pigments to suit different requirements.

The influence of pigments on the rheology of lithographic ink concentrates can also be controlled by inducing a limited degree of "irreversible" aggregation of the crystals during pigment manufacture. For example, calcium 4B toners have an open aggregate structure ($S_{BET}/S \approx 0.9$ in commercial pigments). Inducing a controlled degree of face-to-face packing of crystals ($S_{BET}/S \approx 0.7$ to 0.8; i.e. reducing S_{BET}) which survives in the ink, produces pigments that give ink concentrates with significantly better rheology, and with only minimal loss of colour strength and transparency[5]. Indeed in this special case there is reasonable correlation between ink viscosity and S_{BET} (Figure 7). Correlation of these two properties is not normally to be expected.

Figure 7

η/η_s is limiting viscosity (Casson) of lithographic inks containing calcium 4B toners (all at same concentration) relative to that of a standard ink. ● is result with ink medium alone. The line is a line of sight fit.



References

1. Maikowski, M. A., *Ber. Bunsenges. Phys. Chem., 1967,* **71,** 313; *Progr. Colloid Polym. Sci., 1976,* **59,** 70.
2. Hauser, P., Herrmann, M., and Honigmann, B., *Farbe und Lack,* 1970, **76,** 545; 1971, **77,** 1097.
3. Carr, W., *JOCCA,* 1971, **54,** 1093.
4. Felder, B., *Helv. Chim. Acta,* 1968, **51,** 1224; *J Colour and Appearance,* 1971, **1,** 7.
5. McKay, R. B., XVIII FATIPEC Congress, 1986, **2/B,** 405; PPCJ, 1987, **177,** 126.
6. McKay, R. B., *JOCCA,* 1988, **71,** 7.
7. McKay, R. B., and Mather, R. R., *Colloids and Surfaces,* 1987, **27,** 175.
8. McKay, R. B., XIII FATIPEC Congress, 1976, 428; *Brit. Ink Maker, 1977,* **19,** 59.
9. Black, W, Hesselink, F. T., and Topham, A., *Kolloid-Z. Z. Polym.,* 1966, **213,** 150.
10. McKay, R. B., *J. Appl. Chem. Biotechnol.,* 1976, **26,** 55.
11. Ditter, W., and Horne, D., Proc. 4th Int. Conf. Org. Coatings Sci. Technol., ed. Parfitt, G. D., and Patsis, A. V., *Technomic,* Westport, Ct, USA, 1980, p.114.
12. McKay, R. B., Particle Size Analysis, ed. Groves, M. J., *Heyden,* London, 1978, p.421.
13. McKay, R. B., 6th Int. Conf. Surf. Coatings Sci. Technol. ed. Parfitt, G. D., and Patsis, A. V., Technomic, Westport, Ct, USA, 1982, p.173.
14. Vold, M., *J. Phys. Chem., 1959,***64,** 1608. ■

Continued from p.119

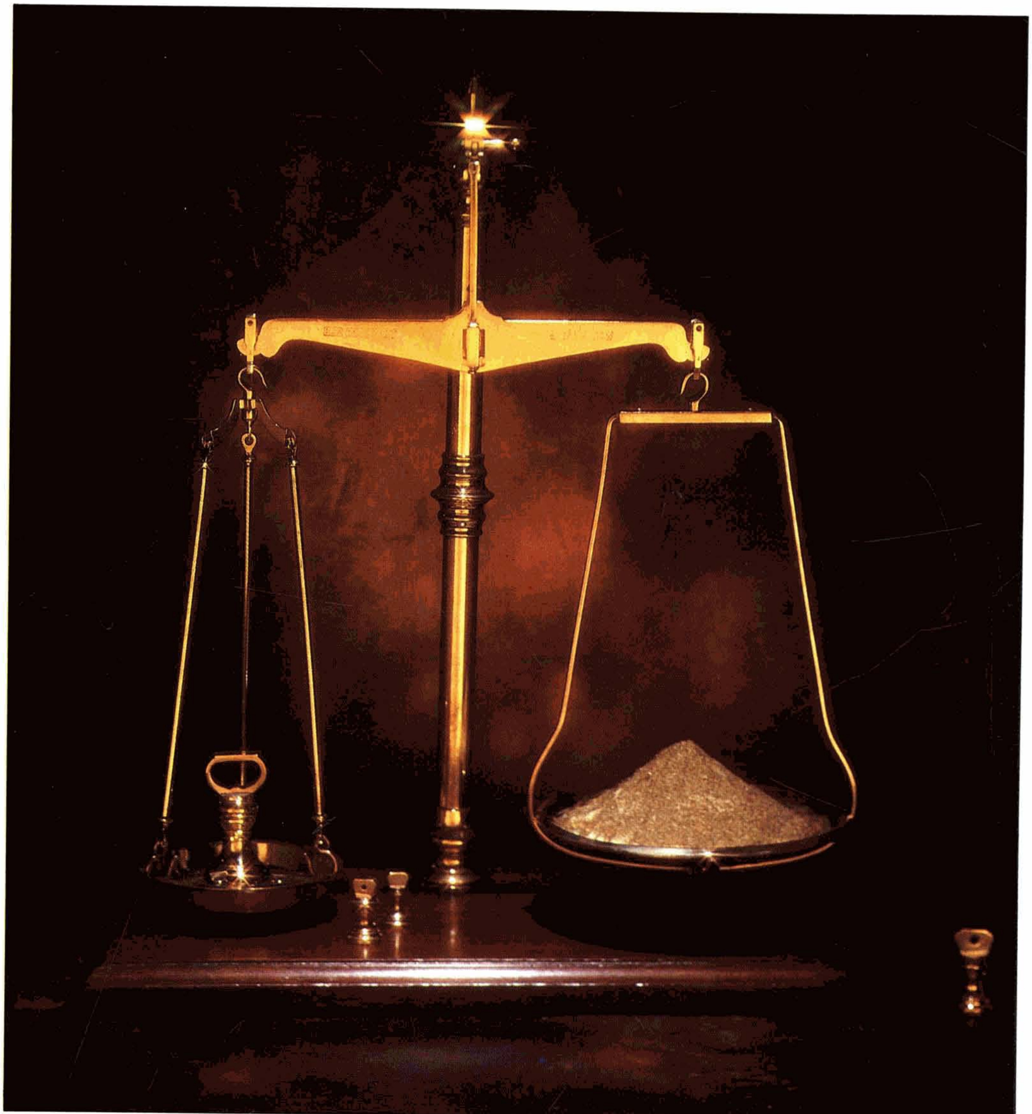
working life. He then gave a detailed summary of the types of sealants available, their properties and also details of the constituent raw materials and formulation variables.

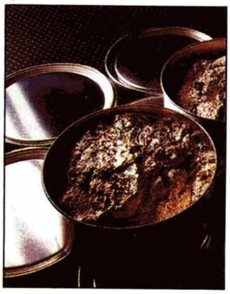
He emphasized the importance of the choice of type of sealant with regard to the area of use and working life, and he outlined the problems that can arise when these considerations are not properly taken into account.

Mr Dent completed the talk with some very practical examples of typical uses of sealants, alone and in conjunction with other materials in glazing, construction and industrial enviroments.

A lively question time, not entirely disconnected with DIY applications rounded off an interesting evening.

P. Knight ■





Nickel-based pigments for electrically conductive paints

by A. C. Hart, Hart Coating Technology, P.O. Box 10, Brierley Hill, West Midlands DY5 2RQ, UK.

Abstract

The requirement for surface coatings which can act as effective shielding for electronics devices from radiofrequency and electromagnetic interference (R.F.I./E.M.I.) is growing as the number of these devices proliferates and the need for such shielding becomes incorporated in standards and legislation.

Organic-based coatings, and in particular wet paints, provide a very attractive method of applying this type of shielding. These systems are not, however, inherently electrically conducting and therefore can only provide effective shielding if suitable conductive pigments are incorporated.

Nickel has a combination of properties which make it a very attractive material for this application. This paper describes the properties of conductive pigments based on nickel in relation to their use in R.F.I./E.M.I. shielding applications and also deals with coated pigments where nickel is used firstly as the substrate material and secondly as the coating on a less conductive substrate.

In recent years a new branch of surface coating technology has grown up based upon the requirement to produce coatings which are capable of providing effective shielding for electronic equipment against radiofrequency and electromagnetic interference (R.F.I./E.M.I.).

All types of electronic equipment can be affected by extraneous electrical and magnetic signals. Such devices can act as receivers of interference, generated by natural sources, such as lightning, or by other electronic or electrical devices. Alternatively the equipment may be an emitter of this type of signal interfering with the operation of other devices in the vicinity. The majority of interference problems are generated in the frequency range between 10 Kilohertz and 100 Gigahertz.

With the proliferation of electronic devices in a wide range of industrial and domestic applications it is becoming increasingly necessary to shield this type of equipment from interference to ensure its reliable operation. In some applications this has become absolutely vital, for instance on aircraft operating 'fly-by-wire' control systems where the shielding of the computers controlling the flight systems must be absolutely foolproof — for obvious reasons. In other applications shielding problems may cause less dramatic effects, such as the malfunctioning of a normal commercial computer installation, which may nevertheless be very inconvenient and costly.

When electronics devices were housed in metal boxes of one sort and another the problem of R.F.I./E.M.I. interference was less acute since the metal of the container often provided an effective shield in itself. However, metal has been largely replaced by plastics as the construction material for this type of application and since plastic housings are generally non-conductors of electricity they provide no shielding at all for the equipment which they contain.

It is not possible, within the limits of current plastics technology, to produce housings for electronic equipment from plastic materials which have a sufficient degree of electrical conductivity to offer effective shielding. It has therefore been necessary to devise methods of coating the non-conductive containers with a system which is electrically conductive and which will therefore provide the required degree of shielding. The four major systems which have been used to provide shielding coatings are:

☐ Paints.

☐ Metal Spraying Techniques.

☐ Vapour-phase Deposition Techniques.

☐ Aqueous-based Systems, such as Electroless Plating.

The use of paint-based systems has become widely accepted in the shielding industry because they have a number of distinct advantages. In general the capital cost of the equipment for application of a paint coating is much less expensive than for any of the alternatives. In addition, facilities for paint application are readily available in many locations, whereas the more capital intensive alternatives are few in number. Thus the cost of using a paint system becomes more attractive since the need to transport the housing long distances for coating is eliminated. Paint is also ideal for coating complex shapes, such as the interior of a computer housing, due to the flexibility of the application process which can be used selectively only in the areas of the moulding where the coating is required. Another advantage of using a paint system for the shielding coating is that the moulding is normally coated on the outside for appearance thus the two systems are very compatible.

Paints do however, suffer the same disadvantages as plastics in that they are usually inherently non-conducting and would provide no shielding effect. To produce a paint which is conductive it is therefore necessary to incorporate conductive pigments into the system.

A number of materials have been used as conductive pigments including graphite and a number of metals which are available in the form of small particles suitable for incorporation into organic media. Of these metals nickel is perhaps the most important for large scale use due to a combination of attractive properties. This paper examines the various properties of nickel particulate pigments and describes the reasons why the material is so popular for incorporation into this type of coating.

Properties of nickel pigments

In order to produce a system with good shielding effectiveness it is well accepted that the coating must exhibit good electrical conductivity. It therefore follows that the pigment used must also be highly electrically conducting. In this respect nickel looks to be unfavourably placed in relation to other alternative metallic pigments. Table 1 shows the relative electrical conductivities of a number of alternative materials which can all be obtained in suitable particulate form and which are used to produce conductive organic coatings.

From this it would seem that nickel would not perform particularly well. However, the situation in reality is far more complex and properties of the materials other than their inherent conductivity play a highly important part in determining the performance in a conductive organic-based coating.

This type of coating consists, not of a totally coherent metallic film within the organic medium, but of a series of discreet metallic particles suspended in the vehicle. The resultant conductivity is therefore critically dependant upon the way in which these particles make contact with each other and provide electrical continuity throughout the film. The properties of the metallic particles which influence the mode of contact are thus at least as important in determining the resultant electrical conductivity of the coating as the inherent electrical conductivity of the metal.

One other important factor influencing the choice of metallic filler is, of course, cost and some of the materials shown in Table 1, whilst exhibiting excellent technical properties in all respects are ruled out of general use for normal conductive coatings simply on the grounds of being too expensive.

Table 1

Relative electrical conductivities

Silver	1.05
Copper	1.00
Gold	0.70
Aluminium	0.61
Nickel	0.20

The reason that nickel is so widely used in R.F.I./E.M.I. shielding coating is due to the fact that it exhibits a unique combination of complementary properties which enable highly conductive coatings to be formulated using it as the basic pigment. These properties are discussed in more detail below.

Chemical properties

Since the conductivity of the film is critically influenced by the contact between the individual particles within the organic vehicle it follows that the chemical properties of the metal which affect the surface condition of the particle, such as its resistance to corrosion, will have a considerable effect upon the ultimate conductivity of the coating system.

In this respect nickel exhibits excellent properties. One of the major uses of the metal for many years has been as a corrosion resistant material. Both the pure metal and many of its alloys, notably the nickel-containing stainless steels, have been used in an extremely wide range of corrosive environments due to their high resistance to attack. The use of nickel as a corrosion resistant coating, primarily as pure electrodeposited metal, is also well established.

Small particles of nickel of the type used in conductive organic coatings are just as resistant to corrosion as massive nickel used in other applications. The surface of the metal is not completely free of oxide, however, but rather a thin, stable and, most importantly, electrically conductive oxide forms on the surface which allows excellent conductivity between contacting particles. Nickel pigments produced especially for this type of application are treated during manufacture to produce a surface which has the correct oxidation condition to maximise particle to particle contact thus enhancing their performance.

Furthermore, nickel, being very resistant to corrosion even in quite aggressive environments and at elevated temperatures, remains stable within the organic vehicle both on storage before application as a coating and also after application when it is in the form of a thin composite film. Thus nickel-containing coatings retain their electrical and shielding properties in difficult operating environments and over long periods of service.

The properties of nickel in this respect can be contrasted with those of two other metals which from the point of their electrical conductivity, as shown in Table 1, and also from a cost consideration might be thought to offer a better performance. Aluminium, for example, has very good inherent electrical conductivity but unfortunately forms a very stable surface oxide with high electrical resistance. Thus there is little or no conductivity between adjacent particles due to the resistance of this surface oxide. Another alternative, copper, does give good particle-to-particle contact and can be used to produce highly conductive coatings. However, the corrosion resistance of copper is relatively low and the particles can readily corrode within the organic film producing a decrease in conductivity and shielding performance with time. Specialised copper pigments which are stabilised to overcome this inherent disadvantage are becoming available but there is always some degree of doubt with this metal due to its poor inherent properties in this respect.

Magnetic properties

Of the metals generally considered suitable as pigments for shielding coatings nickel is the only one which is ferromagnetic. Of the other ferromagnetic metals iron is not suitable since it has extremely poor corrosion resistance. Cobalt on the other hand whilst having useful properties is generally much more expensive than nickel, particularly in the form of small particles.

The magnetic properties of nickel result in the coatings containing this metal having more effective shielding properties against electromagnetic interference. This is particularly effective when the purpose of the shielding is to prevent signals being emitted from the electronic device as opposed to being received by it.

Nickel particle Morphology

In view of the fact that the coating system consists of large numbers of small metallic particles in intimate contact with each other it is evident that the shape of these particles will have a very significant influence on the conductivity achieved and therefore upon the shielding performance.

The shape of small metallic particles usually depends on the method by which they are manufactured. For example, metal powders produced by atomisation processes, where the molten metal is broken up into small droplets which are rapidly cooled to give solid particles, generally take the form of rather irregular spheres.

There are a number of methods of producing small nickel particles including atomisation processes and some using decomposition processes from aqueous-based systems. However, there is one process used for nickel production, the nickel carbonyl process, which although not unique to this metal (carbonly iron powders are produced commercially) is not applicable to many metals such as copper which might be used as conductive pigments. The great advantage of the nickel carbonyl process, related to conductive pigment production, is that it can be used to produce a wide variety of shapes and sizes of nickel particles.

The principles of the process are simple and have been described in detail by Antonsen [1] and Hayes and Antonsen [2]. Briefly, however, the process depends upon the ability of nickel to form gaseous nickel tetracarbonyl by reaction with carbon monoxide gas:

$$Ni + 4\,CO \rightarrow Ni(CO)_4$$

The reaction is reversible and by changing the conditions the nickel tetracarbonyl can be persuaded to decompose to form nickel metal and release carbon monoxide which can be recycled. The process has two very significant advantages. Firstly, because so few elements undergo this type of reaction the process is specific to nickel and therefore metal of extremely high purity is produced. Secondly, because the decomposition of nickel carbonyl is a vapour phase process the conditions under which the reaction takes place can be varied to produce a variety of shapes and sizes with a very high degree of control over these properties.

NOW AVAILABLE

COLOUR INDEX *International*

PIGMENTS AND SOLVENT DYES SUPPLEMENT

This Supplement contains new technical and chemical information relating to these colorants (previously published in Volume 8 and *Additions and Amendments No. 65-68*) together with completely revised C.I. Generic Names and alphabetical commercial names indexes. An alphabetical index of range names is included for the first time.

If you already have a copy of the 1982 PIGMENTS AND SOLVENT DYES volume, the SUPPLEMENT will update it to July 1988. A special annual issue of P&SD *Additions and Amendments* will be available from 1989 onwards.

Order (to be accompanied by remittance)
from: THE SOCIETY OF DYERS AND COLOURISTS, PO BOX 244,
BRADFORD BD1 2JB, WEST YORKSHIRE, ENGLAND
(except for orders from the Americas (excluding Commonwealth Countries),
which must be sent to AATCC, PO Box 12215, Research Triangle Park,
North Carolina 27709-2215, USA)

To: SODAC, PO Box 244, Grattan Road, Bradford, West Yorkshire BD1 2JB
I enclose remittance of £............
Please send me .... set/s of COLOUR INDEX "PIGMENTS AND SOLVENT DYES (THIRD EDITION 1982)" together with the "1988 SUPPLEMENT" @ £125

Please send me .... copy/copies of COLOUR INDEX "PIGMENTS AND SOLVENT DYES SUPPLEMENT 1988" @ £72.50

NAME ....

ADDRESS ....

....

Enter C211 on Reader Reply Card

PIGMENT HANDBOOK

3 Volume Series

Volume 1: Properties and Economics

Edited by P. A. Lewis, 2nd Edition, Publ. 1987, 974pp, Price £175/$260 (inc. of p&p)

Represents the expertise from worldwide authorities in the pigment industry, giving readers ready access to such topics as the physical and chemical meaning of colour, the worldwide market for pigments, and the properties and major reasons for use of each of the pigments covered in the text. Most chapters include a new and unique section concerning the effect of the pigment under discussion on human health and on the environment in light of new legislative standards.

Contents:

● White Pigments ● Extender Pigments ● Coloured Inorganic Pigments ● Coloured Organic Pigments ● Black Pigments ● Metallic Piogments ● Nacreous and Interference Pigments ● Luminescent Organic Pigments ● Fluorescent and Phosphorescent Inorganic Pigments ● Misc. Pigments: Cuprous Oxide, Mecuric Oxide, Modified Barium Metaborate.

Contributors include:

A. Walker—Anzon Ltd., F. Graser—BASF, M. McLaurin—Buckman Laboratories Inc., H. Breitschmid—Ciba Geigy, A. Gray—Dominion Colour Co., D. Gregg—Englehard Speciality Chemicals Div., J. Loya—Ferro Corp., P. A. Wriede—Heubach, A. C. D. Cowley—ICI Colours, D. Antonsen—INCO, T. E. Remmers—Manville, L. Greenstein—Mearl Corp., D. Keller—Pfizer Inc., B. L. Kaul—Sandoz, R. Ferguson—Silberline Inc., C. Thieme—Solvay & Cie, C. Lawson—Sun Chemical Corp., A. Harvey—RT Vanderbilt Co., J. E. Hall—Tioxide, M. Nowak—Troy Chemical Corp., K. Manchada—Union Carbide.

Volume 2: Applications and Markets, Publ. 1973, Price inc. p&p £150/$225.
Volume 3: Characterization and Physical Relationships, Publ. 1973, Price inc. p&p £130/$195.
Pigment Handbook — three volume set — Vol. 1, 2, 3. Price inc. p&p £430/$640.

ORDER FORM

To: **Oil and Colour Chemists Association, Priory House, 967 Harrow Road, Wembley, Middlesex HA0 2SF.**

Please supply .... copy(ies) of PIGMENT HANDBOOK, VOLUMES 1/2/3 (delete where appropriate) for .... (inc. of p&p) or the complete set of three volumes for £430/$640 (inc. of p&p). Cheques made payable to: OCCA — Post with remittance to the above address

Name ....

Address ....

....

Telephone ....

In general, the types of nickel powder particle which can be produced can be divided into two categories, spherical and dendritic. Figure 1 shows the appearance of a very regular spherical nickel powder produced by the carbonyl process. the regularity of the spheres is contrasted in Figure 2 with the irregular shape and size distribution of copper particles.

Figure 3 shows the structure of a dendritic nickel powder pigment (NOVAMET Nickel Type 525) produced specifically for use in shielding applications. The particle size distribution of this material determined by Microtrac analysis is shown in Table 2.

Dendritic nickel powders such as NOVAMET Type 525 are produced with a particle size distribution of this type since this gives rise to enhanced conductivity when the material is incorporated into an organic vehicle. For other uses, however, in particular the production of conductive inks, a much narrower range of particle size distribution, and frequently smaller overall particle size, is called for and for these applications spherical nickel is frequently the preferred form. Table 3 shows the particle size distribution of a highly refined nickel powder developed specifically for conductive applications where approximately 80% of the material falls in the range 4-11 microns.

Figure 1

Spherical nickel powder produced by the nickel carbonyl process.

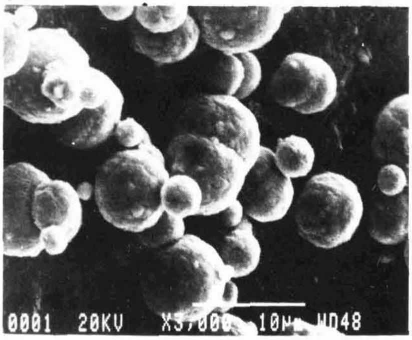


Figure 2

Spherical copper powder.

Figure 3

Dendritic conductive nickel pigment (NOVAMET Type 525).

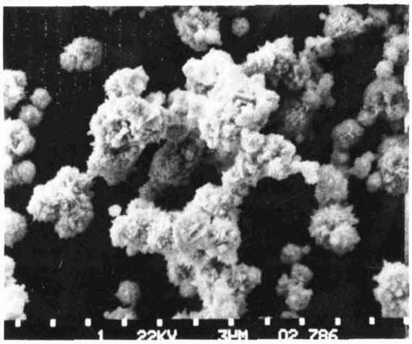


Table 2

Particle size distribution of filamentary nickel powder (NOVAMET Nickel Type 525)

Size (Microns)	%
<31	100.0
<22	72.3
<16	55.3
<11	41.8
<7.8	32.8
<5.5	15.7
<3.9	0.0

Table 3

Particle size distribution of refined nickel spheres.

Size (Microns)	%
<22	100.0
<16	97.4
<11	90.2
<7.8	72.1
<5.5	35.7
<3.9	10.2
<2.8	6.8
<1.9	2.7

Another property of nickel particles produced by the carbonyl process, resulting from their very high purity, is that they are ductile which enables them to be deformed by mechanical means to form flat metallic flakes. This is carried out by a ball milling process, described in detail by Antonsen[1]. The parameters of the flaking process can be closely controlled to give a morphology which maximises the electrical conductivity. In Figure 4 the structure of one such nickel flake pigment (NOVAMET HCA-1), developed specifically for the production of conductive organic-based coatings, is demonstrated. The thickness of the flake is in the region of 1 micron and the aspect ratio is typically between 20:1 and 30:1.

The effect of particle morphology on the electrical conductivity of organic coatings is quite considerable. Figure 5 shows the conductivity obtained when various concentrations of metallic nickel pigments, of different morphology, are incorporated into an acrylic type of vehicle. The materials produced were drawn down on glass plates to give coatings of wet film thickness 0.380 mm which makes possible the use of heavy pigment loadings without damaging the coating integrity. Resistivities were measured in ohms/sq using the technique described earlier[3].

It can be seen that the dendritic and flake type pigments produce similar conductivities for equivalent loadings, the dendritic giving rather superior results below about 39% nickel and the flake form somewhat higher conductivities above this nickel loading. Although the differences in conductivity look relatively small at the higher pigment loadings they are significant since as the technology develops coating producers are being called upon to provide higher and higher conductivity levels. Thus the minimum resistivity figure of 0.11 ohms/sq achieved in this work with the flake pigment is a practically useful improvement on the 0.22 ohms/sq which was the lowest figure obtained with the filamentary nickel.

The spherical nickel can be seen to produce much lower levels of conductivity over the whole range of pigment loadings. This might be thought to suggest that these materials are of no use at all in conductive coatings. This is not, however, the case since they are useful in conductive inks, where the small particle size and the very tight control which can be achieved with size distribution are very valuable in producing a material which can be more easily printed.

One further advantage of the flake morphology is demonstrated in Figure 6 where the dry film coating thickness of the coatings is related to the resistivity. The pigment loadings used were selected, using the results shown in Figure 5 to correspond to that at which the conductivity levelled out and were respectively, flake nickel 43%, filamentary nickel 37%, spherical nickel 70%. The results demonstrate that the flake, presumably as a result of its ability to pack more closely in the organic film, showed a reduced dry film thickness for a given level of conductivity. This is significant in practice since specifications governing coating application are frequently drawn up on the basis of coating thickness.

Coated particulate pigments

One of the classical ways of altering and enhancing the properties of any material, which applies to bulk products as well as to small particles, is by the provision of a surface coating which has different properties to the substrate. In relation to nickel and small particulate

Figure 4

Nickel Flake conductive pigment (NOVAMET HCA-1).

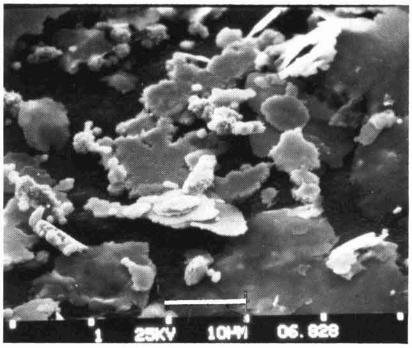


Figure 5

The effect of pigment loading on the resistivity of various conductive nickel systems.

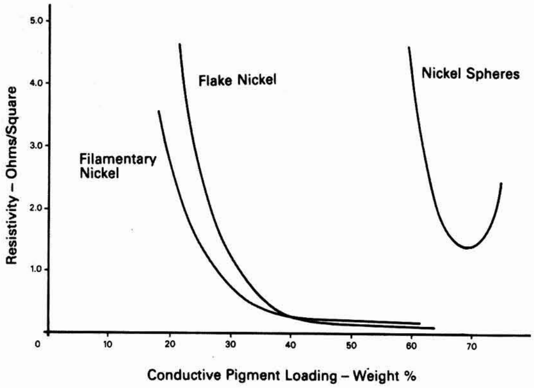
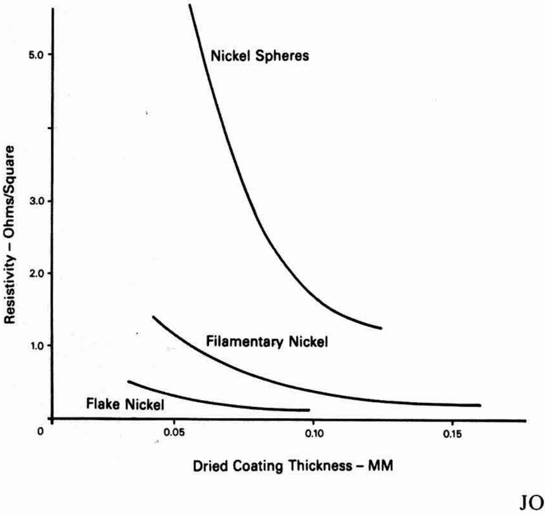


Figure 6

The effect of dried film coating thickness on the resistivity of conductive nickel systems.



pigments there are two ways in which this approach can be applied. Firstly, coatings can be applied to the surface of nickel pigments themselves. Alternatively, using the nickel carbonyl process described earlier, coatings of nickel can be applied to the surface of other substrate materials. A wide range of substances can be treated in this way providing they can be obtained in a particle size suitable to the vapour phase process. A limited number are of interest in the context of conductive pigments, however.

Silver-coated nickel

Because of its very high inherent conductivity, see Table 1, silver is obviously a very desirable material to use in R.F.I./E.M.I. shielding applications since it gives very good performance. However, the cost of this metal prevents its widespread use and it is normally only employed in applications, such as in the aerospace industry, where the expense is justified in terms of safety.

By coating silver onto a cheaper substrate material, however, a large degree of the inherent conductivity of the silver can be retained within the final coating system due to the fact that the conductive properties of the pigment particles are largely determined by their surface characteristics.

Nickel is in many ways an ideal material onto which to deposit a silver coating. Firstly, the technology for depositing silver onto nickel, using aqueous deposition systems, has been available for many years in the electroplating industry. The technology of these processes is now very refined and sophisticated which ensures a high degree of reproducability. Secondly, nickel already exhibits good electrical conductivity in its own right and it does seem advantageous to have an electrically conductive substrate for particles used in conductive applications. In addition to this the nickel particles have excellent mechanical properties which makes the coated particles very robust. Silver coating of glass particles can, for example, be carried out but the fragility of the substrate leads to problems both in manufacture and use in organic-based systems. One other advantage of nickel is that it retains its magnetic properties when coated with silver and thus a silver-coated nickel particle will have certain advantages in terms of its shielding performance compared even to pure silver.

The chemical stability of nickel and its relative dissimilarity in other chemical characteristics to silver also leads to the coated particles being very stable. The problem with silver-coated copper, for example, is that the copper is so similar in properties to the silver that it forms a solid solution at all proportions of the two metals. Consequently, there is a tendancy for the copper to diffuse into the silver layer if the material is heated to too high a temperature during any part of the manufacturing process or during use. This causes a discolouring of the material and will result in a loss of both conductivity and corrosion resistance. This restricts the use of silver-coated copper to manufacturing sytstems and applications where high temperatures are not encountered.

The range of particle shapes available with silver-coated nickel is not as large as for uncoated nickel pigments since it is not easy to process the filamentary types of material. Both spherical particles and flakes can be produced, and the silver content can be varied over a considerable range. It is normally considered that 15% silver represents the optimum amount for coating since this will reliably ensure that the surface of the nickel is substantially covered completely with silver. Thicker coatings of silver are employed for some special purposes but are naturally more costly.

Other coatings on Nickel

A number of the precious metals, such as gold and platinum, have been coated onto nickel particles to produce conductive composites. However, they are at present rarely used because of the very high cost.

Nickel-coated graphite

Of all of the materials onto which nickel can be coated graphite is perhaps the most potentially useful in the conductive coating field. It is chemically inert, mechanically robust, inherently electrically conducting and relatively cheap. It also has the added advantage of having a much lower density than metals which affects the final density of the coated particle. This has two advantages, firstly reducing the cost of any given volume loading and secondly producing less of a problem in terms of settlement of the pigment particles from the organic vehicle.

Figure 5 shows the structure of a typical nickel coated graphite particle, produced using the vapour phase carbonyl process. The metallic coating can be clearly defined against the darker substrate. A very wide range of nickel contents can be readily achieved from 25% to 85% nickel by weight. Due to the density difference, however, it is necessary to approach 50% by weight nickel before complete coverage of the substrate with the metal can be assured.

Nickel-coated graphite can be used to achieve a higher level of conductivity than pure graphite whilst offering a lower price than pure nickel pigments, principally due to the lower density of the particles. They are, however, a relatively new product and their full impact on the shielding technology scene has yet to be made.

Applications of nickel conductive pigments

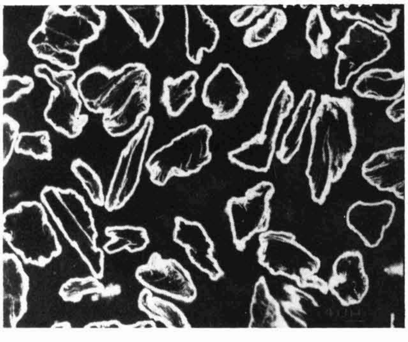
By far the greatest application of nickel conductive pigments is in wet paint systems, air-drying acrylic being one of the favoured media.

The process of formulating this type of paint system is quite complex. The basic requirement is, of course, to obtain as high a level of electrical conductivity as possible. In order to do this it is necessary, as well as selecting the correct conductive pigment, to ensure that the suspension of the

Continued on p.121

Figure 7

Structure of typical nickel-coated graphite particles.



Review of proposed *BS 8202: Part 2

Coatings for fire protection of building elements: Part 2: Code of practice for the assessment and use of intumescent coating systems for providing fire resistance

by C. Lloyd-Lucas, ICI Speciality Chemicals Group, 19 Broad Ground Rd, Lakeside, Redditch, Worcs B98 8YP, UK

Intumescent coatings are improving in performance and are becoming more widely accepted. However it is essential that they are correctly applied as their performance is based on chemical reactions to generate insulation as opposed to permanent insulation given by passive forms of fire resistance which are inherently easier to police from a QC aspect.

With such a state of affairs intumescent coatings became a candidate for a code or guidance document and in 1983 the Fire Research Station and the GLC prepared documents which subsequently with the assistance of manufacturers, regulatory bodies and test houses became the basis of a submission to BSI (Elements and Components for Buildings Standards Committee) and has become a proposed code now sent out for public comment.

The code's opening statement is that it is essential for manufacturers and suppliers to have a quality assurance scheme complying with BS 5750 which demonstrates the producer's commitment to quality.

Scope

The scope of the document does not include surface spread of flame but relates to coatings providing fire resistance and protection and includes appraisal and application methods, as well as the areas of durability and aging assessment and primer and top coat compatibility. The code ends with maintenance in use.

Definitions

The section on definitions naturally includes "intumescent coating" which bears stating here as there are different types of coating and this proposed code only relates to one type namely that which is used to achieve standards of fire resistance defined by BS 476: Part 21 (until recently known as Part 8). Also some readers may not be totally familiar with the term intumescent.

"Intumescent coatings react under the influence of heat by changing their physical and chemical structure. During this process the coating swells and foams and increases in thickness by producing a carbonaceous char which acts as an insulating layer for the substrate."

Validation

After the usual section on definitions there is a section on validation, basically requiring that evidence be provided that the code is met (i.e. test reports from NAMAS approved laboratories demonstrating achievement of performance criteria).

It explains that while any system changes may affect performance and should be tested it may be impractical on account of cost, and variables such as source of raw materials and range of primers; and concludes that such chemical or physical changes would require full retesting whereas detail changes may be validated using analytical or small scale testing (provided correlation is shown).

Also acceptable may be authorised assessments based on relevant data together with fire resistant tests where it is uneconomic to test all combinations of shape and size.

Choice of product

The choice is determined by uses, which are primarily to provide fire resistance and in some cases corrosion protection and decorative appearance to structural elements. This section is included for its information and example value. It also keeps the document in line with similar style codes.

Materials, surface preparation and finishing coats

The section starts with a description of the processes involved in intumescence and typical ingredients. With this background understanding the relevant parameters concerning the use of these coatings is more easily understood. Due emphasis is made on the importance of preparation as this effects performance. The surface preparation is typical for painting of structural steelwork (e.g. abrasive blast to SA 2.5) and the usual parameters concerning temperature, humidity and condensation are to be observed. The priming operation is not only crucial from the corrosion and bonding viewpoints but it is also essential to have a chemically compatible system (that is one that is the same generic type and with the same product name as that used in the full scale fire test). Any exceptions (e.g. barrier coats) must have fire test data to verify their acceptability and onsite tests must be supplemented by chemical analysis or fire tests.

Intumescent coatings can be of either "thin film" or "thick" film. Thin film are paints and typically are less than 2 mm thick, and up until recent times have not been as durable as thick film (3-20 mm) from a mechanical damage or an environmental exposure viewpoint. (If the film is epoxy based [thick or thin] it has generally superior durability characteristics compared to synthetic rubbers). Many thin film paints cannot achieve such high fire ratings as thick film which can achieve 90, 120 and in some cases 180 minutes and have a broader range of †P/A factor which in practice means they can protect very slender sections and are not restricted to the easier profiles ("I") but can protect rectangular or circular hollow section.

Also thick films can achieve higher ratings in more severe fires, e.g. Hydrocarbon than the BS 476 Part 21 heating regime. To achieve this sometimes some thick film intumescents use wire meshes either built into the matrix or applied to the surface. However, thick films are more expensive per square metre applied than thin films.

If a wire mesh system is used to bond the intumescent coating to the substrate the primer is not required to fulfil the bonding task provided such systems satisfy the firetest requirements. The

---

* This draft was prepared under the direction of BSI ECB/24 which was originally set up to draft a code for Sprayed Mineral Insulation which subsequently had its scope enlarged and became 8202 Part 1. The work of the committees continues as further codes are envisaged on related topics and all credit and acknowledgement is given to those at FRS, PSA and other bodies and organisations who have strived to produce the documents in this series.

† [A measure of heat sink, P/A or Hp/A is the ratio of section perimeter (in m) to cross sectional area (in sq m), ranging generally from 26 (large heat sink) to 400 (small heat sink) with 180 being a typical average member.]

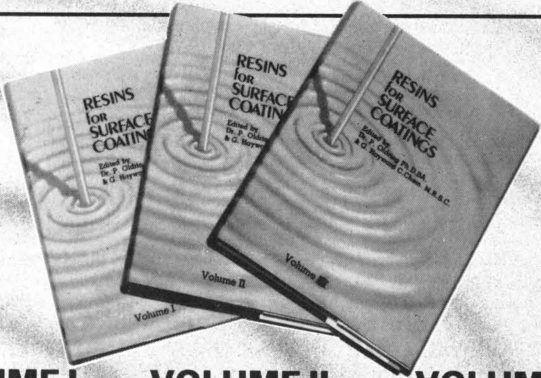
NEW JUST PUBLISHED

This major series of text books has been written by a team of specialist practising Chemists, working at the forefront of their technologies in the development of resins for printing inks, coatings and paints.

Their emphasis is on practical formulation for an extensive range of surface coatings to cover their applications throughout the industry.

RESINS for SURFACE COATINGS

Edited by:
P. Oldring B.A., Ph.D. and G. Hayward, C.Chem., M.R.S.C.



VOLUME I

An introduction to Polymer Science
Glyceride Oils
Hard Resins
Oleoresinous Media and Varnishes
Resin and Rosin Modifications
Alkyds and Alkyd Modifications

pp223

Price **£40.00***

VOLUME II

Epoxy Resins
Phenol-Formaldehyde Resins
Amino-Formaldehyde Resins
Polyamide Resins
Vinyl Resins
Acrylic Resins

pp350

Price **£45.00***

VOLUME III

Polyurethane Resins
Polyester Resins
Water Soluble Resins
Resins for Electrodeposition

pp320

Price **£45.00***

*Plus postal charge per volume of £4.00 for Europe. £7.00 for the rest of the world, post free for UK.

SPECIAL PRICES OF £115.00* FOR ALL THREE VOLUMES

ORDER FORM

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

Please supply .... copy(ies) of RESINS FOR SURFACE COATINGS, VOLUMES I/II/III (delete where appropriate) for .... plus p&p* .... or the complete set of three volumes for £115.00* plus p&p* ....

Name ....

Address ....

....

Telephone ....

Paint and Surface Coatings

Theory and Practice

NEW

Edited by R. LAMBOURNE,
Technical Manager,
INDCOLLAG (Industrial Colloid
Advisory Group), Department of
Physical Chemistry, University of
Bristol.

696 pages; Published April 1987; £84.30/$189.85
(incl. of p+p, overseas orders are sent surface mail).

CONTRIBUTORS:

D. A. Ansdell, Technical Manager, Automotive Products*.
J. Bentley, Senior Scientist, Research Department*.
T. R. Bullett, Retired. Formerly Research Director, Paint Research Association, Teddington, Middx.
A. Doroszkowski, Research Department*.
F. K. Farkas, Consultant, FKF & Associates.
J. A. Graystone, Technical Manager, Research Department*.
R. A. Jeffs, Retired. Formerly with Research Department*.
W. Jones, Research Department*.
R. Lambourne, University of Bristol.
A. H. Mawby, Director, Refinish Marketing, PPG Industries (UK) Ltd, Ladywood, Birmingham.
Miss J. F. Rolinson, European Technical Manager for Products and Materials*.
T. A. Strivens, Senior Scientist, Research Department*.
G. P. A. Turner, Technical Manager, Industrial Coatings Research*.

* ICI Paints Division, Slough.

CONTENTS: Paint Composition and Applications—A General Introduction; Organic Film Formers; Pigments for Paints; Solvents, Thinners and Diluents; Additives for Paint; The Physical Chemistry of Dispersions; Particle Size and Size Measurement; The Industrial Paint Making Process; Coatings for Buildings; Automotive Paints; Automotive Refinish Paints; General Industrial Paints; An Introduction to Rheology; The Rheology of Paints; Mechanical Properties of Paints and Coatings; Appearance Qualities of Paint—Basic Concepts; Specification and Control of Appearance; Durability Testing.

Orders can be sent to the association by completing the form below and by **Prepayment** only

ORDER FORM

To: Oil and Colour Chemists Association, Priory House, 967 Harrow Road, Wembley, Middlesex HA0 2SF, UK

Please supply .... copy(ies) of Paint and Surface Coatings at . . . £84.30/$189.85 per copy, price inclusive of p+p.

Cheques must be made payable to OCCA — Post with remittance to the above address

Name..

Address..

....

....

Telephone...

same principle applies to intumescent panels.

Regarding finishing coats, in the case of decorative and protective finishes it is essential that the intumescent coating's fire performance remains unaffected. Effects may occur in several ways, e.g. chemical effect, constraint of intumescence, coating weight or elasticity. The points to note on top, sealer coats are that the intumescents surface condition is optimised for maximum bond and that pigmentation will not usually effect fire performance.

For decorative coats the above factors apply but the focus is on the potential weight problem if repeated overcoating occurs. (Some thick film are not affected by such overcoating).

However generally the thin films are more decorative, flexible, have a large primer range, are easier to apply and are lighter. But each product should be looked at on its merits as there may be variance even within generic type.

Structural fire resistance

The concepts relating to fire testing, assessments and the factors influencing intumescent performance are outlined (as they have been above) and attention is drawn to specific important aspects, e.g. stickability – the ability of an intumescent product to remain in place during a fire (as this stickability varies with substrate shape and size, evaluation applies accordingly).

A warning is given regarding the enclosing of intumescent coatings so as to restrict their expansion if it affects the overall fire resistance performance. Likewise attention is drawn to the need for assessments to relate to dry film thickness performance and note reinforcement used such as scrim at edges.

Comment is made that for tension members assessments can be made from data based on compressive and flexural tests. Similarly data for cast iron, aluminium etc. can be based on criteria for steel members with the substitution made for the appropriate critical temperature.

The section on retention of protective coatings advises of the factors influencing char retention such as surface finish and primer, char adhesion, member shape and size, application conditions, and use of mechanical retention.

Attention is drawn to the fact that heating regimes other than those of BS 476 Part 21 may be required to meet special needs such as the heat curve for a slowly developing fire details of which are given in an appendix. (It was believed at one time that a fire regime of a more severe nature than BS 476 Pt 8 known as a "Fully developed natural fire" should be a mandatory test for intumescent coatings however after testing nearly all the coatings on the market it was found that all intumescent coatings behaved satisfactorily and the concept was dropped.)

Durability

One of the most important areas relating to intumescence is that of durability. While BS 476 Pt 21 states under the section on conditioning that a specimen shall have the strength and moisture content as it is expected to attain in service in a building, this in practice is not closely defined and difficult to police.

Comment in the market place has been that intumescent systems could deteriorate if exposed to high humidity inter alia and their subsequent fire performance could be adversely affected, unlike passive fire protection where the extent of such deterioration is self evident. In practice if such deterioration of intumescent coatings did take place it is also self evident. However this is one of the principal reasons for the drafting of this code and the section on durability should dispel the reservations regarding intumescent durability, as it specifies what durability tests must be undergone by intumescent systems (system=surface preparation, primers, intumescent and top coats as firetested) before they can be used in particular exposed site locations. (It is strongly argued by some that such durability tests should be included in similar codes for the same reasons.)

The section specifies a testing programme found by selection from a table (qv) the corresponding exposure situation for which the system has been designed. (The table under weatherometer refers to a figure which forms part of the code and details the orientation of the specimen in the weatherometer.)

The procedure states that for each test in this programme, one specimen (+ one as control) of equal size should be prepared with the intumescent system from the same batch, if practicable, and environmentally tested, and then subjected to the heating regime of BS 476 Pt 21 for nominally one hour. (30 mins testing is considered unsatisfactory as unprotected steel can under certain conditions last close to 30 mins.)

Each weathered specimen should achieve a fire resistance time within 25% of the fire resistance time compared to the control specimen and should not reach an average steel temperature greater than 550 deg C after at least 54 mins for satisfactory durability.

Specimens should be "I" sections of minimum serial size 152 x 152 x 37 kg/m, 500 mm long and minimum P/A=165 and the applied intumescent system must be within 10% of the dry film thickness (dft) when firetested to BS476 Pt 21 for the same time period.

Special environmental tests are believed to be beyond the scope of this proposed code, and in any event may be covered by various standards or specifications. However, it is recommended these be carried out as required and more common examples are listed such as mechanical and impact damage, high pressure washing and scrubbing, solvent and hot oil spillage, radioactive contamination, corrosive chemicals, hot and humid environments and gas and biological attack.

Site control

As least as important as any other part of the code is the section on site control as any inadequacies may result in poor fireresistance performance. This section is divided into "Before", "During" and "After" application to ensure actions are taken at the appropriate time. In the Before Application section, emphasis is placed on the execution of works by trained persons whose abilities (e.g. instruction concerning application procedure, material loading, thicknesses and quality checks) should be checked with the coating manufacturers' representative.

A specification should be provided consisting of:

1. exposure situation (as defined in table)
2. scope (e.g. steelwork size and area, number, lengths and kg/m of members) [kg/m because if this varies in a building, although the serial size is the same, the P/A varies and hence so may the required coating thickness]
3. thickness schedule giving which thicknesses are to be applied to which member (which may vary from member to member depending on P/A and number of sides exposed to fire)
4. primer and top coat details (including preparation and compatibility)

In addition to this schedule Health and Safety requirements should be complied with and a trial panel representative of the finishes expected should be produced for subsequent QC use.

During application a further checklist is provided detailing such matters as shelf life, storage, substrate preparation, monitoring of environmental conditions for compliance with manufacturers' instructions, wet thickness measurement, and means of

Table 1

Durability test programme

Exposure situation	External	Partial external with construction phase	Partial external (Exposed to UV and rain)	Internal with construction phase	Internal
Description	Fully exposed to weather, including ultra-violet light, temperature cycles, wind-driven rain, salt spray	Fully exposed to weather during construction and subsequently partially exposed	Partially exposed to weather (same conditions as external exposure) and subject to surface condensation	Partially exposed to weather during construction only	Not exposed to weather but subject to temperature and humidity variation over a range which could lead to condensation, e.g. cold bridging
Typical location	All external surfaces	Building not completely weatherproof during construction	Underside of external canopy. Steelwork set back from open facade. In lift shafts, or adjacent to external opening	Building being renovated	Building completely weatherproof at all times during and after application of intumescent coatings
Test Heat exposure 6 months at 50°C ± 2°C in a controlled environment	●	●	●	●	●
Washing 20 cycles, each cycle consisting of thoroughly wetting sample with a 2.5% solution of powdered soap water and leaving to air dry without rinsing	●	●	●	●	●
Freeze-thaw Cycle consisting of −20°C for 24h followed by +20°C for 24h	● 10 cycles	● 10 cycles	● 10 cycles	● 5 cycles	● 5 cycles
Sulphur dioxide BS 3900: Part F8 0.2 L SO_2 per 300L chamber	● 20 cycles	● 10 cycles	● 10 cycles	● 5 cycles	● 5 cycles
Humidity BS 3900: Part F2 or ASTM D2247	● 2000 hrs	● 1000 hrs	● 1000 hrs	● 500 hrs	● 500 hrs
Weatherometer BS 3900: Part F3 using beam (see figure 3)	● 2000 hrs	● 1000 hrs	● 1000 hrs	~	~
Salt spray BS 3900: Part F4	● 2000 hrs	● 1000 hrs	● 1000 hrs	~	~
Natural exposure a) industrial environment b) marine environment	● 2 years minimum	● 1 year minimum	● 0.5 year minimum	● 0.5 year minimum	~

Note 1: Where manufacturers can provide independent assessment of durability and fire testing, some or all of this test programme may not be necessary.

Note 2: Where intumescent coating systems are to be used in specific environmental conditions, other tests may be necessary.

Continued on p.115

An assessment of surfacing materials as barriers to formaldehyde in resin-bonded boards

by S. Dombey, Materials Technology Department, Furniture Industry Research Association (FIRA), Maxwell Road, Stevenage, Herts SG1 2EW, UK.

Abstract

A study has been made of commercial samples of board-surfacing materials, comprising paints, lacquers and impregnated paper foils, to test their potential effectiveness in controlling formaldehyde emission from aminoplast resin bonded core products.

Formaldehyde emission rate monitoring over a three-year period was conducted with a bench-scale apparatus especially designed for research and routine measurements in FIRA's laboratory based at Stevenage.

Polyurethane and polyester type finishes provided effective sealing once the coatings were dry. By virtue of their own emission of formaldehyde, acid-catalysed products could not be considered effective barriers for up to at least several weeks of aeration, i.e. exposure to air at room temperature to allow time for curing and loss of excess formaldehyde.

Microscopic cracks, developed in one paint over MDF (medium density fibreboard), increased emission, and the proven conservation of locked up formaldehyde within sealed boards highlight the need for a critical and cautious approach in selecting products for surfacing boards of high formaldehyde content.

Introduction

Free formaldehyde in resin-bonded products arises in two ways: from incomplete polymerisation with urea in the manufacture of products and hydrolytic decomposition of the cured resin following manufacture. In the first instance it is usually designated "residual" and in the second as "secondary" formaldehyde.

Formulae for the "simplest" fundamental unit of urea formaldehyde (UF) polymer have been suggested, though it is generally recognised that the structure of the fully cross-linked resin, though built on methylene and ether links, can be more complex. Strict chemical equivalents are rarely used in the manufacture of UF resins. The molar ratio of formaldehyde to urea used in a particular process is dictated by technical and other considerations and is normally less than the equivalents ratio 2:1. In general, the higher the molar ratio, the more cross-linked, hence the harder, the polymer. This can be a desirable feature in the manufacture of UF-bonded composite boards, for example wood particle board, medium density fibreboard (MDF) and similar products. High formaldehyde:urea ratios, however, lead to high residual formaldehyde content of new boards, which owing to increasing pressure on manufacturers to reduce formaldehyde levels, is a disadvantage.

Even though statutory requirements of formaldehyde-related industries to reduce environmental levels from emissions are on the whole mild in the United Kingdom, considerable reductions by resin and board manufacturers have been made in recent years, partly in response to economic pressure from overseas markets and partly in anticipation of likely drive for harmonisation of EEC standards.

Reduction in formaldehyde levels of unsurfaced boards can be achieved in several ways, of which the use of scavengers and lower molar ratios are the most important.

The technology based on the scavenger concept is still in its infancy and adequate information on their long-term effectiveness is lacking. Post manufacturing treatment of boards with gaseous ammonia is perhaps the most favoured technique based on this concept – it can be effective and is generally economical, but owing to the volatility of this compound its action stops once it escapes from the board. In the treatment it reacts with formaldehyde to form the solid compound hexamethylenetetramine and thus reduces the residual formaldehyde level of newly manufactured boards, but it is doubtful that post manufacture treatment of this kind can affect the generation of secondary formaldehyde through hydrolytic decomposition of the resin, the source that is becoming increasingly significant as the formaldehyde contents at manufacture are being reduced.

The nominal overall UF resin content of a conventional wood chipboard is about 10% by weight and the moisture content at 40%-50% relative humidity is about 8%, and it can be higher in more humid environments.

Not only is it an accepted fact that at high relative humidity the formaldehyde emission rate increases but some investigators have in fact also produced correction factors for emission test measurements when tests are conducted at relative humidities different from a standard.

Lowering the formaldehyde:urea molar ratio naturally cannot continue below levels at which desired physical properties of composite boards are beginning to become seriously impaired; and these levels have already been reached by some manufacturers without necessarily attaining the ultimate goal of extremely low emission rates in compliance with statutory controls in some countries.

In this situation impervious surfacing materials to control emission from composite boards are important.

Surfacing products have a dual role in this context, i.e. (a) containment of the formaldehyde within the core material and (b) stopping or reducing moisture up-take from the environment and thus minimising hydrolytic degradation of the resin.

Accordingly FIRA has recently carried out an experimental evaluation of samples of conventional surfacing materials, all industrial products, including wood veneers, impregnated wood-grain paper foils, lacquers and paints supplied to the cabinet furniture industry.

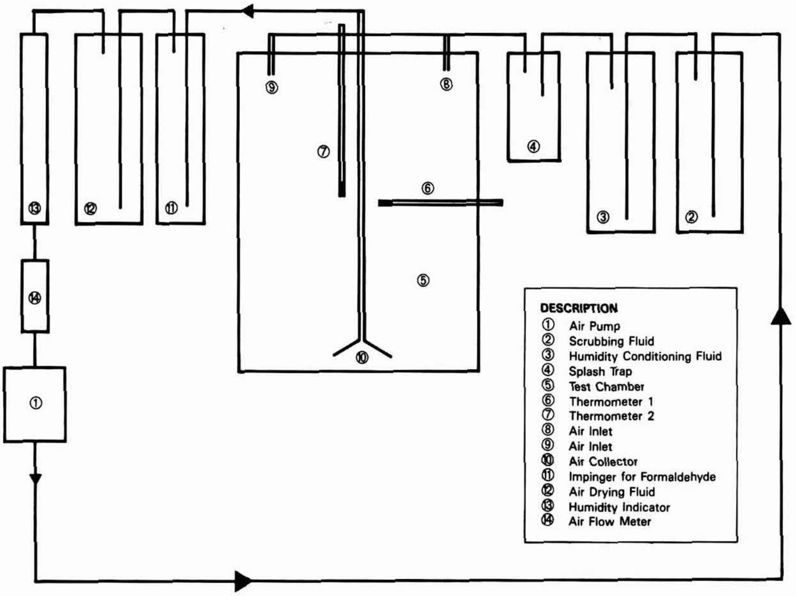
The FIRA method for emission measurement

A technique for measuring emission rates and long-term monitoring was specially developed at FIRA for this purpose and is described below.

The apparatus shown diagrammatically in Figure 1 was designed to accommodate samples of board and other sheet materials up to 300mm × 200mm in size in a closed chamber, through which humidified air is circulated by means of an external pump. The spontaneously emitted formaldehyde is thus swept from the chamber and the emergent air carrying it is passed through a solution of ammonium acetate within external impingers in

Figure 1

Semidiagrammatic plan of apparatus for measuring rates of emission of formaldehyde.



which the gas is trapped for analysis.

The air-flow rate is controlled to balance the emission rate and the test is normally conducted at, nominally, 45% relative humidity and 23°C temperature.

The mass of formaldehyde collected within the impingers over a 1-2 hour test period is determined spectrophotometrically, the preferred reagent in the present investigation being acetylacetone, with which measurements were made at 414nm wavelength.

A good correlation has been established between the FIRA method for emission measurement and the large-scale climate chamber tests designed for boards, and is supported by statistical correlation between each of these methods and the perforator value, i.e. the extractable formaldehyde content.

The main advantages of this method over the large-scale chambers are low operating costs, speed in conducting the tests and adaptability for products that are not really suited for the large-scale climate chambers, especially wood finishes, paper foils, adhesives and textiles.

A detailed discussion of correlation with the large-scale chambers and other methods will be the subject of another article.

The application of the FIRA method for coatings

Sample preparation (General)

This laboratory had no control over composition or manufacture of the products investigated, though the application of surface coatings to substrates consisting of industrial grade chipboard, MDF and sheet glass, was made in the author's laboratory, using conventional spraying and pressing techniques.

Following preparation, the test pieces were stored in a large open-plan laboratory, with free access of air being allowed to all emitting surfaces.

Emission measurements following brief periods of drying, were carried out at frequent intervals over a three-year monitoring period up to the time of writing.

Products evaluated

1. Paint systems for MDF

Like wood chipboard, medium density fibreboard is a porous product that can best be finished with liquid coatings, i.e. paint, if the surface is first sealed to prevent loss of finish, by diffusion, into the board.

Five cabinet grade coating systems namely a polyester, a polyurethane, a nitrocellulose and two acid-catalysed types, all comprising a basecoat/primer and a topcoat, were investigated. They were applied to a conventional board, perforator value 28g/100g, in accordance with common industrial practice, mainly by spray, unmodified in any way and thus by necessity the dry coating weights, determined in retrospect, were different for each system, though within the boundaries of $70g/m^2$ and 100g/m· for both basecoat/primers and topcoats.

The boards were stored, at laboratory temperature, with ambient air having access to all sides, for one week before emission measurements were commenced, then returned to their storage positions until the next measurements were taken.

The results obtained over a two year period of testing are shown graphically in Figures 2 and 3.

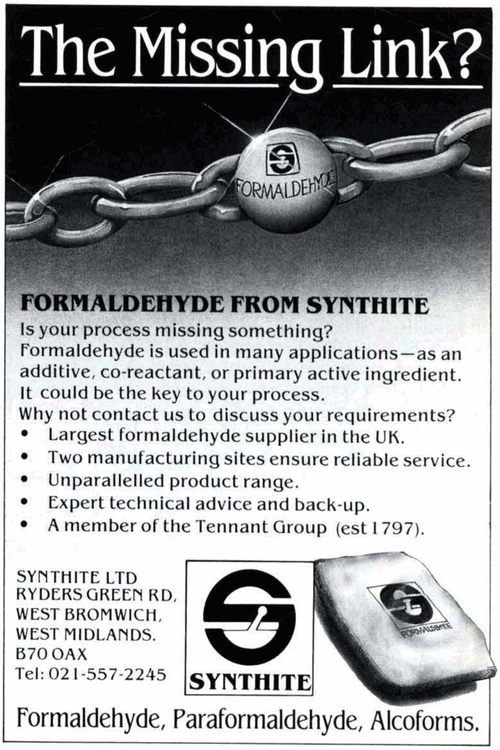
2. Resin-impregnated paper rolls

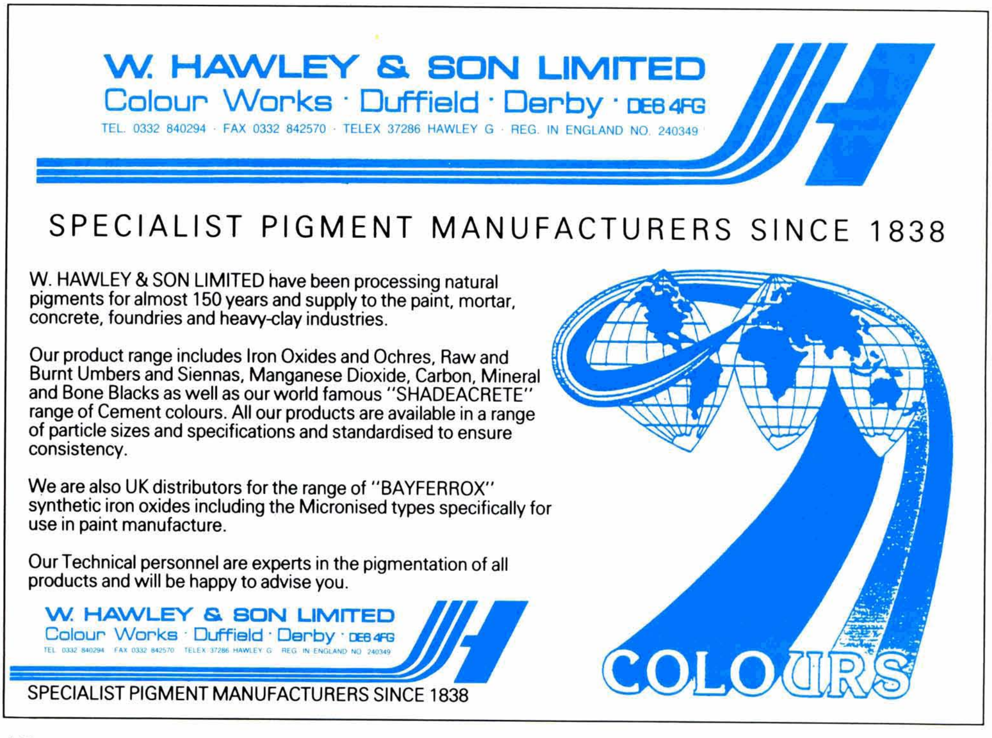
The materials used in this evaluation were standard commercial products, manufactured only a few weeks before their inclusion in the project. The technical data on their composition, and intended application, as supplied by the manufacturer, were as follows:

Foil A: $80g/m^2$ printed foil, containing 30% amino/acrylic resin and finished with $16g/m^2$ amino/acrylic lacquer, for use as decorative foil on chipboard.

Foil B: $105/m^2$ printed Kraftfoil, containing approximately 35% amino/acrylic resin blend; for use as an


150
148
525
75
135
100
95
800
105
130
300
JOCCA


FORMALDEHYDE
FORMALDEHYDE



interior lining for furniture.

Foil C: 80g/m^2 flexible interior foil, containing 30% amino/acrylic resin by impregnation; for use as balancing foil on panels surfaced with wood veneer.

The foils were stuck onto 300mm × 200mm, 15mm thick chipboard, perforator value 36mg/100g, with a pre-catalysed urea formaldehyde adhesive, hot pressed, and a general-purpose polyvinyl acetate adhesive. The aproximate spreads and the corresponding pressure times and temperature were:

UF adhesive, approx 70% solid: 100g/m^2, 120°C; 60 seconds, polyvinyl acetate adhesive, approx 40% solid: 160g/m^2; cold pressed for 16 hours, at 20°C.

An additional set of foil samples were fixed, without adhesive, onto 2mm sheet glass, for controls, the edges being sealed to confine formaldehyde emission to the face of the foil only.

Other controls consisted of unsurfaced board and one coated with polyvinyl adhesive minus paper.

Emission measurements were commenced after a lapse of 48 hours following preparation and regular monitoring was maintained for 36 months.

The course of emissions over a two-year period is shown by Figure 4 (UF-bonded), 5 (PVAC-bonded) and 6 (free foils).

3. Clear lacquers for decorative wood-based substrates, e.g. veneers

Crown-cut ash (Fraxinus excelsior) and straight-cut cherry (Prunus serotina) were adopted as examples of open-grained and close grained woods, hot pressed to chipboard (perforator value = 36mg/100g) with pre-catalysed UF adhesive, at 120°C for 60 secs.

The lacquers were:

a PU – diisocyanate-derived polyurethane, two pack

an AC – urea-formaldehyde type acid-catalysed, two pack

a PC – pre-catalysed resin-modified nitrocellulose.

The three lacquers were also applied to sheet glass to assess their own emission characteristics as well as to the veneered boards, two spraycoats with sanding in between. In sample preparation the aim was to simulate normal production procedures and no attempt was made to standardise strictly the application rate, though the dry coating weights were subsequently calculated once the lacquers were completely dry, and they were as follows:

Polyurethane	(A) :	83g/m^2
UF	(B) :	130g/m^2
P/C	(C) :	108g/m^2

Other controls consisted of unsurfaced chipboard and veneered chipboard.

Figure 2

Changes in the rates of formaldehyde emission, in the short-term, from four paint systems, consisting of sealer/primer and topcoat, upon MDF.

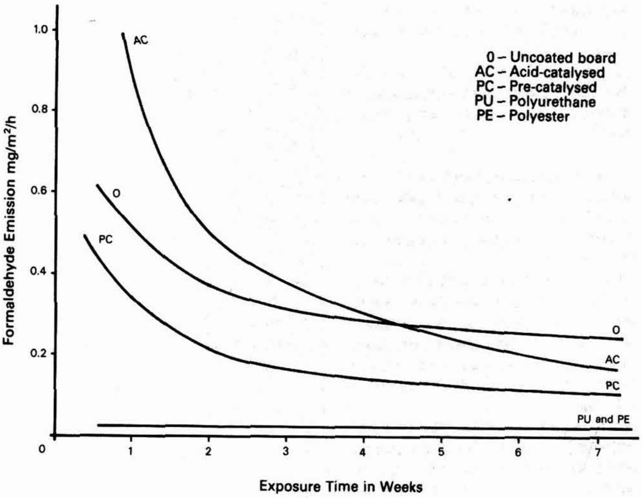


Figure 3

Formaldehyde emission from paint systems upon MDF in long-term exposure to air.

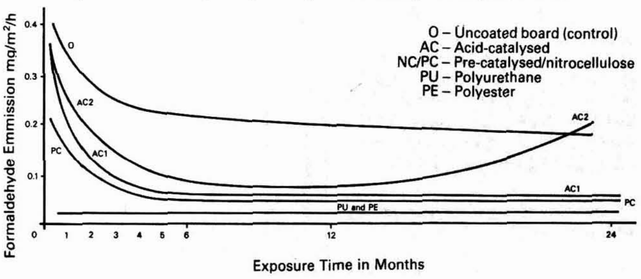
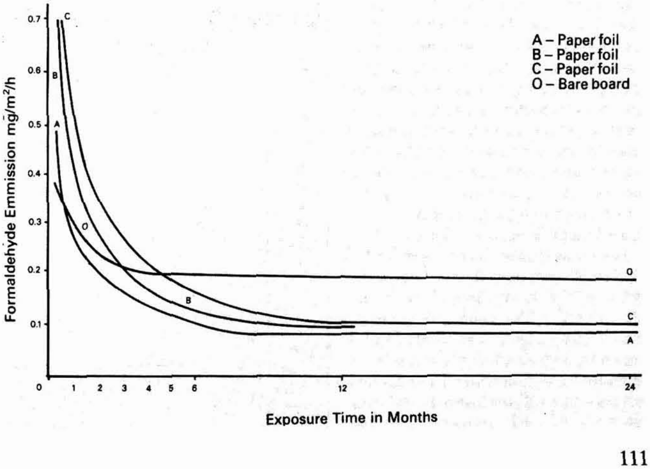


Figure 4

Evolution of formaldehyde from resin-impregnated paper foils, UF glue-bonded to chipboard, in long-term exposure to air.



The test pieces and controls were left exposed to air at laboratory temperature for one week before measurements were begun.

The results are shown graphically in Figure 7, 8 and 9.

Evolution of formaldehyde from acid-catalysed lacquers during early stages of curing

The materials supplied for this exercise comprised two standard commercial grade cabinet lacquers and two experimental products of undisclosed formulations.

The products were applied to 300mm × 200mm size glass sheets in identical wet film thicknesses but, owing to differences in the solid contents, the dry coating weights, which were determined in retrospect, varied between 50g/m^2 and 70g/m^2.

The coatings were flashed-off at room temperature, circa 20°C, for one hour, the air velocity past them being approximately 0.1 m/sec, then emission measurements were made at intervals for up to 24 hours. A final measurement was carried out 28 days later, during which time the test pieces were spaced out in the laboratory in the usual manner.

The test results are presented both in terms of emission rate (mg/m/^{2}/h) and as percentage weight loss of the dry film, calculated from the actual coating weights, Table 1 and are also shown graphically by Figures 10 and 11.

The benefit of stove-drying of A/C coatings

Although the emission rate from freshly applied acid-catalysed finishes initially declines rapidly at room temperature, experience shows that it could be from several weeks to two months before it reaches the region of 0.13mg/m^2/h, which is in the likely transition zone between E2 and E1 emission classes, as indicated by monitoring results. Since heat-assisted drying, including stoving, is consistent with present industrial practices, a brief investigation was made of the benefit of oven-drying a standard two-pack A/C lacquer, applied to veneered chipboard pressed some four years previously and whose emission rate by now was steady at 0.12mg/m^2/h at 23°C. (E1 class.).

The spray-applied finish was flashed off for 30 minutes, then it was oven-dried at 70°C for periods of 30, 60 and 120 minutes. The course of emission during subsequent weeks at 23°C is shown by Figure 12, from which it was apparent that following the maximum stoving time of two hours, the time lapse to the E1 emission rate was

Figure 5

Evolution of formaldehyde from resin-impregnated paper foils, PVAC-bonded to chipboard, in long-term exposure to air, and controls.

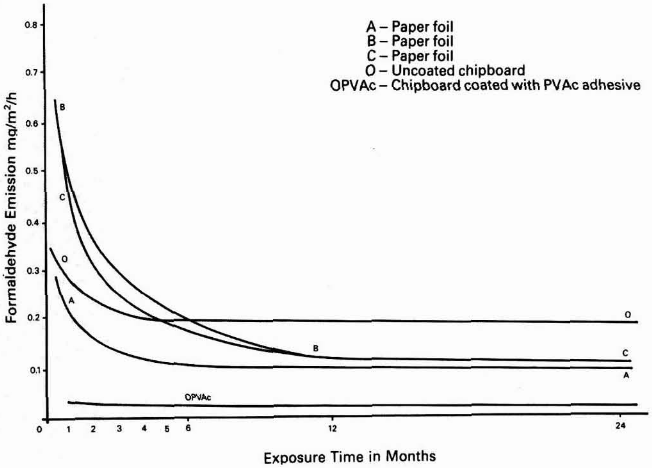


Figure 6

Evolution of formaldehyde from three resin-impregnated paper foils, unbonded, on sheet glass support.

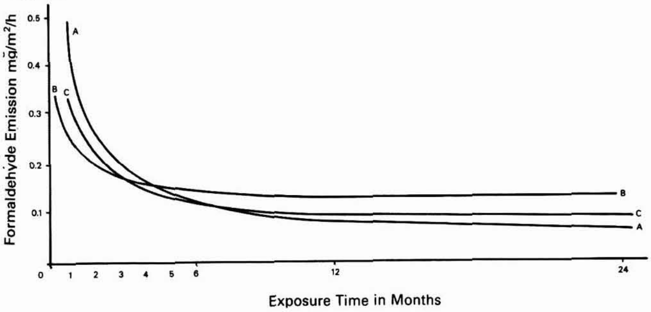


Figure 7

Changes in the rates of formaldehyde emission, in the short-term, from three lacquers applied to ash veneer bonded to chipboard with UF glue.

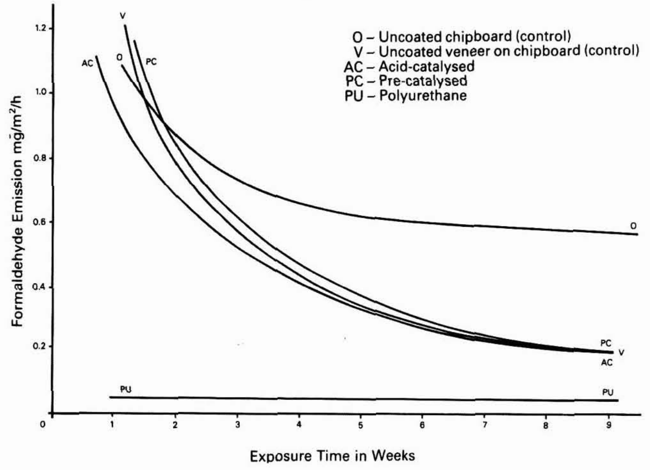


Figure 8

Emission of formaldehyde from three finishes upon ash-veneered chipboard and controls in long-term exposure to air.

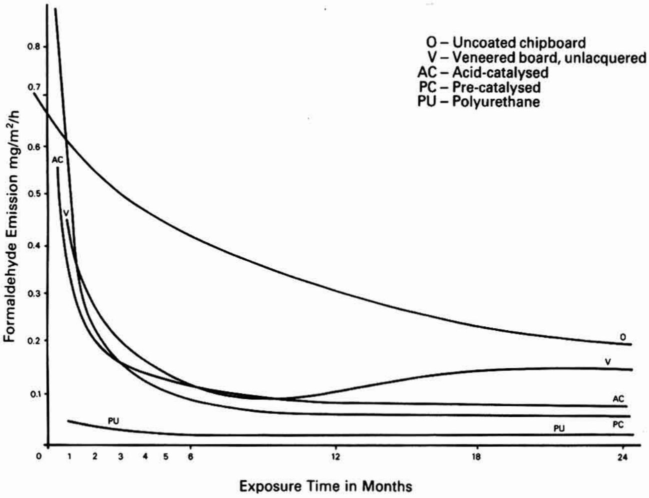


Table 1

Evolution of formaldehyde from fresh films of acid-catalysed lacquers on sheet glass during curing.

Lacquer number	Time in hours following casting	Formaldehyde, rate of release	
		mg/m²/h	% wt. on dry film
1	1	41.3	0.052
	2	34.0	0.042
	6	20.0	0.025
	24	8.6	0.010
2	1	48.5	0.080
	2	39.5	0.065
	6	23.5	0.039
	24	11.3	0.019
3	1	34.7	0.062
	2	27.7	0.050
	6	18.0	0.032
	24	10.2	0.018
4	1	13.0	0.029
	2	11.2	0.019
	6	4.2	0.009
	24	3.1	0.007
1	Following 28 days' exposure to air	0.33	0.004
2		0.88	0.014
3		0.78	0.014
4		0.13	0.003

reduced by about 15 days when compared with the control. The initial emission rate during the first 24 hours of exposure following stoving was, however, reduced by 80 per cent.

Evidence of long-term effectiveness of surfacing materials for boards

At the time of writing, the monitoring of the emission rates from a paper foil-faced chipboard and an A/C painted MDF had been maintained for two years, by which time the emission had long been steady at low levels as shown in Table 2.

To determine the fate of formaldehyde locked up in the boards, the surface coatings and the adhesive, under the paper, were removed by sanding, the bared boards were aired for 48 hours, then the emission rates were measured and the extractable formaldehyde contents (perforator values) determined as in BS 5669.

The results were compared with those obtained at the beginning of the tests two years earlier and are presented in Table 2.

Discussion

Finishes that are free from aminoplasts, i.e. polyurethanes and polyesters, paints as well as lacquers, can form effective barriers to formaldehyde within boards, as soon as dry, provided they are applied in conventional thicknesses and are free from proneness to suffer physical break-down, e.g. cracking or flaking. Coatings based on polyurethane and polyester resins can therefore constitute ideal materials when instant sealing is essential.

The effectiveness of surfacing materials containing amioplast resins could not be ascertained until their own emission rates decreased to a sufficiently low level; this situation took at least several weeks to reach in most cases, depending on formulation. It must be noted that the initial high emission rate and the rate of decline are governed not only by the molar ratio or the proportion of aminoplast to other film-forming solids – the curing rate, i.e. the speed of polymerisation reactions, as function of catalysis, is just as important. The initially high emission rate experienced with pre-catalysed (slow curing) finishes may be explained in this context: weak catalytic action in P/C systems prolonging the curing time, during which emission rate is relatively high.

The liability of acid-catalysed finishes to suffer cracking in use carries some risk of reversion to higher emission rates from boards, i.e. loss of effectiveness in the long term, as has been experienced with an acid-catalysed paint (Figure 3).

The emission through uncoated veneers can be considered as of little consequence, since veneers are normally lacquered in cabinet furniture application, though an element of risk is implicit with inadequately sealed balancing veneers on interior surfaces.

Unlacquered veneer and paper foil can constitute a more or less continuous pathway for formaldehyde in the core board to the surface. Being fibrous they also allow absorption of water vapour from the environment, thus enhancing hydrolitic break-down of UF resin, in the glue line at any rate. Monitoring the course of emission over a two-year period suggests that in normal atmospheric environment the emission rate from or through paper foils can settle and proceed at a steady pace that can be above E1 class level, without much indication of further decline in the immediate future. In fact the emission through unlacquered veneer may even increase after an intermediate period of apparent stability (Figure 8).

Comparison of amino resin surfacing products applied to inert support (glass) with those on wood-based substrates suggests that, provided the coating was free from defect, the formaldehyde emitted came from the coating; the contribution of the UF glue beneath the paper foils and veneer was negligible, and the PVAC adhesive was proved to be an excellent barrier in its own right.

Conclusion

The conservation of free monomeric formaldehyde within well sealed core products, as revealed when the coatings were removed from board following a long steady state period of emission (Table 2) can not only illustrate the potential effectiveness of surfacing materials in controlling formaldehyde emission levels, it also highlights the risks of inadequate surfacing and spontaneous degradation of conventional coatings, terminating their usefulness. It is noteworthy that the early formaldehyde-related customer complaints this laboratory was asked to investigate concerned domestic cabinet furniture in chipboard, with inadequate lining or sealing of interior surfaces. In poorly ventilated environments objectionable concentrations were experienced and the installations had to be withdrawn.

The results of research reported here can leave no doubt that surfacing materials will gain increasing importance in the control of formaldehyde emission from composite products bonded with aminoplast resins.

Figure 9

Changes in the rates of formaldehyde emission, in the short-term, from three lacquers applied to glass.

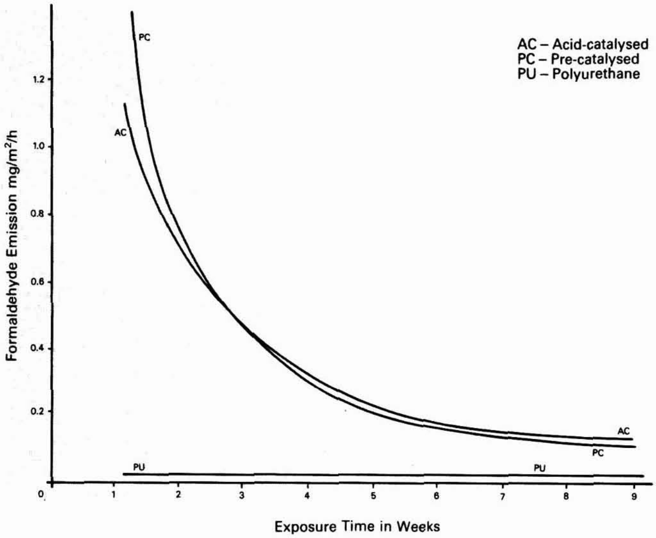


Figure 10

Evolution of formaldehyde from four acid-catalysed lacquers upon sheet glass during curing.

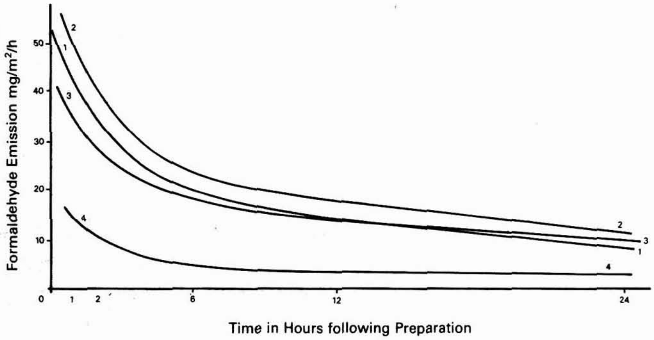


Table 2

Formaldehyde contents and emission rates of boards (a) before coating, (b) before and (c) after removal of coatings following long-term storage.

	Perforator value, mg/100g		Emission, mg/m²/h		
Substrate	before	after	at beginning	before sanding off finish	after sanding off finish
chipboard	36	39	0.92	0.07	0.98
MDF	38	42	0.78	0.03	1.10

Figure 11

Evolution of formaldehyde from four acid-catalysed lacquers upon sheet glass as percentage loss of coating weight, during curing.

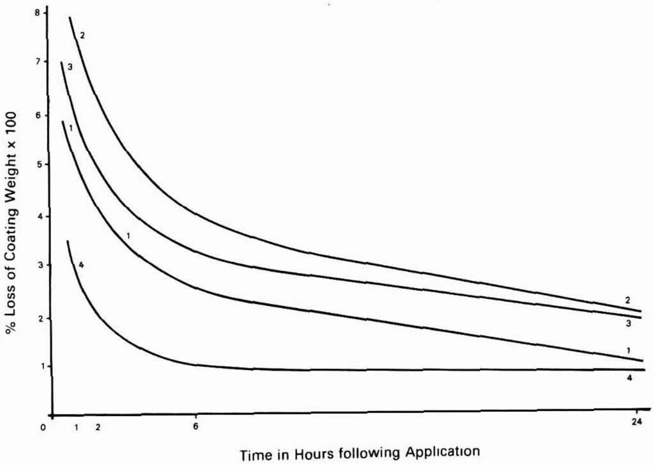
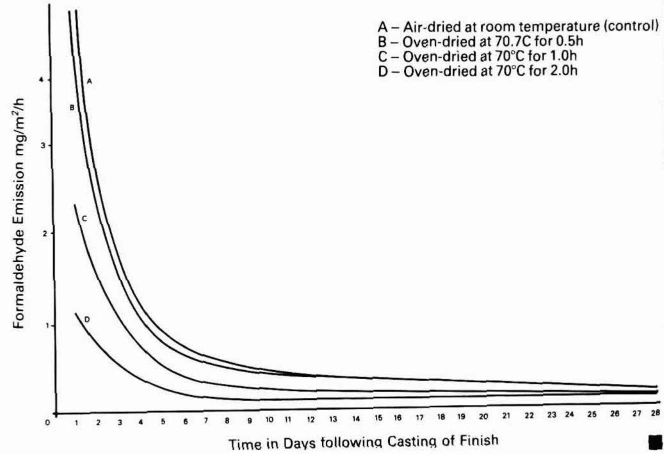


Figure 12

Acid-catalysed lacquer on veneered board: The effect of oven drying on subsequent formaldehyde emission.



■

Continued from p.106

application (e.g. spray, trowel etc).

After application a final checking of dry thickness is recommended at 500 mm intervals [minimum 3 readings] and if the standard deviation from the mean is more than 15% remedial action is to be considered in detail by the inspector.

Finally the client should be advised that the process is complete.

Maintenance

The last section is Maintenance and it is recommended that maintenance schedules be provided to ensure the intumescent coating is not degraded. The schedule may well embrace maintenance of the top sealer coat and inspection for mechanical damage (assessed by durability testing) and its repair as well as washing down and overcoating procedures. Finally the schedules need to state that the coating gives the fire protection to the substrate and must not be removed unless replaced by alternative fireprotection systems.

The code ends with the usual list of publications referred to in the text and appendices detailing (A) alternative heating conditions to those of BS476 Pt 21 (~ Hydrocarbon and slowly developing fires) and (B) structural fire protection of bulkheads and decks.

Summary

At the time of writing the code is still in draft form in as much as public comment has yet to be considered and it could therefore appear in a different form from that above. Nevertheless the data remains as a basis on which to build especially with the 1992 European harmonisation in mind and if followed should ensure problems relating to intumescent coatings are kept to the minimum with what is a very convenient way of achieving fireresistance. ■

COSHH and the Paint Industry

Paintmakers' Association Initiatives

Without doubt the Control of Substances Hazardous to Health Regulations (COSHH) represent the most significant development in occupational health legislation since the Health and Safety at Work etc Act was introduced in 1974. Now that the regulations have been published and the Health and Safety Executive has begun to issue its various pamphlets, guidance notes and approved codes of practice, a clearer picture is beginning to emerge of the provisions of the Regulations and the actions which have to be taken to conform with their requirements.

However, both these official publications and the many excellent commentaries and explanatory articles on COSHH which have been published in recent months in trade, occupational health and safety magazines and journals can only go so far in being of value to particular market and end use sectors and to individual companies and employers.

That COSHH is workplace specific is undeniable – after all the fundamental objective of the Regulations is to safeguard employees who are exposed at work to substances hazardous to their health. As a result employers, particularly those smaller and medium size companies who may not have an existing infrastructure and support system of professional safety officers, occupational health advisors or medical facilities, may find their interpretation of the regulations difficult. Uncertainty and doubt may arise on the correct action, and the extent to which action needs, to be carried out in any particular situation. The paint industry will certainly be no different from many others in this respect.

It is however important to realise that COSHH does not impose many new duties on employers or employees. It sets out the basis on which existing duties can be complied with. In a lot of cases, employers will find that many of the requirements of COSHH have already been put into place as a result of earlier initiatives. Following on from the introduction of the Health and Safety at work Act and through adopting a responsible approach to employee health and safety much will already have been done.

Where COSHH develops on from earlier legislation is in the need to keep comprehensive records of actions carried out in the course of implementing the laid down duties, in the need to develop a systematic approach to hazard identification and risk assessment and in follow up monitoring of both control systems and employee health.

The Regulations themselves detail the requirements which need to be effected if an employer is to fulfil his duties as defined by COSHH. The requirements fall into five broad categories:

☐ an assessment of the risks to employees' health through exposure to hazardous substances
☐ the establishment, use and maintenance of appropriate measures to prevent or control exposure
☐ the ongoing monitoring of the workplace
☐ the health and medical surveillance of employees
☐ the provision of information to, and instruction and training of, employees in relation to their exposure to hazardous substances.

COSHH applies to any substance (which in the context of the legislation includes single substances, intermediates and mixtures in solid, liquid or gaseous form) which

☐ is classified as very toxic, toxic, harmful, corrosive or irritant under the Classification, Packaging and Labelling of Dangerous Substances Regulations
☐ has a maximum exposure limit specified in the Regulations or for which an occupational exposure limit has been approved
☐ is a microorganism creating a health hazard
☐ is a dust of any kind, present at higher than prescribed concentrations in air
☐ is anything not in the above, but which creates a comparable health hazard

Excluded from the scope of the Regulations are substances to which
The Control of Lead at Work Regulations 1980
or The Control of Asbestbos at Work Regulations 1987
are applicable. Additionally, substances which are hazardous to health solely because they are radioactive, explosive or flammable or are at high or low temperature or high pressure are excluded.

The outcome of the applicability criteria is that the paint industry clearly and firmly comes within the scope of COSHH.

The Paintmakers' Association, recognising the limitations of the information available, and its specific value to paint manufacturers has established a number of initiatives on behalf of its members and the industry. Firstly an **interpretative guide** is in the course of publication. This will provide guidance to paint companies on the various requirements. Specifically it will identify those critical and important factors allowing a proper and adequate assessment of the risks to be carried out, and the various control, monitoring, surveillance and training provisions of COSHH to be established.

PA is also issuing a series of **bulletins** to its members. These contain topical advice and updating information. They also serve to remind companies of the actions they need to take now to ensure that assessments and control and monitoring procedures are in place if the implementation dates of 1 October 1989 and 1 January 1990 are to be met.

Publication of the guide will coincide with a series of **seminars** around the country. As well as expanding on, and clarifying, relevant aspects of the Regulations as they apply to the paint industry, the presentations will also include workshop sessions. These will enable participants to raise specific issues and concerns.

The **seminars** are scheduled to take place in **Birmingham (4 April), Manchester (5 April), York (6 April), Newcastle (7 April)** and **London (20 April)**. They will begin at **9.30 am** and conclude in time for a buffet lunch. They are designed as a member benefit only, and will be free to employees of both full and associate, material supplier member companies. However, companies who intend to join PA and have made a commitment to do so in advance of the seminars, will be able to arrange to send appropriate staff on the same free basis. Details of such registration (subject to space being available) can be obtained from **A. J. Newbould, Technical Manager, Paintmakers' Association, 93 Albert Embankment, London SE1 7TY. Tel: 01-582-1185, Fax: 01-735-0616.** ■

From the General Secretary

Jordan Award

The Jordan Award Committee, under the Chairmanship of the Honorary Research & Development Officer, Dr Simon Lawrence, convened on 15 February to consider nominations received for the prestigious Jordan Award to be presented at the Chester AGM.

Disappointingly, only two papers were submitted for consideration by the Committee, reflecting perhaps the narrow terms of reference for the Award which restricted nominations from those aged under 35 at the time of publication of their paper. Nevertheless, the papers considered were both of a high standard and the Committee were of the unanimous opinion that the paper submitted by Iain Melville, describing work undertaken in collaboration with Leslie Simpson, both of the Tioxide Group of Laboratories and entitled "Wood Finishes – Field and Laboratory Tests" would receive the Award for 1989. The Committee also decided that the value of the Award should increase to £200 together with a commemorative scroll.

The Committee volunteered to expand its activities to include the evaluation and award of the Ellinger-Gardonyi Medal to be first presented at the Chester Conference. The Medal will commemorate the memory of Dr Marianne Ellinger, a great supporter of OCCA technical meetings and whose very generous bequest provides the financial base for the shortly to be announced Ellinger-Gardonyi Trust Fund.

The Medal will be awarded to the author of the best paper presented at the Biennial OCCA Conference and will be judged on the technical merit of the paper, rather than on its presentation.

The Ellinger-Gardonyi Bequest has taken a considerable time to register with the Charity Commissioners but it is hoped that registration will be completed in time for the April meeting of Council. Past President Frank Redman has been charged with preparing a report for Council on the application of the Trust Fund and as part of a very wide consultative exercise has consulted with all the major paint producers and raw material suppliers. The positive response from industry and helpful suggestions put forward will ensure that the Trust Fund is applied to the maximum benefit of the industry and Association and will enable many projects that would otherwise fall by the wayside through lack of funds to proceed. Full details of the Trust Fund and its application will feature in future issues of *JOCCA*.

OCCA International

The Association has certainly not allowed Frank Redman to gracefully fade away since stepping down as President and in addition to his responsibilities for the Ellinger-Gardonyi Trust Fund he has also accepted President John Bourne's invitation to become the new International Secretary of OCCA International.

OCCA International is an informal grouping of national paint societies, established in 1984 to foster close relationships between individual sections and through the sections' members world-wide. The founder Secretariat was provided by the Australian Association, with Tom Backous the first International Secretary. Its principal product has been a series of six Newsletters with limited distribution being principally through Sections rather than to individual members. With the transfer of the Secretariat to the UK it is likely that there will be a re-think on the aims and objectives of the organisation and this topic will be one of the agenda items to be considered at a shortly to be convened meeting of Past Presidents.

One likely change is that future issues of the Newsletters will be carried as printed copy within *JOCCA* and in other surface coating journals rather than being distributed as a free standing Newsletter. The first issue of the Newsletter will include a progress report on the establishment of a unified professional qualification for surface coating technologists and the launch of the Ellinger-Gardonyi Trust, in addition to details of the new Secretariat and its transfer to the UK. Future issues will concentrate on items of an international relevance or those that transcend national consideration. One of the difficulties and criticisms of the previous Newsletters has been that they did not feature sufficient news from outside Australia. This was through no fault of the Australian Secretariat but reflected lack of interest in the submission of articles from other Associations. It is hoped that this will not be repeated in the new style Newsletter, but will depend on the submission of articles and news items by other associations and sections.

Readers of this column may well question the significance of OCCA International and in particular what additional functions it performs other than those already provided by the Association through its international role and by other organisations including FATIPEC and ICCATCI. Frank Redman would be most interested to hear any comments you have on OCCA International, its role and purpose. Your comments should be addressed to Frank at Priory House. ■

Forthcoming OCCA Events

14-15 March 1989
Jnt OCCA/PRA Symposium "The Role of Surface Coatings in Fire Protection", Heathrow, London.

21-24 June 1989
OCCA Chester Conference.

Hull Section

Printing ink technology

The second meeting of the session was held at the Duke of Cumberland, Cottingham, on 7 November, 1988. Members and guests heard Mr G Hutchinson, Consultant to Croda Inks, deliver a paper entitled "Prospects and Problems In Printing Ink Technology".

The paper which will be published in a subsequent issue of *JOCCA*, centred on how developments in inks had met the challenges of faster press speeds, new and more difficult substrates, health and safety legislation, environmental considerations and raw material difficulties, in an increasingly competitive market.

As usual, Mr Hutchinson captured and held the interest of his audience with his great knowledge of the subject and enthusiastic style. He went on to deal with a number of questions from the floor concerning newsprint quality, smearing and the varying rates at which water-based systems are replacing solvent-based inks, depending on the segment of the industry being considered.

A vote of thanks was proposed by Mr P. A. Bentley and readily endorsed by the audience.

D. Robinson ■

London Section

Bridge corrosion

The third technical meeting of the London Section for the 1988/89 Session was held on Thursday, 17 November 1988, at the Naval Club, Hill Street, London. Mr Neil Tasker of Buckmann Laboratories gave a talk entitled "A 5 Year Bridge Corrosion Study".

Mr Tasker's talk centred on the performance of modified barium metaborate when compared with a modified zinc phosphate and calcium borosilicate. All three are commercially available corrosion inhibitors free of lead and chromate. To introduce the bridge study the Speaker presented a set of slides illustrating the superior performance of the modified barium metaborate corrosion inhibitor during a salt fog test covering several primers.

The Speaker explained that in the bridge study the three corrosion inhibitors had been formulated into similar paints by an independent paint manufacturer. The paints were applied using identical conditions to the steel stringers of three bridges situated in a similar environment. Slides taken after four and five years illustrated the deterioration of each type of coating. Corrosion was shown to be worse on the bridges protected by paints based on zinc phosphate and calcium borosilicate. Both these bridges required repainting after five years. In concluding his talk, the Speaker stated that the third bridge, painted with the paint containing barium metaborate, was still in good condition after eight years.

A lively discussion period followed where the ability of barium metaborate to perform in a "truly" marine environment was questioned. Some of the differences between the European and American markets were also emphasised. A vote of thanks was given by Brian Gilliam and those attending were able to enjoy an excellent buffet hosted by Buckmann Laboratories.

D. Tooke-Kirby ■

Manchester Section

Anti-corrosive pigments

On Monday, 9th January 1989, Manchester Section embarked on a new venture, holding a joint meeting with the North West Branch of ICorrSt at the Mechanics Institute, Manchester. This was the first ever joint meeting held by the two organisations and was attended by 67 members and guests.

The speaker, Dr. Nigel Whitehouse, Pricipal Scientific Officer of the Paint Research Association, introduced by Barry Windsor, Vice-Chairman of the North West Branch of ICorrSt, presented a paper entitled "Anti-Corrosive Pigments – Shape, Science or Simple Serendipity".

Briefly describing the corrosion mechanism of iron, the lecturer explained how this can be inhibited by suppressing either the cathodic reaction, the anodic reaction, or the flow of electric current. Corrosion inhibitor is added in low levels to the corrosion enviroment to reduce corrosion rate. Historically red lead and zinc chromate were considered to be the two staple anti-corrosive pigments, but can no longer be regarded as such.

From the red lead reaction mechanism, AZELATES were investigated as possible anti-corrosive pigments. Only magnesium azelate showed any promise, but it has proved to be difficult to make on a commercial scale.

Zinc phosphate is the major product marketed as a replacement for red lead and zinc chromate. It is of low toxicity, but is not very reproducible. Attempts to improve performance by combining zinc phosphate with borate, or micronisation have been looked at, the theory behind the anti-corrosive properties of zinc phosphate being briefly described.

As an alternative to zinc phosphate, molybdate, zirconate, and tungstate have been investigated, but the overall costs are very high, and they have been blended with inert core pigments to reduce costs.

There have been a number of recent innovations regarding anti-corrosive pigments. Ion exchange pigments were briefly described, these being promising in the laboratory, but not good reproducibly on a commercial scale. Aluminium Triphosphate has been developed in Japan, its anti-corrosive mechanism was illustrated, and its use in combination with zinc phosphate particularly on galvanised steel outlined. Rare earth metals are being investigated as a basis for possible anti-corrosive pigments, however there is little information available on those, although some do show some promise. Tannates are well-known, and their source and mechanism was described. From this Iron Tannate is developing, but only low non commercial yields can be obtained at the moment. Barium metaborate is very popular in the USA its proposed mechanism was described and its properties and uses briefly outlined.

Ferrites are another type of anti-corrosive pigment of fairly recent origin, their reaction mechanism being illustrated by the lecturer who concluded this aspect of the talk by outlining work carried out at the PRA in recent years on other possible anti-corrosive pigments.

Looking to the future, requirements for a successful corrosion inhibitor area:

☐ Effective pH 6 to 9
☐ Low but effective solubility
☐ Reaction must not adversely affect the coating
☐ Inhibit both anodic and cathodic reactions
☐ Reaction products to be of low solubility and protective

After an extensive and lively question and answer session, the vote of thanks was proposed by Fred Morpeth, Chairman of OCCA Manchester Section. The lecture was followed by a mini-exhibition, the exhibitors being Buckman Laboratories, N.L./Steetley, Heubach and Lawrence Industries, and the evening concluded with a buffet partially sponsored by the exhibitors and subsidised by both Manchester OCCA and ICorrSt.

M. G. Langdon ■

Newcastle Section

Fungi and wood

Some 45 members and guests attended the third meeting of the 1988/9 session at St Mary's College, University of Durham, to hear Mr Len Tasker of Buckmann Laboratories give a lecture on "Fungi and the Deterioration of Wood".

Mr Tasker began by describing the various forms of fungi which attack wood, i.e. the moulds, stains and parasitic (rotting) types. They do not contain chlorophyll and therefore do not need sunlight for propogation; they are spore bearing, often reproduce asexually and spread through wood via filamentous growths (hyphae) along sap canals and through cell walls. They require oxygen, moisture and a temperature range of 15-30°C for significant multiplication. These points were illustrated by a series of coloured slides showing hyphae for mycellial masses, spores (fruiting bodies) and a diagram showing a typical life cycle.

Next, Mr Tasker contrasted the effects of the various fungi. Moulds and stains deeply penetrate wood, the former showing masses of coloured spores at the wood surface and the latter staining the bulk of the wood a specific colour, e.g. blue, brown, orange, grey, etc. Whereas both increase wood porosity greatly, stains do not weaken the wood as drastically as moulds. Rotting fungi degrade cellulose, causing weight loss and change of shape. White rot bleaches and makes wood spongy, whereas brown rot tends to attack pine only and causes surface checking. Soft rot fungi causes decay from inside the wood outwards, moves across the grain and enters through soil contact, as with railway sleepers. Dry rot (merulius lacrymans) actually transports moisture via rhyzomorphs, causing extensive decay and requiring drastic treatment to eliminate.

He concluded by pointing out that wood is an excellent structural material which lasts for centuries if properly handled. General rules for best performance include proper seasoning, dry maintenance and avoidance of soil contact unless the wood has been thoroughly impregnated with an effective preservative.

Answering questions on preservation, Mr Tasker referred to the current health questions of hitherto excellent materials TBTO, PCP and creosote. Newer synthetic preservatives naturally are subject to highly stringent regulation during Registration, apart from the imminent COSSH regulations; the toxicity package for round-the-world registration could be in excess of a million pounds in cost. For best results wood needs a vacuum-pressure treatment; typical points of weakness after installation are joint movement and insufficient protection of end grain. Other questions related to the speed of staining fungi attack, within hours of tree felling in Indonesia, the prevention of this and problems in using stain-affected wood. The question of lumber companies floating felled timber in rafts down river brought out the interesting point that, in temperate climates, the cold water had some preservation properties in reducing the available oxygen concentration necessary for fungal attack; naturally, such wood needs kiln drying afterwards.

The vote of thanks was given by the Newcastle Section Chairman, Mr S. Lynn, after which the excellent buffet sponsored by Buckmann, together with wines and ales, was enjoyed by all concerned.

J. Bravey ■

West Riding Section

Caulks and sealants

West Riding continued their interesting and varied series of lectures containing topics not directly connected with the surface coatings industry, but closely allied. The technical lecture entitled "Caulks and Sealants" held at The Mansion, Roundhay Park, Leeds, on Tuesday, 17 January, was given by Paul Dent, the Laboratory Manager at Hunting Vallance, Leeds.

Mr Dent defined the requirements of a sealant in terms of adhesive and cohesive strength, extensibility, elasticity and useful

Continued on p.93

London Section Ladies' Night

London Section Ladies' Night held at the Royal Chase Hotel. Back row (L to R): Mr K. Arbuckle, Social Secretary London Section; Mr C. Pacey-Day, General Secretary; Mr G. North, President Designate; Mr B. Canterford, Chairman London Section; Mr B. Myatt, Chairman Midlands Section; Mr C. Shaw, Chairman Bristol Section; Mr B. Mitchell, BPVLC; Mr D. Bannington, Mitcham Polymer Club; Mr B. Gilliam, SDC. Front row (L to R): Mrs Arbuckle, Mrs North, Mrs Myatt, Mrs Canterford, Mrs Shaw, Mrs Mitchell, Mrs Gilliam, Mrs Bannington.

Manchester Section

Wine tasting

The annual ladies' lecture was held at the Mechanics' Institute, Manchester, on Monday, 5 December 1988, and was attended by 55 members and guests. The topic of this year's talk was "Wine Tasting" which was presented by Terrence George of Willoughbys Ltd, the Manchester based Wine Merchants.

Ten wines had been selected for tasting and each was briefly described. The wines had been selected on the basis of good value for money.

After the short talk, the serious business of tasting the selected wines commenced, the quality appearing to improve with every one tested. The wine tasting was followed by a buffet which, as usual on these occasions, was subsidised by the Section.

M. G. Langdon ■

Natal Section

Christmas Party

The Annual Christmas Cocktail Party was held on Friday, 2 December 1988, at the Durban Club. This event was supported by a record number of sponsors this year.

The Section Chairman, Mr Robin Archer, welcomed members and guests and made special mention of the presence of Mr Tom Howard, Honorary Member and one of the founder members of OCCA in South Africa, also Mr Kurt Engelbert, Honorary Member still serving as Treasurer on the Natal Section Committee.

Guest speaker was Mr Ian Morrison a past Deputy Mayor of Durban who gave a short historical address on Durban's development over the past 150 years.

R. H. Philbrick ■

News of Members

Hugh Young

A former West Riding Chairman and Member of Council, Mr Hugh Young has recently achieved further recognition in his other major love – swimming. A long-serving Harrogate swimming coach, Hugh was installed as President of Yorkshire's Amateur Swimming Association at their recent meeting in Leeds. His elevation to county status is just reward for his enthusiasm and dedication – the qualities much in evidence during his activities on behalf of OCCA.

B. Widdop ■

**OCCA
CHESTER
CONFERENCE 1989
See Page 80**

Obituary

Harry Smith, AMCT, FTSC – 1916-1988

Mr J. E. Mitchell writes:

Harry Smith who died on 13 December 1988 at his home in Thornton, Liverpool, aged 72 was an ebullient Chairman of Manchester Section during the early post war years.

Born in 1916 he was educated at Hulme Grammar School in Oldham later completing his studies in Manchester where he qualified as an Associate of Manchester College of Technology – now UMIST.

Like many a budding technologist he started work in the ICI laboratories at Blackley and went on to join the paint industry via Davidson's in Liverpool. Developing his career he moved to the laboratory of Keystone Paint and Varnish Co. in Hindley, near Wigan, eventually becoming Technical Director in charge of R and D.

In the early 1950s his company was absorbed into the Berger Group – later to become Berger-Jensen and Nicholson Group. Thereafter Harry Smith held various management positions in Bristol, London and in Holland. In 1972 he joined the BJN group in Africa in charge of their unit at Dar-es-Salaam. Retiring from business in 1977 he returned to live in Thornton near Liverpool.

Elected a member of OCCA in 1944 he served on Manchester Section Committee 1951-1960 and was elected Chairman 1960-1962. He was Hon. Publications Officer 1954-1956 and Representative on Council 1956-1960 and 1962-1964. He was elected a Fellow in the Professional Grade.

A competent Paint Technologist who supervised the R & D programme of his company through the period of exciting technical innovations following the war he possessed a skill of communicating enthusiasm and a zest for living without loss of commitment to the job in hand. All who knew Harry Smith will remember him an as effervescent happy man.

He is survived by his widow Irene and his two sons to whom the Association extends its deepest sympathy at this sad time. ■

New members

Ordinary members

Bartels, T., PhD *(General Overseas – Netherlands)*
Depetris, S. *(Ontario)*
Foster, R. J., MSc *(London)*
Foxwell, M. S., BSc *(Ontario)*
Harrison, M., BSc *(Thames Valley)*
Hildred, R. N. *(West Riding)*
Kilpatrick, T. S. *(Scotland)*
Lam, K. W., BSc *(General Overseas – Singapore)*
Vincent, T. D. *(London)*
Zukowski, G. Z., BSc *(Manchester)*

Associate members

Dattani, G. J. *(London)*
Richards, P. H. *(Manchester)*
Rooschuz, K. *(Transvaal)*
Webster, B. D. *(Transvaal)* ■

Continued from p.101

particles in the medium is such that the optimum conductivity is achieved. This involves a balance between choice of resin, selection of suitable surfactants and correct solvent balance. These parameters need to be chosen in such a way as to ensure that the pigment, which is much more dense than the medium, remains in suspension both in storage and application and also that during the drying process the metal particles are given chance to come into contact to as great a degree as possible to enhance the conductivity. As well as the basic need for conductivity other properties of the paint system such as its applicability and appearance, in particular the smoothness of the coating, are naturally of importance. Smoothness is particularly required since rough coatings may allow small fragments of the system to fall loose which can be disastrous since it can result in these conductive particles interfering with the operation of electronics systems within the device.

During the past few years many advances have been achieved in nickel-based conductive coatings as a result of improved formulation. Higher levels of conductivity can now be achieved consistently and the other properties of the paint such as sprayability and appearance have been radically improved. Much can in fact be achieved in this direction by using the flake type of pigments but improvements can also be affected by other changes in formulation and processing technique.

So far it has not been possible to obtain a high enough pigment loading in a powder system to produce a conductive coating employing this technology. Water-based systems have been investigated but it is doubtful if any are in commercial use.

The other biggest area of application of the conductive pigments, and the one in which the silver-coated materials come into their own, is in the production of electrically conductive elastomeric gaskets. These are generally based on silicone resins and the type of application in which they are used, aerospace and military, are such that can justify the use of these relatively expensive materials due to the very high performance targets which are demanded.

Summary

Nickel has assumed a highly important role in the production of conductive organic-based coatings for use in radiofrequency and electromagnetic shielding applications. This is due to the fact that this metal has a unique combination of advantageous properties including electrical conductivity, oxidation and corrosion resistance as well as being magnetic. In addition, as a result of the process by which nickel is manufactured, it is available in small particles with a range of shapes and sizes which enable the optimum morphological properties for any particular coating system to be selected.

Consequently, nickel-based pigments are now widely used in this type of system which is finding ever increasing application as the number of electronic devices which require shielding increases and the standards to which the shielding must be applied become more exacting.

References

1. Antonsen, D. H. Pigments Handbook, Vol I, *John Wiley and Sons Inc.*, 823.
2. Hayes, E. J. and Antonsen, D. H., *Metal Powder Report*, 1986, **41,** 71.
3. Hart, A. C., *Transactions Institute of Metal Finishing*, 1983, **61,** 150. ■

Classified Advertisements

JOCCA
CLASSIFIED ADVERTISEMENTS

can be placed by contacting Frank Craik:
Telephone: 01-908 1086
Telex: 922670 (OCCA G)
Fax: 01-908 1219

SITUATIONS WANTED

FTC; ATSC
Qualified Chemist seeks interesting and challenging position. Years of experience in the science, technology of Surface Coatings, Production Management. Willing to work abroad. Trinidadian by birth. Worked in UK before.
Please reply to: **Box 8831, JOCCA, Priory House, 967 Harrow Road, Wembley, Middx HA0 2SF.**

FOR SALE

FOR SALE

Laboratory Three Roll Mill; Steel Rolls 6 by 3 inches. With Motor, Belt Drive and Stand.

H. J. Stern,
The Laboratory, Adie Road,
Hammersmith Grove, London W6 0DW.
Telephone (01) 748 4342.

SERVICES

SHELLACS NATURAL RESINS GUMS & WAXES

A. F. SUTER & CO. LTD.

Swan Wharf 60 Dace Road
London E3 2NQ
Tel 01-986 8218. Tlx 919056 SUTERS G
Contact B. A. Slater

SWANLAC
ESTABLISHED 1906

INDEX TO ADVERTISERS

SITUATIONS VACANT

UNION CARBIDE

UNION CARBIDE ranks amongst the major chemical companies in the world. The Corporation's business in Europe and the Middle East is conducted through Union Carbide Europe S.A. in Geneva.

Our Chemicals & Plastics Technical Service Laboratory has an immediate vacancy for a

CHEMIST

for the UCAR Coatings Resins Technical Service Department

The main responsibilities will be to

- Develop application technology for the coatings industry based on proprietory Union Carbide resins;
- Provide technical assistance to our European customers and our sales force;
- Liaise with our R&D department in the USA by visits and frequent correspondence;
- To guide and supervise a technical assistant.

The position requires

- Good knowledge of English, knowledge of other European languages would be an asset;
- A university degree or equivalent in chemistry and specifically a knowledge of polymer chemistry;
- 2-3 years experience in industry, preferably in coatings or related;
- Self motivation and initiative to perform with little direct supervision;
- Willingness to travel up to 20 percent of his time.

Qualified candidates are invited to send their curriculum vitae and certificates to Mrs Carolyn Guhl of:

UNION CARBIDE EUROPE S.A.
15, chemin Louis-Dunant, 1211 Geneva 20
Tél.: (022) 39 64 08

Pira is the UK research centre for the paper, publishing, printing and packaging industries. It operates competitively in world markets and provides research, consultancy, training and information services. Pira is growing annually at around 20% in turnover and requires additional high calibre staff. Location is in Surrey at Leatherhead. The work environment is excellent, career development is assisted, and a good pension scheme is available.

Pira's Printing and Information Technology Division wishes to appoint:

Senior Technologist - Technical Services Laboratory

This is a unique job which deals with investigative problems which arise from ink, paper and other substrates compatibility as well as the processes of printing. The work is challenging, the environment is stimulating and at the centre of developments in printing and the new imaging processes such as ink jet. The successful applicant will be a science graduate (or equivalent) and have experience in printing ink, adhesives or related technology.

The post offers a variety of experimental laboratory work combined with report writing and customer visits throughout the UK. There are excellent opportunities for career development. Salary will be by negotiation, depending on experience and qualifications.

Send application and CV to Pira's appointment consultants:
Dr M H Blunden-Willms
PBW Associates
Chantry House
53 Harriotts Lane
Ashtead
Surrey
KT21 2QG
Tel: (0372) 278335

Classified Advertisements

SITUATIONS VACANT

No. 1 in Europe – Leaders Worldwide

Tioxide

TECHNICAL OFFICERS

The Chemicals Division of Tioxide UK Limited is one of the world's largest producers of organic titanium chemicals. These are used as catalysts, crosslinkers and surface modifiers in such diverse applications as emulsion paints, printing inks, silicones, plastics, resins and oil recovery formulations.

We are now looking for two experienced development chemists to work within an existing team supporting and generating the vital development work required to increase the range of our products and their applications.

The salary will be dependent upon experience but is likely to be in the range of £15K – £17K. Other benefits will include substantial cash profit sharing, non- contributory pension and life assurance and 27 days annual leave.

Applications are invited from graduates with at least 5 years experience in the surface coatings industry.

To apply, please write to The Human Resources Administrator, Tioxide UK Limited, Haverton Hill Road, Billingham, Cleveland, TS23 1PS quoting reference number HRD/11/89.

DEVELOPMENT CHEMISTS

South Wales **£neg Above Average**

A dynamic, innovative and market leading UK subsidiary of a Swiss Company, my client provides tomorrow's solutions to the problems encountered by today's motor industry. Continuing success demands they now recruit 2 commercially minded and forward thinking chemists to fill these career positions.

Both posts encompass detailed testing and assessment techniques which include environmental cycling and accelerated wear and corrosion evaluation. Current development areas include viscosity, sprayability, heat resistance, stability and product interaction.

Anti Corrosion Coatings

In addition to the development of their existing petroleum based range you will be responsible for formulating and testing new products with special emphasis on water based, anti corrosive products.

With a paint technology or general chemical background you will ideally have 2 years experience in the formulation and testing of water based emulsification systems, polymers, petroleum derived soaps, oxidates and sulphonates.

Plastisols and Adhesives

The range includes underbody pvc plastisols, sealants, and special plastisol adhesives. Raw materials include calcium oxides, pvc, polyurethane, plastisisers, and acrylic, epoxy and polyurethane resins. This is a detailed testing and development role working closely with some of the world's leading motor manufacturers on their future projects.

Two years experience in pvc and/or polymer based chemistry allied to an adhesives or plastisols background would be considered ideal.

For both posts you should be qualified to at least HNC level and have an innovative but pragmatic outlook together with the skill to balance technical perfection with commercial viability. You must have a record of achievements which include the successful development of new and existing formulations in a profit conscious environment.

In return we offer negotiable, above average salaries, good benefits and full relocation. More importantly, your career is linked directly to your progress with opportunities world wide.

Graduates

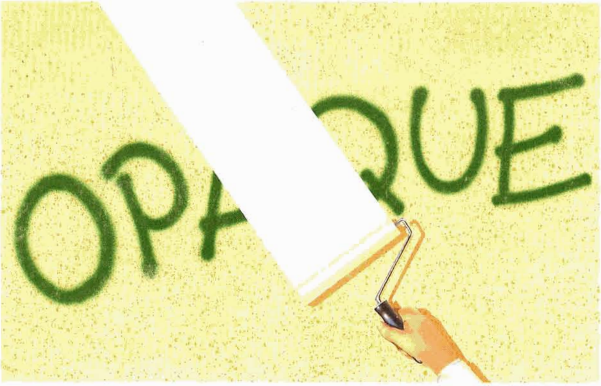
If you think you're up to the job, but lack the experience, write and convince us you can apply purist skills to practical projects.

For a job specification write to or telephone (in confidence) Paul Allen, PER, 4th Floor, Pearl Assurance House, Greyfriars, Cardiff. CF1 3AG. Telephone: (0222) 383286.

PER

RECRUITMENT CONSULTANCY


AUTOMOTIVES
POWDERS
VERSATILE
VINYL
SOLVENT
AQUEOUS
SILK


OPAQUE


BRILLIANT
BRILLIANT

23 Dec