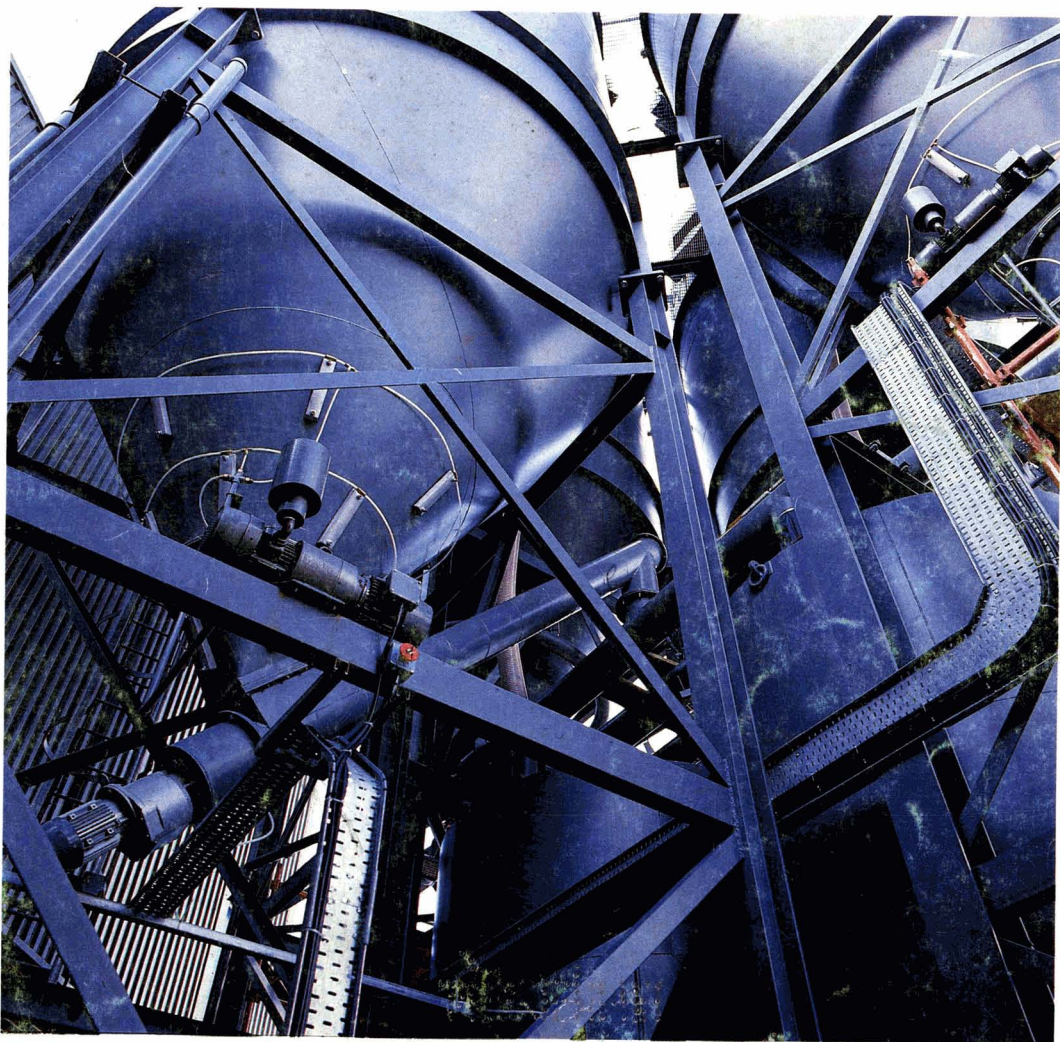




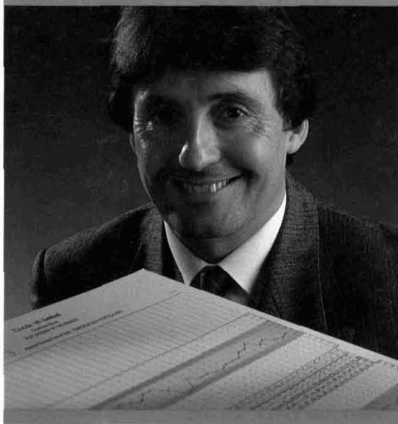
JOURNAL OF THE OIL AND COLOUR CHEMISTS' ASSOCIATION

# J O C C A



■ Storage & Handling  
■ Can Coatings

*the assurance of  
quality*



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# JOCCA

JOURNAL OF THE OIL AND COLOUR CHEMISTS' ASSOCIATION

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**Forthcoming Features:** June—Pigments; Process Operation (PO), Milling, July—Printing Inks; PO Environmental Control, August—1992; PO, IR & UV curing systems

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## Nobel acquires Crown Berger

Nobel Industries of Sweden have acquired Crown Berger Paints from Williams Holdings for up to £240m. Nobel Industries own Casco-Nobel, Sweden's largest paint manufacturer which includes Nordsjo AB and the Sadolin group of companies. Nobel also owns the resins manufacturer Perstorp AB. In the UK, Nobel was previously represented, in the woodstains and preservatives sector, by Sadolin (UK) Ltd. Williams Holdings will retain its North American and Portuguese paints business, and Cuprinol and Polycell brands in the UK.

## Queen's Awards 1990

The following companies in the Surface Coatings and allied sectors were recipients of the 1990 awards:

### The Queen's Award for Export 1990

Datapaq Ltd — exporter of in-process thermal monitoring systems for use in semi-continuous batch manufacturing processes.

Sandon Flexographic Printing Rollers Ltd — exporter of laser engraved flexographic printing cylinders, ceramix anilox rolls, rotary screens and embossing rolls.

### The Queen's Award for Technology 1990

Allied Colloids Ltd: Research Department — For the development of a new and significantly improved process for the production of vinyl amino esters.

Elcometer Instruments Ltd— For the development of microprocessor-controlled coating thickness gauges.

ICI Colours and Fine Chemicals — For the development of benzo difuranone dyes for polyester.

Sericol Group Ltd — For the development of diazo-photopolymer emulsions to produce photostencils for screen printing.

### RHEOX announce ONCOR sale

RHEOX Inc has announced the sale of its ONCOR lead-based, anticorrosive pigment product line to Kikuchi Colour and Chemical Corporation, effective 9 March,

1990. The sale consists of current inventories, equipment and technology necessary to manufacture ONCOR M-50, ONCOR F-31 and ONCOR Y47 products. The business will be operated by Kikuchi's subsidiary, Dominion Colour Corporation, which is headquartered in Toronto, Canada. RHEOX, acting as an agent, will continue to sell ONCOR products during the transition period.

Michael J. Kenny, chief operating officer and president of RHEOX Inc, said, "The sale of the ONCOR pigment line reinforces our long term strategy to focus on the further development of water-borne rheological additives and our NALZIN 2 anticorrosive pigment business."

### Courtaulds joint venture in China

Courtaulds Coatings has established a joint venture company in Shanghai with a majority holding under the name 'International Paint of Shanghai Company Ltd' to manufacture marine and offshore coatings.

Courtaulds Coatings is a subsidiary of Courtaulds plc, the international industrial materials and chemicals company which recently demerged its textiles business, and is the acknowledged world leader in marine coatings. 51% of the venture is held by Courtaulds Coatings. The other partners are Shanghai Kai Lin Paint Manufacturing Company (Kai Lin) with 29% and China Ocean Shipping Company (COSCO) and China State Shipbuilding Equipment and Material Company (CSSC) with

10% each.

Commenting, Michael Pragnell, Managing Director of Courtaulds Coatings, said: "We have been trading in China for many years, and have been manufacturing marine coatings under licence with Kai Lin since 1982. During this time Chinese shipbuilding has grown steadily and now regularly builds ships for foreign owners. This growth and the significance of Chinese fleets in world shipping makes it a logical step for us to invest in manufacturing in China. We are fortunate in being able to work with Kai Lin, with whom we have been associated for many years."

### Schering Northern investment



New Schering Industrial Products Headquarters, Widnes

Schering AG Berlin, West Germany, have invested another £4.5 million in new offices, laboratories and warehouse in Widnes. In an official ceremony today to open this modern complex in Gorsey Lane, Widnes (which now houses the Schering Industrial Chemicals business in one location, having previously been spread over five different areas in the UK), Dr Vita, the Chairman of Schering AG, expressed his delight at the progress seen in the UK.

### A bicentenary, and a world lead in ecologically-green products

Zirconium, was first discovered in 1789 by Martin Klaproth.

Now in its fifty-fifth year of operation, and already the largest.

producer of zirconium chemicals in the world, Magnesium Electron Limited (MEL) is making the biggest investment in its history — £20 million — to extend its plants at Manchester in the UK and Flemington in the USA, to come on stream in 1990. This will increase the world zirconium chemicals production capacity by one third. More than 70% of the UK output will be exported to over thirty countries.

Zirconium is used in:

- Alkyd paints for quick drying and replacing lead.
- Surface coatings for packaging, replacing formaldehyde giving greater strength and water resistance, and having low toxicity, with approval for use with foods.
- Adhesives with water rather than organic solvent base.
- Inks, also replacing solvents, and giving greater adhesion to plastics.

## US Focus

By Abel Banov  
Co-publisher of the  
American Paint and  
Coatings Journal

### Flexible Epoxy With Impact Strength

An epoxy resin made with difunctional glycidyl ether, and derived from cardanol phenol-bisphenol is now offered by Cardolite Corp. Benefits claimed for the new resin include water and chemical resistance flexibility, impact resistance, thermal-shock resistance, and non-crystallinity.

Uses include high-performance industrial coatings for such end-purposes as flexible tank and railcar linings; chip-resistant automotive primers, and expansion joints for concrete.

### Impeller blades with A Double Life

Aside from its ability to resist abrasion because of the alloy used, a new Morehouse Industries propeller blade promises a double life. The secret is the symmetrical

shape used for its blades. Because of this, the blades can be turned over when one side wears, permitting a second period of use without adversely affecting processing efficiency. Other features of the new propeller blade are its ability to withstand a wide range of solvents, its electrical conductivity, which eliminates the possibility of static sparks. The blade is rated for continuous operation at 145°F. The product name is Polypeller.

### Dow perfects new Control System for Epoxy Resins

A revolutionary production process now enables Dow Chemical Co. to make higher molecular weight solid epoxies, including 7-, 8-, and 9- types.

That means the company can create solid resins with specific viscosity and reactivity for specific applications. In addition, the company believes the new procedures will allow it to produce new types of high molecular weight epoxies, possibly 10-, or 11- types, which, the company says, have not been seriously promoted because they are very difficult to process.

Greater flexibility of the higher molecular weight epoxies allows them to be used in container and coil coatings, and for some automotive finishes.

### Amino-functional Silanes For Adhesion Problems

Where weather and moisture-resistant adhesion to difficult substrates, such as glass, metal, and concrete, is a problem, a new amino-functional silane is expected to be effective.

The aminosilane, Union Carbide's Y-9492, is claimed to be especially suitable for primerless, one-part, moisture-cured urethane systems because of its unique chemical structure. The secondary amine group in the amino-functional silane reacts quantitatively and controllably with free isocyanate groups in the one-part urethane system.

The bis-alkoxysilane structure of the aminosilane adds two silyl groups to each isocyanate group and, thus, provides more durable wet

adhesion than products with only monosilane groups.

### Mixed Metal Oxides Under 2 microns

Fine-particle mixed metal oxides, under 2 microns, are now being offered by Engelhard Corp. The Meteor Plus pigment series has 16 color pigments. Easy dispersion and opacity are enhanced by the fine sizes, it is claimed.

The product, according to the manufacturer, is suitable for use in coil coatings for appliances, and for metal furniture and building products.

## Products

### A new generation of dust-free pigments

**B**ASF scientists at Besigheim, West Germany, have developed a method of producing dust-free pigments. The first to become commercially available is Sicopal® Yellow L 1100, produced as a fine granulate. Other free-flowing, dust-free pigments will follow. Although the new granulates are much bigger than powder particles, colour characteristics are not impaired.

For further information Enter E301

### Anchor's breakthrough in curing agents

**A** new amine, Amicure PACM, and modified versions of it now available from the Anchor Chemical Group represent a significant addition to the limited number and variety of cycloaliphatic amine epoxide resin curing agents previously available in the world. Chemically para amino dicyclohexyl methane, Amicure PACM is manufactured by Anchor's parent company, Air Products and Chemicals Inc, at its plant in Wichita, Kansas.

Amicure PACM can be used as a light-coloured low viscosity liquid replacement for DDM in many epoxy applications,

particularly in the composites sector where it provides the bonus of extremely high fracture resistance.

For further information Enter E302

## Biocide keeps fungi and algae off exterior coatings

ICI's Biocides Business is introducing 'Densil' ND fungicide and algicide — a new formulation designed to protect applied water-based coatings against degradation and defacement. A product of ICI's continuing research programme, 'Densil' ND is a low-colour aqueous dispersion that is effective over a broad pH range (4-10). Also, 'Densil' ND does not cause yellowing of the paint film on exposure to sunlight.

For further information Enter E303

## Equipment

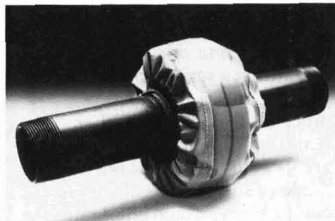
### Ink dispensing

GSE have recently introduced an independent version of the Xenix programmed Quality Control System normally used with the Colorsat computer controlled ink dispensing system. The Colorperfect CP101 is an MS-DOS programmed densitometer based system complete with software package for use with a customer's own desk-top computer. The system will check colours for quality comparing the sample with a "standard" previously checked sample, and will show the user whether the two are within acceptable customer set tolerances of Hue, Chroma and VALvE.

For further information Enter E304

### Pipe flanges

A "see-through" pipe flange safety shield, which not only protects personnel and equipment from dangerous sprayouts but also permits visual inspection of flanges and expansion joints, etc., has just been introduced by Ramco and is



Ramco Vue-Gard

available in the U.K. from Allison Engineering.

The Vue-Gard is constructed in a specially-designed Teflon-coated glassfibre material and a clear TFE-type film which has excellent weatherability and does not haze up.

For further information Enter E305

### Abrasers

Teledyne Taber has introduced digital Abrasers to evaluate the wear resistance of various materials including paint, textiles, etc. Abrasers compare wear resistance qualities of competitive products, analyze and isolate defective materials, and provide additional quality assurance.



For further information Enter E306

### CS Melt

Bohlin Reologi have developed a new CS Melt instrument — the first to be specifically designed for use by the polymer industry — to handle quality control, research and product development projects.

The Bohlin CS Melt unit recently launched is a powerful new

instrument which has been designed to provide a compact enclosed thermal environment which is capable of reaching +400°C. This makes the rheometer ideal for use in any high temperature application work, particularly polymer melts.

For further information Enter E307

## Literature

### PRA Technical Services

A 4pp leaflet entitled "Technical Services" is available from the Paint Research Association — covering facilities available at the PRA for a free copy contact: Mr D Dasgupta, PRA, Waldegrave Road, Teddington, Middlesex, TW11 8LD, UK.

### BSI News

BSI today announced the publication of **BS 1262: 1989 Specification for round lever lid tinsplate cans, paint range**. Specifies a range of capacities from 250 mL to 5 L with dimensions and constructional requirements. Performance requirements related to freedom from leaks, handle strength and lid security are included with related methods of test. Superseded by BS 1262: 1970.

Copies of this standard are available priced £24.70 (£12.35 to BSI subscribing members) from BSI Sales, Linford Wood, Milton Keynes, MK14 6LE.

### European sealants market

Sectors within the European sealants markets are fast growing and yet the market as a whole is relatively unknown because there is very little published statistical data available. To fill this gap IAL Consultants Ltd, (14 Buckingham Palace Road, London SW1W 0QP, Tel 071-828 5036), have published a UK report at £1,250, and three other reports covering the rest of Europe at £950 each.

The UK market is worth £150 million and is forecast to grow at

around 4% p.a. over the next five years, but this overall figure hides considerable changes which are taking place both in the types of sealant used and in end uses. The use of general purpose fillers is forecast to decrease at about 2% p.a. and will represent about 29% of total consumption in 1994 compared with 38% in 1989. Conversely use of high performance polymeric sealants especially polysulphides, acrylics, silicones and polyurethanes, will increase at about 8% p.a. and will represent about 61% of total consumption in 1994 compared with 50% in 1989.

## Meetings

### FATIPEC Congress

The XXth Fatipecc Congress and the EUROCOAT 90 Exhibition will be held at the Acropolis Palace in Nice 16-21 September 1990.

The scheme of these two events —mark the 40th Anniversary of FATIPEC.

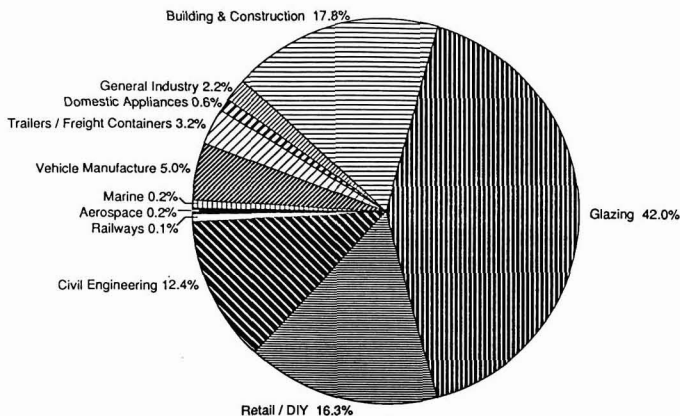
The EUROCOAT 90 Exhibition with over 150 exhibitors will also show the collections of the French Paint & Colour Industries Museum and give information on the Coatings Research & Training Institutes.

Some 1,200 Congress delegates, some 3,000 Visitors to the Exhibition, and the 500 Attendees are expected either for the two-day session on MANUFACTURING: "Paint & Varnish Manufacturing in view of the Millennium: Questions and Solutions" or for the 2nd Conference on ECONOMICS and TRADE: "Specifics of Management and Marketing applied to the Paint & Varnish Industry: Myth or Reality?"

For registration contact: Europe Congress, Voyages Kuoni, 3, Bd Victor-Hugo, F. 0600 Nice, France, Tel: (33) 93 16 08 03; Telex: 461 693 Kuonic, Fax: (33) 93 82 23 51.

**MANCHESTER SECTION  
SYMPOSIUM  
TOWARDS A GREENER  
COATINGS INDUSTRY  
20-21 September 1990**

UK SEALANT CONSUMPTION BY END USE, 1989  
Total Consumption - 61,565 Tonnes



## People

### President for Radtech Europe appointed



**Kevin O'Hara**, Technical Director of Craynor SNC (France) was appointed President of Radtech Europe at their second annual General Assembly held in Essen, West Germany on 29 January 1990. Radtech Europe is a recently formed association to look after the interests of the U.V. and E.B. curing markets in Europe. Mr O'Hara said "Within the Coatings industry, U.V. and E.B. curing is a rapidly growing technology which now forms a significant part of the market as a whole."

Radtech organises a biennial International Conference and Exhibition.

### Scott Bader completes top management restructuring

Following the recent appointment of **Jim O'Brien** as Chairman, Scott Bader now announces the appointment of **Ian Henderson** as Managing Director.

Jim O'Brien took up the Chairmanship of Scott Bader Company Limited on 1 January, after a long career with British Rail, culminating in his appointment as Joint Managing Director (Railways) and membership of the main Board. Prior to becoming Chairman he was a Director of Scott Bader Company Limited.

Ian Henderson brings to Scott Bader a depth of experience in general management, operations, marketing and development in a wide range of industrial and consumer markets. Originally a chemist, polymer-based products have provided a thread of continuity throughout his career. He was, until recently, General Manager of BP Chemicals' speciality polymers interests.

**Godric Bader** has retired as Chairman and takes up the newly-created role of President.

**Ralph Woolf** retires as Managing Director after successfully leading the company's business activity throughout the last decade. ■

## New developments in ambient cure epoxy resins for high performance industrial coatings

by F. Meeus, Dow Europe, Technical Centre Rheinmünster, West Germany

### Introduction

For more than 25 years, epoxy resins have been used world-wide as the standard binder for ambient curing industrial coatings, requiring superior chemical and corrosion resistance. Epoxy resins also have a unique balance of surface hardness, toughness and flexibility and show excellent adhesion to a variety of substrates.

Typical applications are coatings for bridges, industrial plants, ships and storage tanks. When correctly applied over properly prepared steel, epoxy coatings have an estimated service life (in years before first maintenance painting) of 7 to 13 years for environments ranging from heavy industrial plants to rural residential areas<sup>1</sup>.

In recent years, the protective coatings markets have experienced an increasing trend away from the conventional solvent based epoxy/polyamide paints (containing ca. 45-55% solvent by volume at application viscosity) towards high solids, solvent free and water-reducible epoxy coatings.

The challenge we face today is to develop coatings having equal or better performance than the industry standard which is based on a "1"-type solid epoxy resin and a polyamide hardener.

This paper reviews the following recent developments by Dow in ambient cure epoxy resins:

- higher solids epoxy resins for high solids coatings
- low viscous epoxy novolac for high performance coatings
- novel aminated acrylic/epoxy binder for water-reducible coatings.

### Basic epoxy resin chemistry

The primary backbone polymer for epoxy resins is produced by reacting epichlorohydrin and bisphenol A. The latter being the reaction product from acetone and phenol (see Figure 1).

The bis-A epoxy resin with the lowest molecular weight is the diglycidyl ether of bisphenol A. Liquid epoxy resins have viscosities between 6000-14000 mPa.s/25°C. The oligomer distribution, as determined by HPLC, of some liquid commercial grades is given in Table 1.

**Table 1**

Comparison of liquid epoxy resins using HPLC - typical values

Analysis	D.E.R.* 322	D.E.R.* 330	D.E.R.* 331
Average molecular weight	345	363	366
EEW	172	176	182
Viscosity, mPas at 25°C	6500	9023	11560
n = 0 resin species	98-99	92-93	92
n = 1 resin species	0.76	6.2	6.6
n = 2 resin species	0.03	0.35	0.42

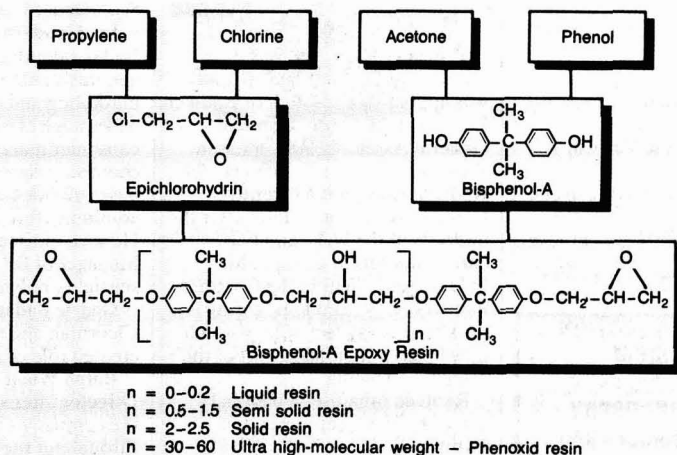
From this basic liquid backbone resin a continuum of semi-solid and solid epoxy resins of increasing molecular weight are produced (Figure 1). The MW and the oligomer distribution determines the maximum attainable solids/solution viscosity ratio as well as the physical and chemical resistance properties such as flexibility, hardness and acid-castic-solvent resistance.

### Curing agents

The most commonly used curing agents for ambient cure coatings are polyamides and amine adducts. Polyamides, more properly termed aminopolyamides or polyamidoamines, are the reaction products of dimerized fatty acids and polyamines such as diethylenetriamine (see Figure 2).

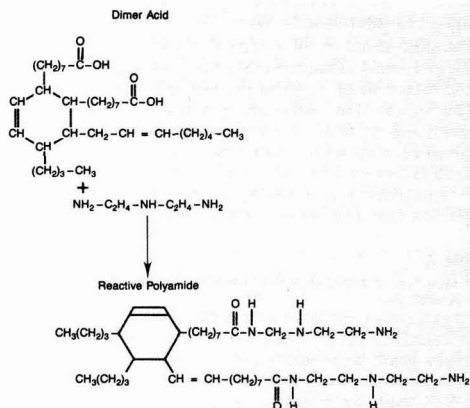
The bulky, waxy nature of the C<sub>34</sub> carbon chain contributes to the excellent corrosion resistance, flexibility and water resistance of the conventional epoxy/polyamide coatings.

**Figure 1**  
Epoxy resin manufacturing scheme





**Figure 2**  
Polyamide hardeners

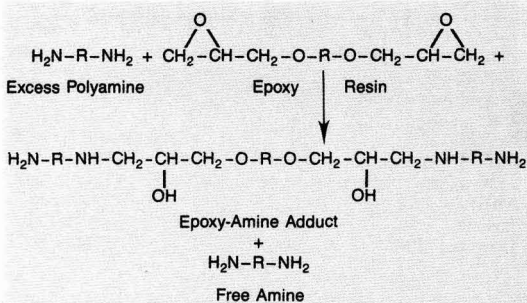


Amine adducts are prepared by reacting an epoxy resin with an excess of amine (Figure 3).

Usually the amine adduct contains the adduct, some level of free amine and possibly other ingredients like accelerators or diluents.

Figure 4 lists some amines used to prepare amine adducts. Since an "all purpose" curing agent does not exist, the selection of the appropriate curing agent will depend on the

**Figure 3**  
Amine adducts

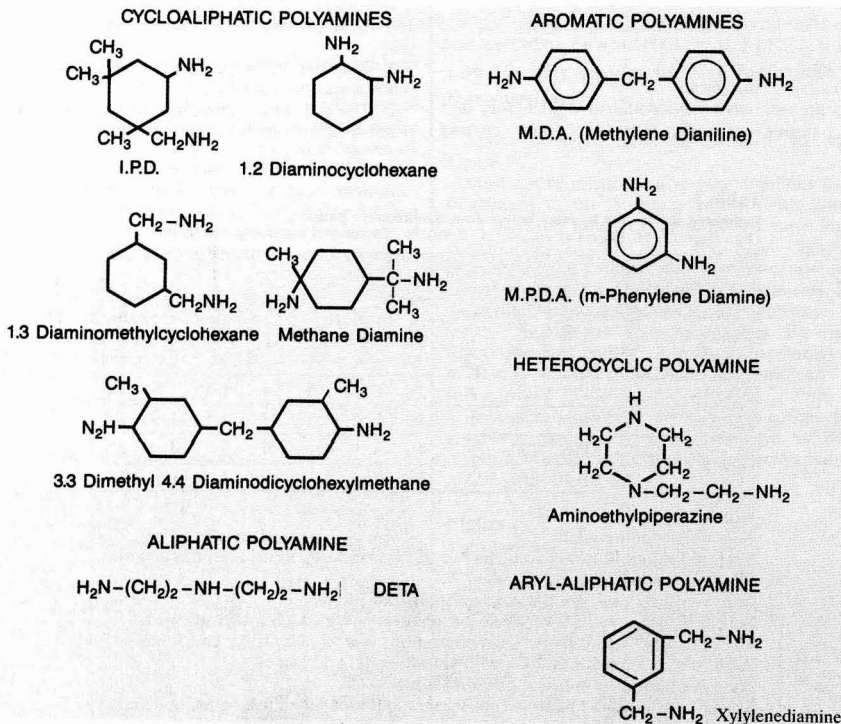


priority assigned to the different required properties of the final cured coating. A general guidance can be found in 2, 3

### Conventional epoxy coatings

The conventional industry standard solvent borne epoxy/polyamide coating for the protection of steel against corrosion as recommended by the Steel Structures Painting Council (SSPC, Volume 2 Paint No 22) has the typical composition shown in Table 2.

**Figure 4**  
Typical amines used to produce adduct hardeners



**Table 2**

Part A	Weight
Epoxy resin (EEW = 450-550) <sup>1</sup>	200
Anti-corrosion pigment	432
Red iron oxide	17
Magnesium silicate	85
Mica	28
Bentone 27	8
95/5 Metanol/water	3
Flow agent	8
MIBK	43
Xylene	126
Dowanol* PM <sup>2</sup>	66
	1016g

<sup>1</sup> D.E.R.\* 671 or equivalent<sup>2</sup> Propylene glycol mono methyl ether

Part B	Weight
Polyamide Resin <sup>1</sup>	107
Xylene	104
	211

<sup>1</sup> Versamid 115, D.E.H.\* 11E or equivalent

Such a conventional epoxy/polyamide coating contains ca. 44% solvents by volume at application viscosity and is used as primer, intermediate and topcoat for the protection of steel structures. These coatings are capable of curing at ambient temperatures as low as 10°C and are fully cured in 5-7 days. They have the following typical properties:

- potlife: min 8 hours
- coverage: 6-10m<sup>2</sup>/litre at 50-70 micron thickness
- salt spray test ASTM-D1654: 1000 hrs with no blisters and max creep of 2mm
- Erichson flexibility: min 6mm

Table 3 lists the estimated service life (in years before first maintenance painting) of some particular epoxy coating

systems compared to alkyds and latex paints. However, the performance of the listed coating systems will strongly depend on how effectively the surface is prepared and cleaned of contaminants.

The cost structure of a typical maintenance operation is given in Table 4. Thus the cost of the coating is only ca. 16% of the total cost of a typical maintenance operation.

This means that, although at a first quick glance epoxy coatings appear more expensive compared to alkyds, this cost comparison reverses dramatically on a total system economic basis in favour of the epoxy coating. One extra year of service life represents a cost saving of 34 times the initial cost difference between the epoxy and alkyd coating!

**Table 4**

Cost structure maintenance operation<sup>1</sup> including labour, equipment and related costs

Surface Cleaning	FF/m <sup>2</sup> †
SP-2 Hand cleaning	30
SP-6 Commercial blast	51
SP-10 Near white blast	60
Application	FF/m <sup>2</sup>
Brush/Roller	14
Spray	17
Coating 150 micron thick	FF/m <sup>2</sup>
Alkyd	10.2
Epoxy	12.2

†FF = French Francs

### High solids/solvent free coatings

The reason why the conventional anti-corrosion coatings contain approximately 48% of solvent by volume is two-fold:

1. The solid "1"-type epoxy resin needs 30-50% solvent to reach workable viscosity.
2. The polyamide hardener also needs 30-40% solvent to reach sprayable or brushable viscosity.

**Table 3**

Estimated service life in years before first maintenance painting

Data from G. H. Brevoort and A. H. Roebuck, Brevoort Consulting Associate<sup>1</sup>

Coating System	No. of Coats	Surface Preparation	Thickness	Mild	Severe	Caustic	Acid	Fresh water immersion	Ammonia	Chlorine	Solvent Resistance
Alkyd	3	SP-6	150	8	3	1.5	1.5	N	1.5	1.5	1.5
Latex	3	SP-6	150	8	3	1.5	1.5	N	1.5	1.5	1.5
Epoxy	2	SP-6	150	9	4	5	4	N	5	4	4
	3	SP-10	250	13	7	9	8	6	9	8	7

Notes:

N = not recommended

Surface Preparation was according to SSPC standards SP-6 - commercial blast,

SP-10 - near white blast

Mild = rural or residential with no industrial fumes

Severe = heavy industrial, chemical plant area with high levels of fumes

Caustic = NaOH up to 50% concentration, with splash, spills and fumes

Acid = mineral acids at 10% with splash, spills and fumes

Amino/Chlorine = splash, spills and fumes

Solvents = aromatic hydrocarbons, ester and alcohol splash, spills and fumes

The obvious solution to reduce the solvent content would be to use liquid epoxy resin (D.E.R.\* 331-type) and solvent-free low viscous amine-adduct hardeners.

Unfortunately, the performance of such coatings is below standard. One of the drawbacks is their brittleness. Compared to "1"-type epoxy resins (8% epoxy) liquid epoxy resins (23% epoxy) have pro volume more than double the amount of reactive epoxy groups. This results in a much tighter and stiffer crosslinked network. In terms of flexibility, this means a drop from a typical 8mm Erichson for a conventional coating down to 0-1mm for such a solvent free coating. Adding plasticizers to increase flexibility is possible but normally yields poor performance in terms of corrosion and solvent resistance.

To overcome these problems, Dow has developed a new intermediate semi-solid epoxy resin, D.E.R.\* 660, with a particular oligomer distribution. This new epoxy resin provides many of the advantages of both liquid and solid "1"-type resins.

Table 5 lists the hardness and flexibility data of coatings based on D.E.R.\* 660 compared to a series of epoxy resins ranging in average molecular weight from ca. 1000 to 376.

**Table 5**

Hardness/flexibility data for coatings<sup>1</sup> based on D.E.R.\* 660 compared to different epoxy resins using the IPD-adduct XZ 87706.05 as curing agent

Epoxy Resin	Workable Solids % wt	% Epoxy/mol resin	Flexibility Erichson DIN 53156	Hardness Buchholz DIN 53153
D.E.R.* 671	70	8.6	9-10mm	100
D.E.R.* 660	85	13.2	8-9mm	118
D.E.R.* 337	90	17.9	1-2mm	115
D.E.R.* 331	100	22.8	0-1mm	150

<sup>1</sup>60 microns on cold rolled steel; pigment/binder ratio 1/1; pigment=1/1 mix of titanium dioxide and zinc phosphate.

As hardener, an isophorone diamine adduct (IPD-adduct) is used, its properties are listed in Table 6.

The data from Table 5 clearly demonstrate the effect of the distance between the crosslinkage points of the polymer network and the flexibility: the effect being non-linear. A denser network yields a much higher Buchholz hardness because a closer spaced network has a greater resistance against the penetration of a sharp edge. From Table 5 it can be concluded that D.E.R.\* 660 provides a good balance of physical properties to serve as a basis for the development of high solids coatings.

Table 7 shows a high solids (85% wt) formulation based on D.E.R.\* 660. The hardener component is based on a combination of a standard low viscous polyamide D.E.H.\* 14 and the IPD-adduct hardener XZ 87706.05 (more reactive version of XZ 87706.15) to match the performance of a typical epoxy/polyamide coating.

**Table 6**

IPD-adduct, XZ 87706.15. Typical Properties

Typical Properties	
Amine value (mg KOH/g)	240-380
Viscosity, mPa.s (Cannon-Fenske at 25°C)	50-120
Colour, Gardner, max	3
Density, g/cc, 25°C	1.00-0.02
Flash point, °C (DIN 51755)	166
Use ratio with D.E.R.* 331 phr	47
D.E.R.* 337	37
D.E.R.* 660	27
D.E.R.* 671	18

Such a high-solids coating makes it possible to reduce the solvent content by ca. 50% compared to conventional epoxy/polyamide paints.

**Table 7**

High solids (85% wt) coating based on D.E.R.\* 660

Part A	Weight
D.E.R.* 660 X80	100
Anti-corrosion pigment	150
Red iron oxide	20
Talc	65
Xylene	15
Ethylacetate	21
Flow agent	3
Part B	
D.E.H.* 14E/XZ 87706.05	23
1/1	
Solids	: 85% wt
Pot life	: 5-6 hrs
Dry to touch	: 2 hrs

### Low viscosity novolac for high performance coatings

#### Epoxy novolacs

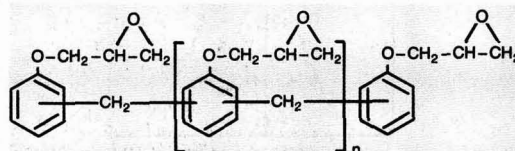
Epoxy novolacs have the chemical structure shown in Figure 5.

Most epoxy novolacs have functionalities from 2.6 to 3.9. Compared to bis A epoxy resins (with functionalities of 1.8-1.9) epoxy novolacs can achieve a much higher degree of crosslinking. In this way, the much tighter crosslinked polymer network will reduce the permeation and subsequent attack of the coating by aggressive chemicals. Especially low molecular weight molecules such as methanol are known to attack standard bis A epoxy coatings. By using the higher functional epoxy novolacs, coatings for storage tanks holding methanol or methanol containing fuels can be formulated successfully.

A disadvantage of epoxy novolacs is that they are highly viscous materials. Also, a post-cure at 60 to 80°C is recommended to achieve optimum performance. This extra

**Figure 5**

Epoxy novolacs



heat-cure is necessary to reach the high degree of conversion, leading to the higher crosslinking density, which gives the superior chemical resistance.

To overcome these disadvantages, a new epoxy novolac XZ 95345 has been developed for ambient cure applications with a viscosity of only 13000 mPa.s at 25°C and a functionality of 2.4 which does not need a post-cure to achieve sufficient conversion.

The curing profile of this new novolac has been measured via differential scanning calorimetry according to the following kinetic procedure:

#### Basic kinetics for the ambient epoxy/polyamine curing process

The basic simplified kinetic scheme for the ambient curing of a coating based on an epoxy/polyamine binder system can be represented as follows:



The rate of reaction given by:

$$\frac{d[\text{EP}]}{dt} = -k[\text{EP}]^n \quad [1]$$

with  $k$  : overall reaction rate constant  
 $n$  : reaction order

whereas  $k$  can be expressed in the Arrhenius form:

$$k = A \exp(-E_a/RT) \quad [2]$$

with  $A$  : preexponential factor  
 $E_a$  : activation energy  
 $R$  : gas constant  
 $T$  : absolute temperature

At any time,  $t$ , the degree of conversion,  $\alpha$ , is defined by:

$$\alpha = \frac{[\text{EP}]_0 - [\text{EP}]}{[\text{EP}]_0} \quad [3]$$

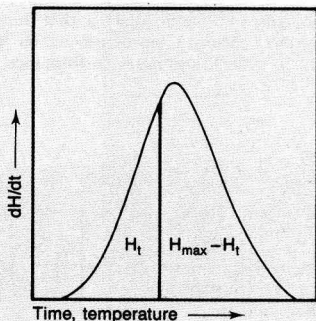
with  $[\text{EP}]_0$  and  $[\text{EP}]$  the concentration of epoxy groups at time = 0 and time =  $t$  respectively.

#### Mettler TA 3000 DSC kinetic program

A typical DSC scan for such an exothermic reaction is shown schematically in Figure 6.

Figure 6

Schematic DSC response for an exothermic reaction



All samples were analysed at a fixed heating rate of 10°C/min. With  $[\text{EP}]$  molecules, reacting with a constant heat of reaction,  $H$ , per epoxy unit, the conversion degree  $\alpha$  at any time is given by:

$$\alpha = \frac{Ht}{H_{\max}} \text{ and } \frac{d\alpha}{dt} = \frac{1}{H_{\max}} \cdot \frac{dH}{dt} \quad [4]$$

The rate of conversion,  $\frac{d\alpha}{dt}$ , measured in this way is related to the kinetics by combining Equations 1, 2 and 3

$$\text{This yields: } \frac{d\alpha}{dt} = k_0 \exp\left(-\frac{E_a}{RT}\right) (1-\alpha)^n \quad [5]$$

$$\text{with } k_0 = A[\text{EP}]^{n-1} \quad [6]$$

The kinetic software package of the Mettler TA 3000 DSC calculates via a regression technique values for  $k_0$ ,  $E_a$  and  $N$ . It also determines  $H_{\max}$ , the total reaction enthalpy for the sample.

#### Experimental procedure

The curing profile at ambient conditions of the epoxy novolac based coatings was evaluated as follows:

After thorough mixing for 5 min, each coating is applied to the inside of an aluminium cup, to a thickness of 2mm. During the course of time, 10mg samples are taken and analyzed via DSC. For each sample taken the total reaction enthalpy,  $H_{\max}$ , together with the reaction kinetics is determined.

According to this procedure, the degree of conversion (CONV) of the coating is given by:

$$\text{CONV}(t) = \frac{H_0 - H_{\max}}{H_0} \quad [7]$$

where  $H_0 = H_{\max}$  determined immediately after mixing

$H_{\max}$  = reaction enthalpy of sample taken after certain time  $t$ .

#### Coatings evaluated

Three different curing agents were used:

1. Isophorone diamine = IPD
  2. IPD-adduct = XZ 87706.15
  3. DETA-adduct = D.E.H.\* 52
- Typical properties of these curing agents are given in Table 8.

The kinetic reactivity data are obtained using Equations 5 and 6 and are given in Tables 9, 10 and 11.

#### Discussion of kinetic DSC data

When an epoxy/polyamine based coating cures at ambient conditions several physical-chemical transitions are taken place<sup>5</sup>.

On a macroscopic scale one observes after a certain time a sudden exponential increase in viscosity, followed by gelation and vitrification<sup>6</sup>. Gelation, which occurs at a fixed specific conversion marks the transition from a liquid to a rubbery state<sup>7</sup>.

Vitrification occurs when the glass transition temperature of the epoxy/polyamine mixture increases to the cure temperature. Therefore, vitrification can mark the transition of a liquid to an ungelled glass state or the transition from a

rubbery state to a gelled glass. Only the latter yields good performance properties.

The theoretical degree of conversion at the gel point for an epoxy/polyamine system depends on the ration, R, of the rate constants for the primary amine/epoxy reaction,  $k_1$ , and the secondary amine/epoxy reaction,  $k_2$ :

$$R = k_2/k_1$$

For a stoichiometric coating formulation, conversion at gelation increases from 50% for  $k_2 \gg k_1$  up to 62% for  $k_1 \gg k_2$ .

The actual measured conversion at gelation agrees with these theoretical values.

The experimental data from Tables 9, 10, 11 all indicate that for the first hours of cure  $k_1 \gg k_2$ . This means that up to a conversion of ca. 50% only the primary amine groups have reacted.

The coating with pure IPD as hardener reaches a conversion of only 70% after 7 days cure at 23°C. As a consequence

only a small amount of the epoxy groups have actually formed crosslinkages. This will explain the poor mechanical and chemical resistance data given below.

**Table 12**  
Conversion data for coatings based on XZ 95345 and different curing agents

Time	Curing agent		
	IPD CONV %	IPD-Adduct XZ 87706.15 CONV %	DETA-adduct D.E.H.* 52 CONV %
1 hour	5	20	34
2 hours	8	37	54
7 hours	54	60	65
1 day	66	75	74
2 days	68	89	78
7 days	70	95	83

**Table 8**  
Typical properties of curing agents used

	IPD	IPD-Adduct XZ 87706.15	DETA-Adduct D.E.H.* 52
Amino Hydrogen Equivalent Weight	43	90	44
Viscosity, 25°C, mPa.s	18	110	6000
Mix ratio with XZ 95345,phr	25	52	26

**Table 9**  
Kinetic data for coating based on XZ 95345/IPD. Curing temperature 23°C

Time	Conversion %	Peak Exotherm Temp, °C	Activation Energy, E <sub>a</sub> kJ/mol	Reaction order n	ln k <sub>o</sub>
0	0	107	89	2.8	24
1 day	66	131	51	1.3	10
7 days	70	130	50	1.3	10

**Table 10**  
Kinetic data for coating based on XZ 95345/IPD-adduct XZ 87706.15

Time	Conversion %	Peak Exotherm Temp, °C	Activation Energy, E <sub>a</sub> kJ/mol	Reaction order n	ln k <sub>o</sub>
0	0	96	82	3	22
1 day	75	146	53	1	11
7 days	95	139	52	1.2	12

**Table 11**  
Kinetic data for coating based on XZ 95345/DETA-adduct D.E.H.\* 52. Curing temperature 23°C

Time	Conversion %	Peak Exotherm Temp, °C	Activation Energy, E <sub>a</sub> kJ/mol	Reaction order n	ln k <sub>o</sub>
0	0	97	95	2	27
1 day	76	99	58	1.5	14
7 days	83	102	48	1.2	10

The conversion data obtained using Equation 7 are summarized in Table 10.

### Physical-chemical test data

The mechanical and chemical resistance properties of the different coatings were determined after 7 days cure at 23°C. Test results are given in Table 13.

From Table 13 it follows that the coating based on the DETA-adduct shows the highest resistance to small solvent molecules such as ethanol and methanol. This is due to the chemical structure of DETA which, in combination with the 2.4 functional novolac, yields a crosslinked network with smaller spacings between crosslinkages compared to IPD. This also explains why a coating with a conversion of epoxy groups of 83% has a better resistance to solvent permeation/attack by small molecules, compared to a coating with 95% conversion.

of the formulations ca. 3-5% solvent is included. Often a mixture of a glycoether and isopropanol is used to improve drying speed, flow and gloss.

A typical formulation is given in Table 14.

The most important application for these water-based epoxy paints is coatings for concrete surfaces, because of their excellent adhesion to damp concrete. Although adequate for many applications such paints have some distinct weaknesses such as the short pot life of only 1-2 hours, and the impossibility of producing true white coatings.

To overcome these disadvantages, Dow has developed a novel patented<sup>10</sup> amine functional acrylic polymer, XZ 95330, which in combination with liquid epoxy resins, yields water-reducible coatings that combine the weathering and colour properties of acrylics and the chemical/corrosion

**Table 13**

Physical-chemical test data of coatings based on XZ 95345 and different curing agents, after 7 days cure at 23°C

	Curing agent		
	IPD	IPD-adduct XZ 87706.15	DETA-adduct D.E.H.* 52
Conversion %	70	95	83
<b>Chemical Resistance</b>			
% wt change after 1 W immersion:			
Water	0.2	0.2	0.5
10% H <sub>2</sub> SO <sub>4</sub>	10	2.1	1.5
10% NaOH	0.3	0.3	0.4
10% Acetic Acid	destroyed	3.1	destroyed
Xylene	6.5	0.1	0.2
Ethanol	destroyed	5.2	0.2
Methanol	destroyed	destroyed	2.3
<b>Tensile Strength, ASTM D-638:</b>			
Peak Stress, MPa	too brittle	42	43
Peak Strain, %		1.2	1.2
<b>Flexural Strength, ASTM D-790:</b>			
Yield Stress, MPa	too brittle	60	69
Yield Strain, %		2	2.1

### Novel aminated acrylic/epoxy binder for water-reducible coatings

Ambient cure water-based epoxy coatings were first introduced in the early 1970s. Their main advantages are economy, non-flammability and reduced toxicity. The majority of these coatings are based on polyamides chemically modified to emulsify liquid epoxy resins<sup>9</sup>. In most

resistance of epoxies. Typical properties of the amine functional acrylic resin are given in Table 15.

XZ 95330 contains as a lipophilic part, an acrylic base polymer which is reacted with an imine to form an amino ethyl ester. Subsequently the amine group is neutralized with an acid to form a cationic salt to render the acrylic polymer water-soluble. This is schematically presented in Figure 7.

As the acrylic polymer is an amine salt and only water-soluble as a salt, the use of basic pH fillers (zinc oxide, calcium carbonate, etc.) will reverse the equilibrium and precipitate the material. Therefore, the formulator needs to use non-alkaline fillers and nonionic or, preferably, cationic additives where possible.

A basic start formulation is given in Table 16 which produces films with physical properties similar to the conventional solvent-borne epoxy/polyamide coatings.

**Table 14**

Water-based floor coating\*

Part A	
Casamid 360	20
Byk 031 Defoamer	0.4
Colour Pigment	10.1
Talc	9.8
Barytes	15
Water	26
Isopropanol	1.8
Propylene glycol mono methyl ether	1.8
	84.9
Part B	
<sup>1</sup> Standard Bis A/F resin (EEW=190) diluted with C <sub>12</sub> -C <sub>14</sub> glycidyl ether	15.1

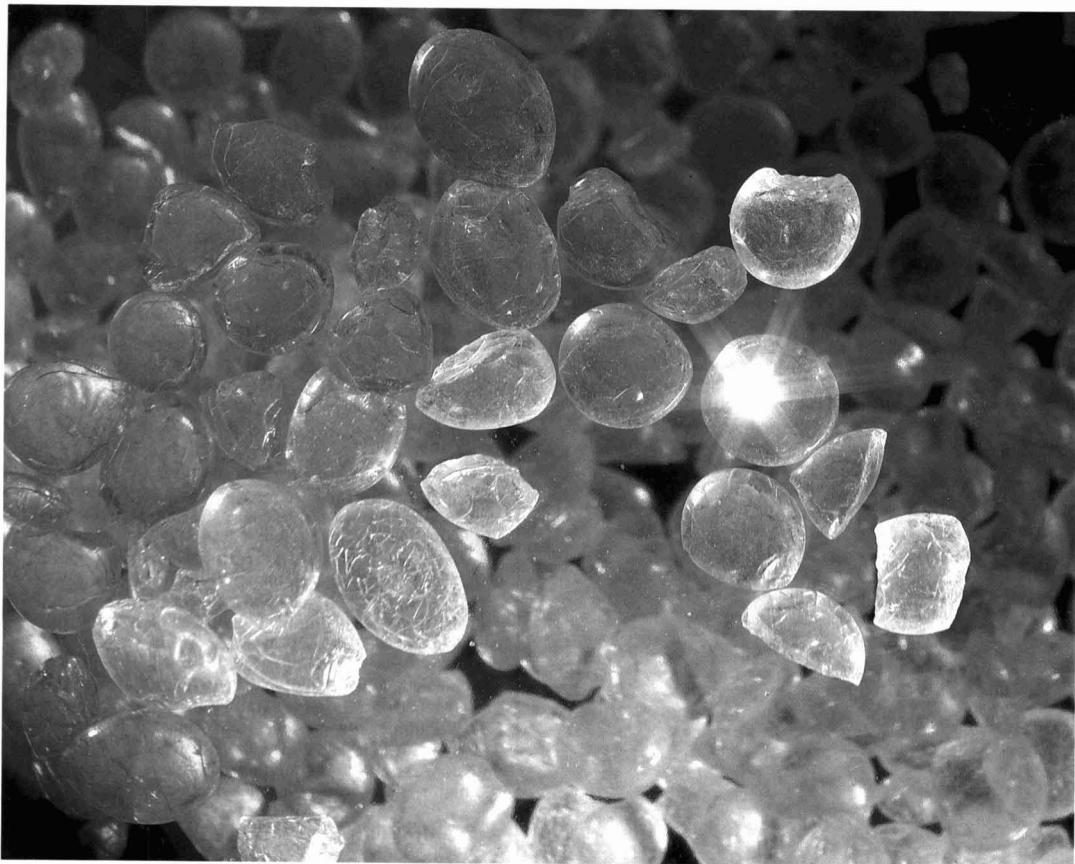
<sup>1</sup>D.E.R.\* 353

**Table 15**

Typical properties XZ 95330

Amine hydrogen equivalent weight	350-450
Viscosity, 25°C, mPa.s	15000-35000
pH	5
Density, 25°C, g/ml	1.1
Colour, Gardner max	3
Non-volatile, %	56
Dowanol* PM	33
Water	11

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Its properties are given in Table 17.

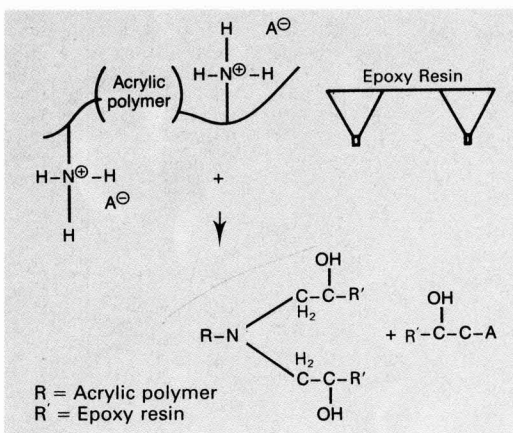
The incorporation of non-alkaline corrosion inhibiting pigments such as Molywhite 101, K-White 84 and certain modified zinc phosphates makes it possible to produce a 3-layer coating system for industrial maintenance which complies with the US Environmental Protection Agency (EPA) guidelines on solvent emission.

In the US, regulation of atmospheric solvent emission from coatings began about 20 years ago with the Los Angeles Pollution Control District Rule 66<sup>11</sup>. More recently, the EPA has issued guidelines to be enforced by individual States, limiting the amount of solvent emission in industrial coatings on an industry-by-industry basis. For industrial maintenance applications a limit of 420 g/litre paint for volatile organic compounds (VOC) has been put forward.

The California Air Resources Board model rule for architectural and maintenance coatings proposes a VOC limit of not more than 290 g/l and 250 g/l respectively<sup>12</sup>.

**Figure 7**

Generalized structure of acrylic amine polymer



**Table 16**

Basic start formulation

Part A	
XZ 95330	25
TiO <sub>2</sub>	30
<sup>1</sup> Defoamer	1.5
Isopropanol	1.5
<sup>2</sup> Dowanol PPH	2
Water	40
	100
Part B	
D.E.R.* 353	12.5
or	
<sup>3</sup> XZ 87715	12.5

<sup>1</sup>Tego Foamex 7447

<sup>2</sup>Propylene glycol phenyl ether

<sup>3</sup>Experimental emulsifiable epoxy resin

### High solids/water reducible coatings. Conclusions

At present there is no similar European EEC regulation on solvent content of coatings, but individual countries in Scandinavia and Germany have already started to enforce certain limiting rules for solvent emission.

These environmental regulations will most certainly

**Table 17**

Properties of acrylic amine/epoxy coating compared to solvent-borne epoxy/polyamide

	Water based Acrylic amine/ epoxy	Solvent-borne Epoxy/ polyamide
Pot life	6-8 hours	7-8 hours
Tack free time	40 min	60 min
Properties after 7 day cure at 23°C and 50% rel. hum:		
Buchholz hardness	120	110
Erichson flexibility	7mm	6-8mm
Gloss, 60°	90	90
Cross Hatch adhesion	100%	100%
Water <sup>1</sup> resistance	80%	80%
10% NaOH resistance	100%	100%
10% HCl resistance	100%	80%
10% Acetic acid resistance	90%	60%
Xylene resistance	100%	100%

<sup>1</sup>Chemical resistance

100%=No effect

0%=Failure

accelerate the change in coating technology away from conventional solvent borne coatings towards high solids and water-reducible coatings.

In Europe, the market share for water-based coatings is estimated to increase from 11% in 1986 to 16% by 1991, for a total market size of 5 million metric tons in 1986<sup>13</sup>.

A similar trend is predicted for high solids coatings.

This paper has given an overview of some recent developments by Dow in ambient cure epoxy resins.

In particular, it has been demonstrated that the new resin D.E.R.\* 660 and the novel amine functional acrylic polymer XZ 95330 make it possible to formulate coatings which comply with the EPA and CARB legislation on solvent emission. At the same time these new developments provide the high performance properties needed by the industry.

### Acknowledgements

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Presentation given at Eurocoat conference Nice 1989

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## Preservation of a quality image—development of an alternative method of can decoration

by J. B. Emerson, CMB Packaging Technology plc, Denchworth Rd, Wantage OX12 9BP, UK

### 1. Introduction

Until the early 1970s beer and soft drink cans were made traditionally by forming a body from a flat blank of previously printed and lacquered tinplate which was then joined by soldering or welding. The can maker fixed one end to the can, the filler packed the product and finally attached the other end to complete the can construction. The can was known as the 3-piece can, reflecting the number of components from which it was made.

Very high quality graphics could be achieved by direct printing of the can body using lithography. Some very sophisticated multi-colour designs became established, particularly in the brewing industry. Many of these became associated with a brand image, the classic case being the Tennents Lager "Lovelies".

This design, featuring a pair of foaming, tall lager glasses on one side of the can accompanied by an attractive young lady to entice the purchaser on the other, is well known and requires the reproduction of high quality images in several colours.

During the early 1970s the lighter and cheaper 2-piece can became available in which one end and the body wall were drawn from steel or aluminium into a container which had improved integrity. The method of construction dictated that the container was decorated and internally lacquered after can manufacture. It was not possible to decorate by lithography and achieve the high quality graphics associated with traditional can making techniques. This did not prove a major limitation for soft-drink containers but the brand image of the Tennents can demanded a novel approach to 2-piece decoration.

### 2. Selection of an alternative decoration process

#### 2.1 The Standard 2-piece can process

Any alternative process offering higher quality graphics than that achievable by the standard technique for 2-piece can

decoration had to overcome any process limitations. In addition, standard labelling of the plain formed container was a potential threat, since the can maker would lose the added value of decorating.

Figure 1 is a diagrammatic representation of how a 2-piece can is decorated. As mentioned earlier, the container is made prior to decoration (except for the neck at the top of the can). An external basecoat is normally applied which is usually white. This is then stoved before application of the external print. The coatings and inks are applied whilst the can is held on a mandrel. In Figure 2 a schematic representation of the printing machine is shown.

A central wheel (blanket cylinder) supports a number of printing blankets (made from synthetic rubber). This rotates in contact with 4 (or sometimes 6) inking stations. The inking stations each consist of a printing plate with the image to be transferred, wrapped around a plate cylinder. Ink is fed to the plate via rubber rollers from a duct at each inking station.

As the central wheel rotates, the colours of the design are transferred one-at-a-time to the blanket. Cans are fed into the machine and rotate against the blanket cylinder when the full design is transferred to each can in turn.

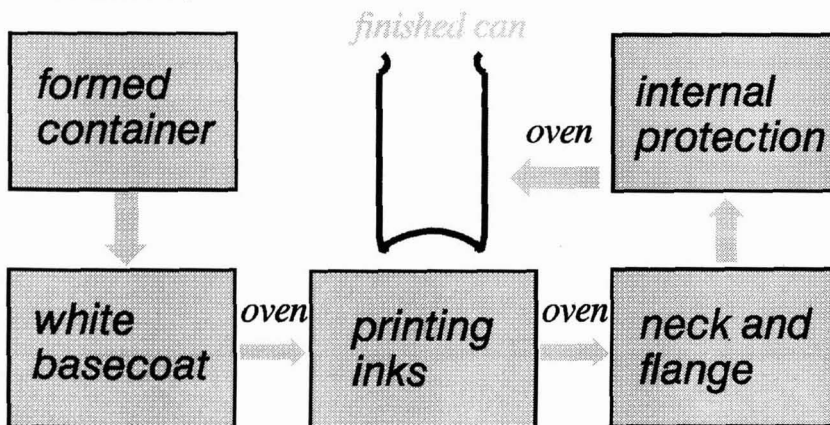
The key print quality limitations defined by the process are therefore:

- a maximum of 4 (or at most 6) colours per design (cans cannot be re-fed).
- no drying between colours—very limited potential for overlap of colours.
- pressure between rubber blanket (resilient) and printing plate (hard) causes slight image distortion.
- very high speed production (600 cans per minute at first, now 1,500 with 2,000 planned).

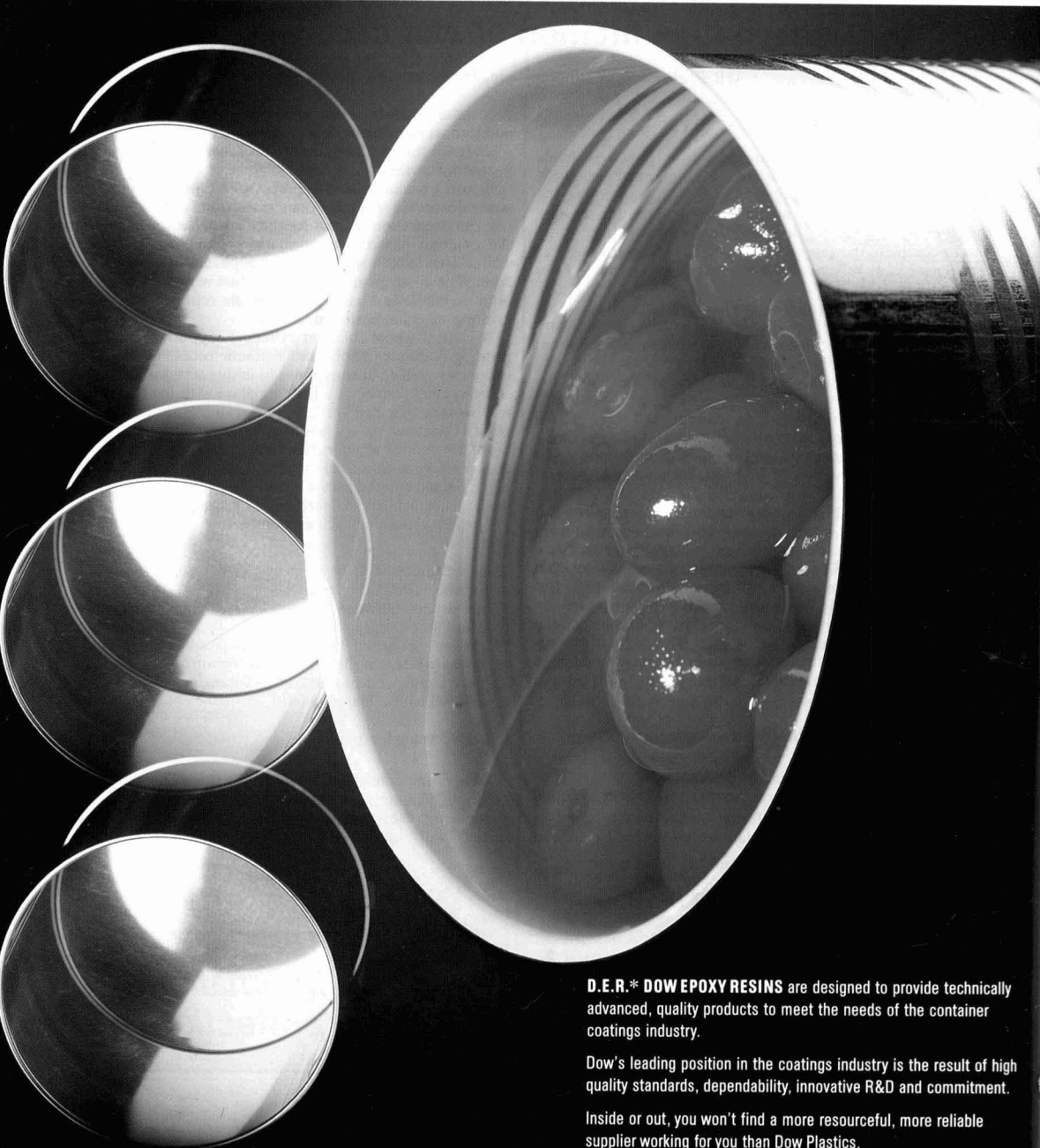
#### 2.2 Dye transfer printing

When first considered in 1975, dye transfer printing was a technology mainly employed by the textile industry. The process involves printing a design on to a carrier (usually paper) with inks containing heat sublimable dyestuff as

Figure 1  
Standard decoration sequence



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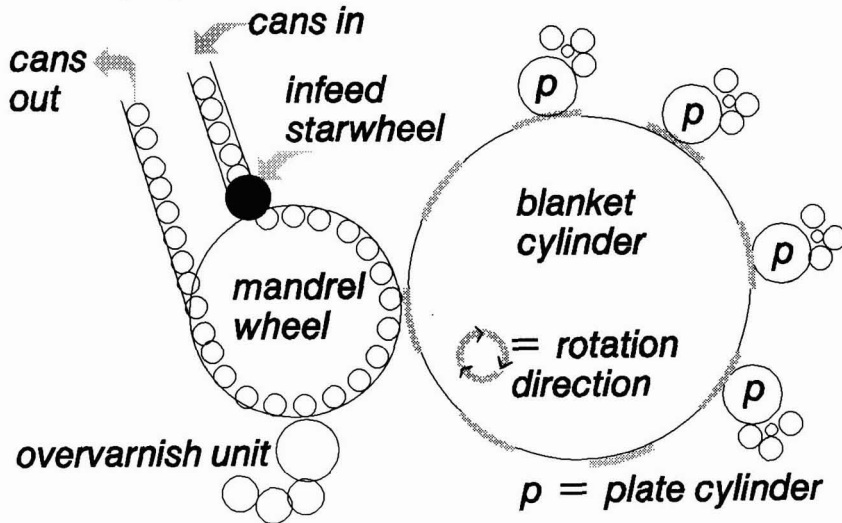
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**Figure 2**  
Two-piece can printing



colourant. The design is printed in reverse, the carrier placed in intimate contact with the material to be printed (design face down) and heat is applied. The coloured dyes sublime into the material from the carrier on heating leaving the transferred positive image on the material.

The potential for high quality can decoration was considered significant. The image could be printed using high quality techniques such as gravure. In particular, the gravure printing process used liquid inks which were well suited as a medium for heat sublimable dyestuffs. The number of colours on a design was no longer limited to 4 and rapid design changes could be accommodated by simply changing the pre-printed carrier to an alternative image. From the container manufacturer's viewpoint, wet ink was removed from the decoration process.

### 3. Development issues

Identifying a potential alternative process was the first stage in a major development programme. The textile dye transfer process was not very suitable for can decoration. A practical method of applying the image carrier, transferring the image and removing the carrier afterwards at speeds compatible with a high output production environment had to be identified. The printing techniques required to produce a consistent, high quality image had to be defined together with a way of presenting proofs of new designs to the customer which would be representative of the production results.

Commercial protection was essential. A Company tradename was established for the process which was called "Reprotherm" to reflect the requirement for heat in the image generation process. All process and material developments were protected by Patents.

### 4. Key elements of the development programme

The key requirements around which the "Reprotherm" process was built are highlighted below.

- Identify image carrier
- Develop printing process
- Transfer technology to production

Whilst specific details of many of these elements remain

confidential the general approach can be outlined.

#### 4.1 Identification of image carrier

The most suitable carrier was a paper label. Since the carrier is discarded once it has done its job, the paper ideally needed to be as cheap as possible but in practice could not allow fibrous material to deposit at the printing stage or on the can during heating. This would prevent image transfer in areas on the design. All other paper properties had to be rigorously defined to suit the printing process, the application to the can and the label removal procedure.

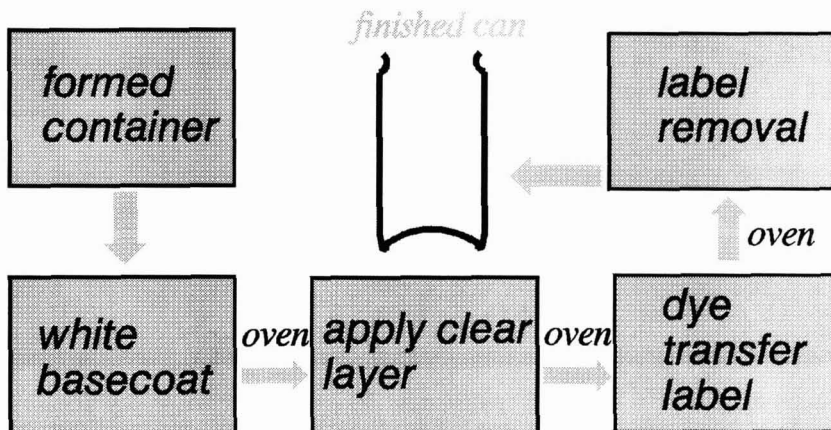
#### 4.2 Development of the printing process

Initial experiments with white basecoated cans showed that the dye transfer image would not transfer well. However, a clear receptive layer was specially developed which, when applied over the basecoat, enabled very efficient image transfer. The clear layer had also to be flexible enough to withstand the neck forming operation of the can but could not be too thermoplastic, or paper fibres would be retained during the heating operation required to transfer the dyes. Excessive thermoplasticity of the clear layer would cause difficulty in removing the paper carrier after the dye transfer operation. The coefficient of friction of this overlayer had to be low as this determines the speed at which the cans may be handled through the manufacturing lines and the customer's filling plant.

Suitable dyes were identified for the gravure ink medium. The final result had to be a high fidelity replica of the customer's original requirement and the dyes had to have certain minimum standards of lightfastness. The image had to be stable to the pasteurisation conditions at the customer's plant (typically in the region of 80°C for 30 minutes in water with chemical biocide additives). The temperature required for dye transfer needed to be high enough so that the untransferred labels were stable under ambient conditions but not so high as to be impractical in the production process.

A colour transparency was the usual medium provided as the original, to be replicated in the final printed image. In the normal printing process, techniques are used to separate the

**Figure 3**  
Reprotherm decoration sequence



transparency into constituent colours. The image is then rebuilt by recombining the colours, one at a time through the printing process. Using the normal colour separation techniques, however, did not result in a faithful reproduction of the original. This was because the constituent dyes did not all diffuse at the same rate or efficiency at a given diffusion temperature. In addition, significant colour development occurred on transferring the image into the receptor layer on the can. This meant that the colour density values of the untransferred image on the label were significantly less than those observed on the final printed can. Standards were developed to ensure a consistent result.

In order to provide a good indication of the likely result to the customer it was necessary to develop a proofing process which could be used to produce a small number of labels for approval, before committing the production run. Since the engraving of gravure cylinders is expensive it was not possible to carry out this operation in order to provide proofs, in case alterations to the proofs were requested by the customer. A technique of generating lithographically printed proofs was developed. The information from these could then be used to carry out the necessary engraving of the gravure cylinders.

Once printed labels were produced they had to be cut accurately to wrap around the can and the images of the 4 girls (5 in the later series) had to be randomised to provide a mixture of "Lovelines" on the supermarket shelf rather than batches of the same girl.

#### 4.3 The production process

Figure 3 illustrates the stages required to generate a "Reprotherm" decorated can. White basecoat is applied in the normal way and this is stoved before application of the clear receptive layer. Internal protection (lacquer) is spray applied and the can is necked and flanged to complete its construction. The dye transfer decoration is the final operation. A labeller applies the paper with its printed image around the can, the image facing inwards. The can plus dye transfer label passes through an oven and the dyes diffuse into the receptor layer on the can surface. The label is then stripped from the can by an air knife leaving the decorated container ready for delivery to the customer.

#### 5. Production experience

The "Reprotherm" process was introduced into production in 1982 and some 120 million cans per year are now decorated in this way. The method has been extended to other designs and technical development continues to improve the capabilities of the process.

Technical innovation has satisfied a market demand and the success of this programme has ultimately led to increased business for both the supplier and the customer. ■

# MANCHESTER SECTION SYMPOSIUM TOWARDS A GREENER COATINGS INDUSTRY

20 - 21 SEPTEMBER 1990

SALFORD UNIVERSITY

Contact: Terry Wright on 061-434 3511 for further information

# How To Run Successful Titanium Dioxide Plants

SCM Chemicals Limited, P.O. Box 26, Grimsby, South Humberside, DN37 8DP  
Telephone:(0469) 571000, Fax:(0469) 571234, Telex:52595

We have been asked this question many times during the last few years, and have always given the answers freely - to customers of course!

The world-wide success we have achieved encourages us to continue to expand the process. We plan to provide these answers freely to customers and potential customers, by means of informative advertising and even more informative visits (to and from) by technical and commercial staff (your place or ours? is the only question at this stage). Both, for preference!

We can provide a few background topics to stir your thinking processes on how we can jointly continue this success.

## 1. Corporate Research Benefits

Firstly, you need a well-researched, reliable, high-quality process for manufacturing a chloride route base pigment. We believe this is greatly helped by having first had access to chloride technologies from several high quality sources. At SCM, we have had access to six or seven of these spreading over more than 20 years. Each technology had its strong points and the combined synergy we have built into our five international chloride plants is excellent. Our own technologists, having such a rich feast of data on their intellectual menu, have had the stimulus of working at the leading edge of their technology. This continued high motivation helps us to increase the "knowledge-content" of our products and to continue adding value through product differentiation. Many of our customers have joined us in this search for excellence, by incorporating these ideas and products into their own development programmes.

## 2. Achievement Through Investment

During the severe shortage years 1983-onwards, SCM brought out major chloride volume increases, including an extra 100,000 tonnes worldwide. We did not play the "announcements game", but merely came up with the extra product when it was most needed. We achieved this by investment and by genuine product improvement by the environmentally preferred route.

When the world pigment shortage was at its most severe, we introduced a series of new and better grades to give our customers an even wider choice in an even greater volume e.g. TiONA®RCL-69 into the European and international plastics market, TiONA® RCL-535, which benefitted greatly from a synergy-boost, in vital properties such as **Opacity, Gloss and Durability** for the surface coatings of the future. TiONA®RCL- 628, for superdurability with high opacity and gloss, represents a very careful and judicious use of modern

zirconium treatments. We continued with our already successful TiONA's®RCL-472, -388, -376 -552 etc. etc.

## 3. Assistance with R & D

The excellence of the new chloride base pigment technology, combined with continually developing surface treatments, has given significant added value to our whole range. Such developments will increase your formulating flexibility and on a price-performance basis they could do a lot for your business too. Would you like to talk to us about multi-purpose grades of high performance titanium dioxide pigments, which actually **Increase** your formulating flexibility?

Perhaps you will let our technical service laboratories assist your own R & D in producing some innovative paints and ideas for your evaluation.

We have already done this for several organisations recently, and the results have been excellent, from both points of view. You could end up with a better product and a lower cost and a secure supply of really high quality titanium dioxide pigment from one of the world's major producers.

## 4. Vitreous Enamelling

Naturally, we have been considering high quality rutile pigments so far.

For those who need anatase, there is always the sulphate process which we use to produce this crystal form. We run our innovative sulphate process with the benefits of the SCM continuous sulphation method, which reduces the surges and variations associated with a batch process. By this route, SCM makes highly dispersible anatase for the world's paper industry (available in the dispersible beater bags with special soluble printing) and for the rubber and rubber latex processes - from rubber tyres to white filament elastic. Additionally, this is where we make the unique, world-leading TiONA VC grade for vitreous enamelling.

Whatever your needs, we would like to see you joining with us in the development of pigments and ideas to continue the progress in



*SETTING THE STANDARD IN TiO<sub>2</sub>*

## Butyl glycol — the efficacious solvent in aqueous coating systems

by W. Appelt, BASF Aktiengesellschaft D-6700 Ludwigshafen/Rhein, W. Germany

Butyl glycol (ethylene glycol mono-n-butyl ether; CAS Reg. No. 111-76-2) has considerable advantages over the other glycol ethers of ethylene and propylene that are used in the coatings industry. These benefits can be ascribed to the well-balanced distribution of hydrophilic and hydrophobic groups in the molecular structure, the free miscibility with water at room temperature, and the rate of evaporation (solvent release) from surface coatings.

Comprehensive studies on the toxicology of ethylene glycol ethers have resulted in a fundamentally better evaluation for butyl glycol than for methyl and ethyl glycol. The current classification of methyl and ethyl glycol according to EEC Guidelines 67/548/EEC and the legislation based on it in the individual countries of the Community does not conform to what is currently known of their peculiar toxicological (teratogenic) properties. An application for the necessary correction has been lodged with the EEC Commission responsible.

Provided that due attention is paid to the obvious and normal safety and industrial hygiene precautions necessary in handling chemicals, butyl glycol does not exert any harmful effects on health. Since it is readily biodegradable, there is no risk of its accumulation in the environment.

### Introduction

Some years ago, ecological demands occasioned well-known coatings manufacturers to intensify their development work aimed at a drastic reduction in the proportion of organic solvents in their products. The ultimate target was to reduce solvent emission on the part of the final consumer, yet retain the quality coatings of that time. The results of these efforts are evident today: low-emission coating systems are now available for almost all known applications in industry, commerce, and the household, e.g. automotive finishes, coil coating systems, anticorrosion paints, and wood and house paints. These systems are already being successfully used on a large scale in practice, and the trend is for increased use. The great differences that exist between the various fields of application are reflected in the demands imposed on the coatings. Thus great care must be exercised in selecting binders, pigments, additives and solvents in individual cases. Formulations for low-emission, e.g. aqueous, coatings, are still largely empirical and require considerable know-how.

The term "low-emission coatings" embraces solvent-free systems, e.g. powder paints and radiation-curable lacquers; solvent-reduced coatings, e.g. medium-solids and high-solids paints; and water-based systems.

### Organic solvents in aqueous coating systems

Aqueous coating systems can roughly be divided into three main groups:

- heat drying/promoted (ambient drying) systems
- systems that dry oxidatively
- systems that dry by physical means.

Experience has shown that a certain proportion of organic solvent is required in the production, storage, and application of these systems; it depends on the field of application and may vary between 2% and 15% of solvent. Investigations aimed at finding suitable types have included ethylene glycol ethers of cosolvents of aqueous systems, and new propylene glycol ethers. These investigations reveal that butyl glycol has optimum properties for the production, storage and

application of aqueous coating systems and is superior to all other glycol ethers of ethylene and propylene.

### Properties of butyl glycol in aqueous systems

#### General

- Butyl glycol is compatible with all currently available water-soluble and water-thinnable binder systems.
- Butyl glycol minimises the viscosity anomaly that otherwise occurs if water-based, stoving and air-drying (oxidative or physical) paints are thinned with water. In this important point, it is decidedly superior to its lower homologues and the monoalkyl ethers of propylene glycol.

#### Aqueous heat drying and systems that dry by oxidation

- Butyl glycol allows the formulation of systems with optimum rheology and thus facilitates application (e.g. for spray gun application, in which case it ensures uniform droplet size distribution, improves levelling, and prevents sagging).
- Butyl glycol permits optimum colour constancy, e.g. in automotive metallic base coats. It thus allows coatings to be touched up, if necessary, with either conventional or aqueous systems. A point to observe is that, if aluminium flakes are responsible for the metallic effect, base coats containing butyl glycol tend to form alcoholates with the evolution of hydrogen. In this case, it is essential to add stabilizers.
- Butyl glycol increases the evaporation rate of volatiles in hot air or infra-red radiator dryers. The well-balanced distribution of hydrophilic and hydrophobic groups in the butyl glycol molecule is largely responsible for this beneficial effect.

#### Aqueous systems that dry by physical means

The advantages of butyl glycol in emulsion paints are as follows:

- It lowers the minimum film-forming temperature.
- It allows optimum solvent release, as determined by the König pendulum-rocker hardness test (DIN 53 175).
- It can be readily incorporated in the paints because of the well-balanced distribution of hydrophilic and hydrophobic groups in the molecule.
- It is freely miscible with water at room temperature.

Other glycol ethers, e.g. those of propylene, may be better film coalescents, but still be inferior to butyl glycol either because they are not freely miscible with water and/or because they are not readily released from the surface coatings.

#### Toxicological effect of butyl glycol

A few years ago, the toxicological properties of ethylene glycol ethers — particularly methyl, ethyl and butyl glycol — was the subject of some concern. Since then, numerous studies have been made in which the effects of the individual substances were thoroughly investigated and clarified. In the light of these studies, differentiated classification for each of the ethylene glycol ethers is justified.

The most important property that concerns handling ethylene glycol ethers is the putative teratogenic effect of methyl and ethyl glycol. It is for this reason that these

solvents have been classified under Pregnancy Group B by the West German Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area.

The classification "Pregnancy Group B" imputes that the risk of foetal injury is likely in the light of the information available. Even compliance with the MAK and BAT values\* cannot fully exclude danger to health of this nature if pregnant female workers are exposed to the substance concerned.

Since butyl glycol did not give rise to these teratogenic effects in experiments on animals, it has been classified in Pregnancy Group C. Classification in this group implies that the risk of foetal injury need not be feared if the MAK and BAT values are followed.

In contrast to methyl and ethyl glycol, butyl glycol does not give rise to an indications of testicular atrophy and injury of the medulla.

In experiments on animals, however, butyl glycol displayed haemolytic effects, i.e. the lysis of red blood cells in the peripheral blood stream and the occurrence of haemoglobin and its degradation products in urine, which thus assumed a characteristic brownish red coloration. These effects were particularly pronounced in rats, mice and rabbits, but not so much in primates, dogs and guinea pigs. Despite the fact that butyl glycol has been used for decades in industry, only the one case of haemolytic effects that could be ascribed to it has been described in the literature, and that occurred after an extrem overexposure. In contrast to teratogenesis, haemolytic effects are reversible.

In the 1989-1990 list of threshold limit values published by the American Conference of Governmental Industrial Hygienists (ACGIH), the figures quoted for the TLV TWA of butyl glycol are 25 ppm and 121 mg/m<sup>3</sup> (skin). The corresponding entry in the 1989 West German list of MAK values is as follows: 20 ml/m<sup>3</sup> and 100 mg/m<sup>3</sup>; H = may be absorbed by the skin; ceiling limit category II, 1. If these values, together with the usual safety and industrial hygiene precautions relating to handling chemicals (e.g. avoidance of skin contact), no risks are involved in handling butyl glycol.

These remarks on the ethylene glycol ethers apply equally well to their acetates, which are hydrolyzed in the human body into the corresponding ethers and acetic acid.

Since butyl glycol has very little volatility (its vapour pressure is 0.89 mbar at 20°C), the risk of its being inhaled is slight.

#### Biodegradability of butyl glycol

The following values were obtained by internationally recognized laboratory test methods to determine the

degradability of butyl glycol in waste water streams:

BOD<sub>5</sub> = 1105 mg/g

COD = 2125 mg/g

□ Decrease in DOC in the Zahn-Wellens test > 90%

In the light of these figures, butyl glycol is readily biodegradable, and will not accumulate in the environment. These results have been confirmed by experience gained in practice.

In the West German catalogue of water pollutants, butyl glycol is listed in Category (WGK) 1, which pertains to pollutants that have only a weak effect on the quality of water.

If the normal precautions are taken in running it into an acclimated water treatment plant, butyl glycol will not exert any disturbing effect on the efficiency of the activated sludge. In other words, the microorganisms in the activated sludge must be acclimated to the solvent to ensure successful biodegradation. Peak loads and overloads in the water treatment plant should be avoided.

#### Further reading

Information of a general and a more advanced nature on butyl glycol is given in the following technical literature published by BASF Aktiengesellschaft†.

#### Technical information bulletins

- Butyl glycol in wäßrigen Beschichtungssystemen — Ein Überblick (TI-CIW/ES 016 d; January 1990)‡.
- Butyl glycol, butyl glycol acetate — Untersuchungen zur Toxizität der Glykolether und deren Acetaten (TI-CIW/ET/ES 015 d; October 1989)‡.
- The biodegradability of glycol ethers — with special reference to Solvenon® PM (TI-CIW/ES 013 e; February 1989).

#### Technical leaflets

- Butyl glycol (M 1546 d; January 1990)‡.

† Obtainable on request from: BASF Aktiengesellschaft, Unternehmensbereich Industriechemikalien, Marketing Weichmacher und Lösemittel, CIW/ES, H 201, D-6700 Ludwigshafen, W. Germany.

‡ The English-language versions will be published in due course.

\* MAK values are the maximum allowable workroom concentrations of the substances concerned that do not impair the health of the employee nor cause undue annoyance. BAT values are the maximum allowable concentrations of the substances concerned that can be tolerated in the workroom from the biological aspect and can be considered as equivalents to biological exposure indices. ■

## OCCA ANNUAL GENERAL MEETING

Thursday 14 June 1990

Naval Club, Hill Street, London 4.45pm

# Solvent emission from newly painted surfaces

by G. Rosén and I. M. Andersson, National Institute of Occupational Health, Division of Industrial Hygiene, S-171 84 Solna, Sweden

## Abstract

Two different models describing the rate at which solvents evaporate from a newly applied paint have been studied. According to one model, the transport rate in the liquid phase governs the emission rate. A specially designed device was used to evaluate the models. The results showed that the model was accurate in describing the drying process if also the air velocity over the surface were considered.

## Introduction

The exposure to organic solvents during surface coating operations using paints and varnishes represents a major industrial hygiene problem. The extent to which workers are exposed is governed by a number of factors, such as application and work techniques, work place ventilation, the use of personal safety equipment and the paint's emission of various solvents during drying.

The emission of solvents during drying of paint depends on the chemical and physical properties of the various solvents, both in the paint layer and in the gas phase above that layer, their vapour pressures, the temperature and air flow patterns across the surface. This makes it hard to perform exact calculations of the different processes in a system this complex, depending on the numerous parameters involved. Simplifications are necessary in any predictions about the emission of solvents from a paint with a given composition.

An evaluation model (YL-number), which only considers the product's total solvent content and the threshold limit values of the solvents, has been used in Sweden for several years. A similar model (MAL-number) is used in Denmark. This model also takes into account the vapour pressure of the pure solvents at room temperature. These numbers provide guidance on the industrial hygiene problems which can be anticipated during the use of paints with various properties. Since the Swedish YL-number is viewed as an excessively crude and, frequently, misleading aid, the paint trade has stopped using it. However, there remains a need for a comparative value capable of providing useful guidance in the choice of paints with the most favourable properties possible, viewed from the industrial hygiene point of view.

The aim of the present study was to ascertain whether a simple model could be devised to describe a simplified model for solvent emission during paint drying. The model would cover most of the drying phase and make it possible to predict the magnitude of emission with acceptable accuracy.

## Mechanisms of drying

When a layer of paint is applied to a surface, the layer mainly consists of binder dissolved in solvents, various pigments and suspended or dissolved filler. At the time of application almost half of the paint consists of solvents. During the drying phase, all the solvents should, in practice, diffuse to the paint surface, vaporize and then be swept away in the gas phase. According to Fick's Law, the rate of solvent diffusion in the paint layer depends on the diffusivity of each solvent in the mixture and the driving force, i.e. the concentration gradient. This concentration gradient develops because solvent at the surface of the paint layer vaporizes and evolves from the paint. The rate of vapour emission into ambient air is governed by Fick's Law in the same way as the

rate in paint. However, the diffusivity here are those of the substances in the gas phase. The driving force is supplied by the saturation vapour pressure of the solvents, their concentration in ambient air and the transport distance in which diffusion is assumed to be the main transport mechanism. This distance, referred to as the laminar boundary layer, is governed by flow conditions across the surface. A high air velocity and turbulence reduce this transport distance, thereby increasing the driving force. So two completely different transport mechanisms, each operating at different velocities, are involved and jointly comprise the entire process. This means that the total transport rate is governed by the slowest. In a paint with a very high concentration of solvents, the rate of solvent escape from the paint surface initially determines the rate of solvent emission. Information on temperature, solvent composition and flow conditions then make it possible to calculate the emission of solvents. A relevant calculation model has been described by Feigley et al<sup>1</sup>. The required chemical and physical parameters are available in tables but can also be estimated by means of different methods<sup>2</sup>. Emission from a paint containing only one solvent is constant as long as temperature and flow conditions in the gas phase are constant.

The solvents concentration in the paint layer drops as they evolve from the paint. This reduces the diffusivity of solvents due to increased viscosity<sup>3</sup>. At a given point, the two transport velocities will be identical. The rate of solvent diffusion in the paint layer will then determine the rate of solvent emission.

At this stage in the drying process, emission displays a continuously declining course. According to McCabe<sup>4</sup>, the rate at this stage in the drying process is governed by conditions within the paint layer according to the following equation:

$$X = X_1 \frac{8}{\pi^2} \sum_{n=1,3,5 \dots}^{\infty} \frac{1}{n^2} \exp(-n^2(\pi/2)^2 \frac{D_1 t}{s^2}) \quad (1a)$$

X and X<sub>1</sub> represent the mass of the free solvent as a proportion of the mass of the solid phase at time t and t=0 respectively. D<sub>1</sub> is the solvent's diffusivity in the paint, and s is the diffusion distance. Here, the concentration of the volatile substance, the thickness of the layer and the substance's diffusivity determine the magnitude of emission. If the factor D<sub>1</sub>t/s<sup>2</sup> is greater than 0.1, the equation can be simplified as follows:

$$X = X_1 \frac{8}{\pi^2} \frac{1}{\exp\left(\frac{D_1 t}{s^2} - \frac{n^2}{4}\right)} \quad (1b)$$

This applies to most situations here. The error in X is less than 1.5%.

According to another model<sup>5</sup>, the drying process can be described as follows:

$$X = X_1 \sum_{n=1}^{\infty} \frac{2L^2 \exp(-\beta_n^2 D_2 t/s^2)}{\beta_n^2 (\beta_n^2 + L^2 + L)} \quad (2)$$



$\beta_n$  are the positive roots of

$$\beta \tan \beta = L \quad (3)$$

$L = sk_c m / D_2$  in which  $k_c$  is the mass-transfer coefficient,  $m$  is the equilibrium constant for the substance (gas/liquid phase) and  $D_2$  is diffusivity in the paint layer.

According to a number of articles on the emission of solvents from paint, both the described phases are important during the drying process<sup>1,3,6-8</sup>. This means that a model for emission estimation may need to incorporate both these phases.

## Methods

### Testing and sampling equipment

In an effort to study the drying process, a device was built in which certain important parameters could be controlled and measured<sup>9</sup> (Figure 1). Paint is applied to a glass plate. The latter was then immediately transferred to a drying chamber.

An adjustable Erichsen applicator (model 411/80) was used for paint application. The painted plate was 8 x 38 cm. Over the surface was a laminar airflow with a flat velocity profile at the air inlet. The flow direction was parallel to the paint surface. The flow rate, temperature and relative humidity were adjustable and measured. The surface temperature of the paint could be measured with an IR method through two windows in the chamber's roof.

Air leaving the chamber contained solvents from the paint. These solvents were analyzed with a direct-reading, HNU photo-ionization instrument<sup>10</sup>, or a MIRAN 1A IR instrument or with gas chromatography. The latter analyses were performed using an AID gas chromatograph with a 2.0 m column packed with Carbowax 400. The column temperature was 75°C.

When analyses were performed with the photo-ionization device, the measurement data on solvent concentrations, temperature of the air and paint surface, relative humidity and air velocity were fed into a data logger. Mean values of data stored in the data logger were calculated every 5th second. Samples assayed with the gas chromatograph were collected in glass syringes for immediate analysis<sup>11</sup>. The

sampling time was 5 minutes during the first 30 minutes of drying and was subsequently increased. The air velocity and the temperature were then determined.

Irrespective of the analysis method, the amount of paint applied was determined through weighing.

The experiments utilized a model paint consisting of a pure siccative medium oil linseed alkyd resin with solvents. The alkyd (SOALKYD 2145) has a fatty acid content of 54% (calculated as triglyceride). The polyol is glycerol and the P.A.-content is 33%. Acid value is max 10. The solvents used were iso-butanol, n-butanol, n-butyl acetate, ethanol, ethyl acetate, ethylene glycol monoethyl ether acetate, toluene and xylene.

### Experiment strategy

The goal of the study was to determine whether a simple model was capable of describing paint drying with sufficient accuracy. The study's design was therefore concentrated on identifying the importance of the various phases (the impact of gas or solid phases on the emission rate). The next step was then to identify the necessary parameters and to evaluate the accuracy of studied models in forecasting emissions.

## Results

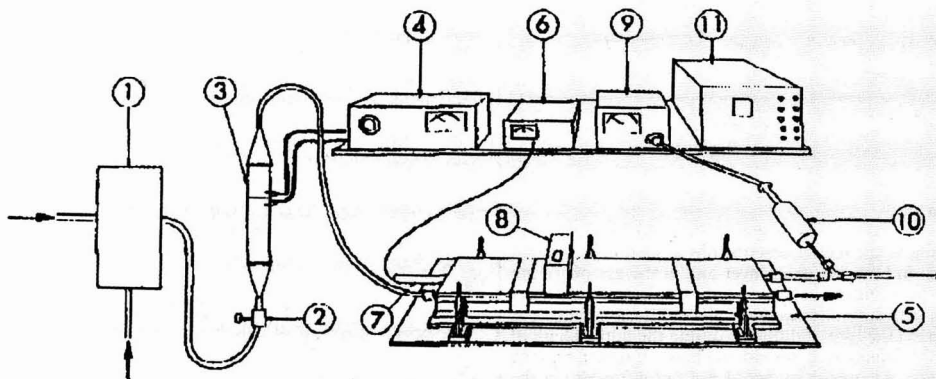
### Rate-determinative phase

Figure 2 shows the drying process when a paint consisting of 50% toluene (by weight) and 50% alkyd resin dries.

The analyses were performed with the IR instrument. The temperature was 22°C, and air velocity was 0.1 m/s. The results show that solvent escape in the studied model paint declined linearly as the level of solvent in the paint declined, at least throughout most of the drying process. Solvent emission increased sharply during the initial phase of drying. In the example shown in Figure 2, a little less than 10% of the solvent quantity was emitted in the first half minute. This is because the concentration of solvent in the laminar boundary layer was 0 when the time was 0. In the first few seconds, the boundary layer concentration increased, and emission then increased successively. The volume of the gas cell in the used instrument causes a delay of response which also explains that the emission initially appears to increase. In an effort to study

Figure 1

Experimental device for investigating the emission of solvents from painted surfaces. At 1, dry and humid input air is mixed and heated to the desired temperature. 2 is a flow control, and 3 is an orifice plate for flow measurement. 4 is a pressure gauge connected to 3. The freshly painted material is loaded in the experimental chamber 5. Temperature is measured with instrument 6 by means of the measuring sensor at 7. The surface temperature of the paint can be measured at 8 through a window in the chamber. 9 is a direct-reading instrument for solvents with the measuring probe located at 10 in air leaving the chamber. Samples for analysis in a gas chromatograph are also extracted there. 11 is a data logger for recording measuring data.

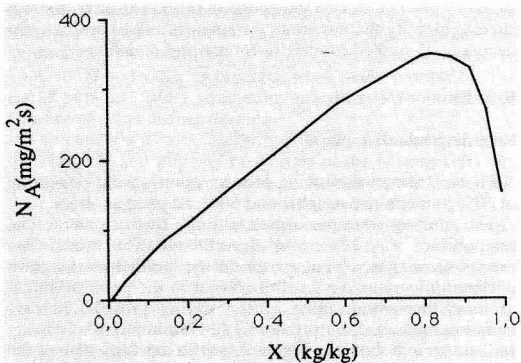


this process, similar tests were performed with other solvents. The results are shown in Figure 3. The analysis was performed using gas chromatography, and the reported solvent emission represents a mean value for the measurement period (a minimum of 5 min).

The results of these experiments show that the main course in drying is in accordance with expectations if the rate of the solvent emission is governed by the rate of solvent diffusion in the paint. One exception was ethylene glycol monoethyl ether acetate which was emitted very slowly, compared to the other solvents. A somewhat flat section, i.e. the gas phase governed the emission rate, was seen down to 0.4 kg of solvent/kg of non-volatile matter. As a result of these findings, the model was based on the assumption that diffusion of solvents in the paint layer governed the rate of transport for the entire drying process.

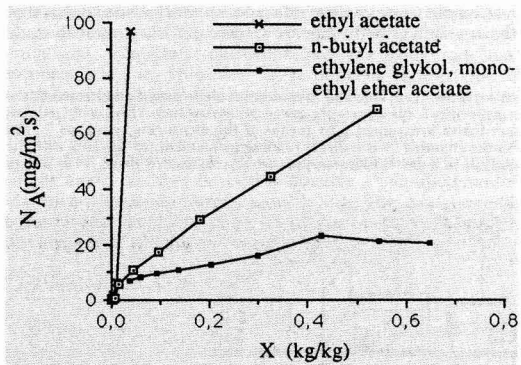
**Figure 2**

The emission of solvent as a function of paint's solvent content. The paint consisted of toluene and alkyd resin.



**Figure 3**

The drying process for three solvents at a temperature of 22°C and an air velocity of 0.03 m/s.



## Evaluation

According to the model described by Equation 2, the rate of diffusion in both the paint layer and in the gas phase are important to the total rate of emission. Equation 1 only takes intra-paint diffusion into account. Since diffusion in the gas phase governs the rate of diffusion during the initial phase of drying<sup>1,3,6-8</sup>, Equation 2 should be best at describing the drying phase. As previously noted, solvent diffusivity in the

paint differs with paint composition. The objective of the evaluation was to find a simplified model capable of describing the drying process with reasonable accuracy. The experiments tried to ascertain a mean diffusivity which fits Equation 1 and Equation 2 respectively to experimental findings. However, this did not prove to be possible for Equation 2. If this equation is to be used for describing the emission of solvent, diffusivity will have to be regarded as a function of time during drying. The evaluation below therefore only refers to Equation 1.

**Ascertaining diffusivity.** The diffusivity of pure solvents in the paint were determined using Equation 1b at an air velocity of 0.03 m/s and a temperature of 22°C. For the calculations, paint thickness  $s$  was assumed to be equal to the thickness of the solid phase without solvent. In the experiments, this thickness varied around 60  $\mu\text{m}$ . The value of  $D_1$  according to Equation 1b, which produced the best fit for measured results up to 20 minutes was calculated. The fit was performed using the least squares method. The results are listed in Table 1.

**Table 1**

Calculated diffusivities for eight pure solvents in alkyd resin according to Equation 1.

Solvent	Paint thickness (m x 10 <sup>6</sup> )	Diffusivity (m <sup>2</sup> /s x 10 <sup>12</sup> )
iso-butanol	63	2.35
n-butanol	63	2.31
n-butyl acetate	56	1.71
ethanol	80	6.08
ethyl acetate	64	12.3
ethylene glycol, mono-ethyl ether acetate	59	0.46
toluene	52	3.40
xylene	63	1.64

The calculated diffusivities can obviously not be viewed as material constants except under specific conditions. Since conditions in the paint change in the course of drying, solvent viscosity and, thus diffusivity, also changes. Another simplification was the use of layer thickness  $s$  as a constant. So results should be viewed as the *mean diffusivity* during most of the drying process.

**Dependence of mean diffusivity on paint thickness.** According to the above, mean diffusivity in the first 20 minutes depends on paint thickness, as residual solvent at any point in time increases with increasing paint thickness. So in an effort to study this correlation, experiments were performed in which the mean diffusivity for toluene was established for different paint thicknesses. The results are shown in Figure 4.

The results show that the mean diffusivity can be accurately described with an equation such as  $D_1 = k \cdot s$  with  $k$  equal to 0.053 here. Air velocity was 0.03 m/s and the temperature 22°C. Thus,  $D_1/s$  is constant.

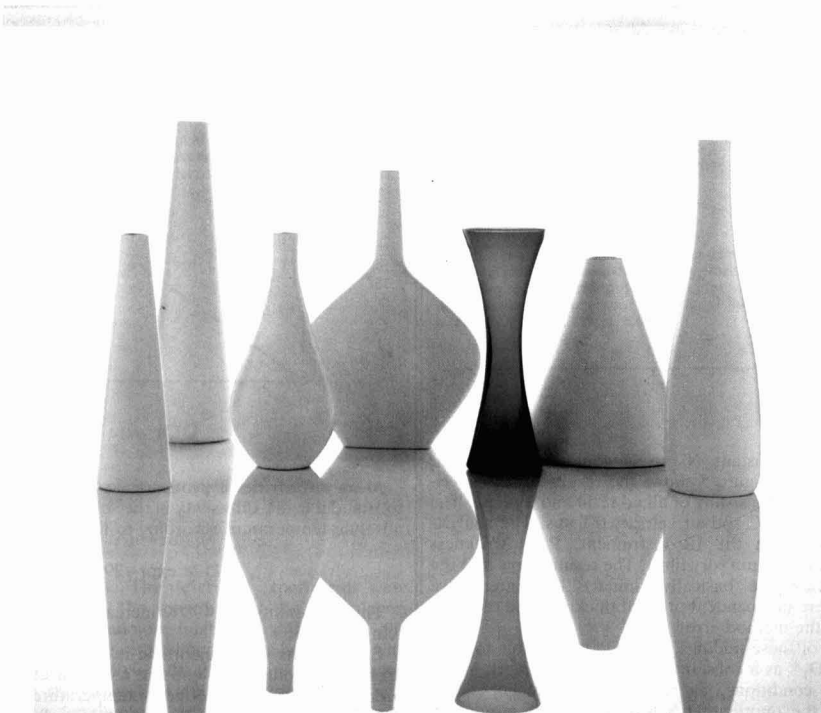
If the Equation 1b is differentiated with respect to  $t$ , the following is obtained

$$-\frac{dX}{dt} = \left(\frac{\pi}{2}\right)^2 \frac{D_1}{s^2} X \quad (4)$$

but

$$-\frac{dX}{dt} = \frac{N_A}{s \cdot \rho} \quad (5)$$

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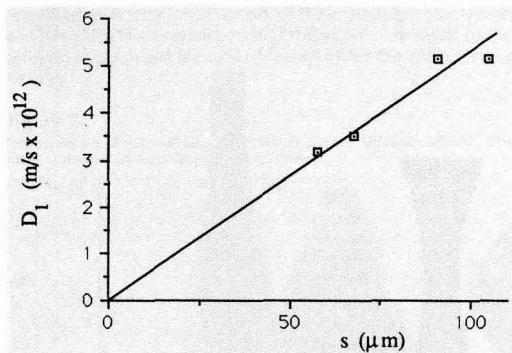


in which  $N_A$  is the solvent's emission rate from the surface per unit of surface area and time and  $\rho$  is the density of the solid phase.

Equation (4)+(5) yield:

$$N_A = \left(\frac{\pi}{2}\right)^2 \frac{D_1 \cdot \rho}{s} X \quad (6)$$

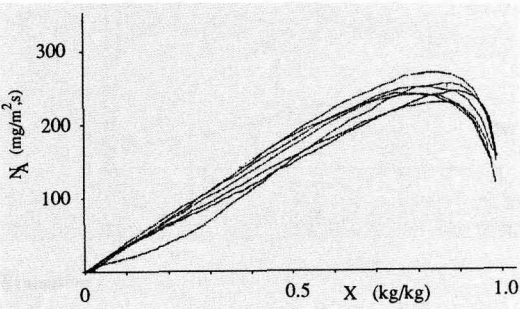
**Figure 4**  
The dependency of mean diffusivity on paint thickness.



With  $D_1/s$  as a constant,  $N_A=f(X)$  would be independent of paint thickness. Figure 5 shows the results of six experiments with a paint consisting of alkyd resin and toluene. The temperature was 21°C and air velocity 0.1 m/s. The analysis was performed with the IR instrument. Paint thickness ranged from 28 to 61 μm (dry film). The results show that the different curves are basically similar. The inter-curve differences were independent of paint thickness and could be explained by the method error.

As a result of these findings, it should be possible to treat the quotient  $D_1/s$  as a constant within the framework of the experimental conditions, as regards paint thickness and viscosity. So the quotient  $D_1/s$  was thenceforth used as a material constant in most instances.

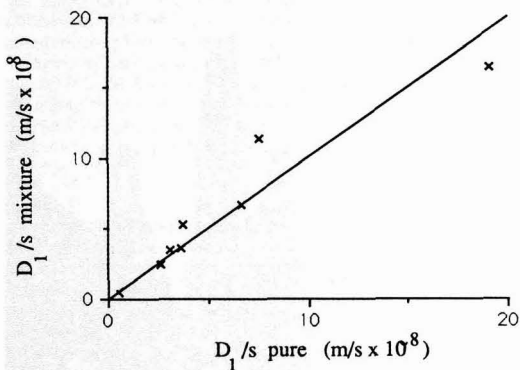
**Figure 5**  
Mean solvent emission  $N_A$  as a function of the solvent concentration  $X$  in the paint in six cases with different paint thicknesses.



**Mean diffusivity in solvent mixtures.** The extent to which the mean diffusivity is affected when other solvents are present in mixtures was studied. The diffusivity of individual solvents were determined by allowing paint with various solvent mixtures to dry at 22°C and 0.03 m/s. Samples were collected in five-minute periods for analysis in a gas

chromatograph. The results are shown in Figure 6. In the figure, the estimated  $D_1/s$  quotients for pure solvents is compared to the corresponding mean values for the quotients found for the mixture. Since the difference between them is not striking, the  $D_1/s$  quotient was regarded as being independent of the presence in a mixture of other solvent, within certain limits.

**Figure 6**  
Mean diffusivity for eight solvents. The measured values for the mixture were compared to pure solvents. The line designates  $D_1/s$  mixture= $D_1/s$  pure solvent.



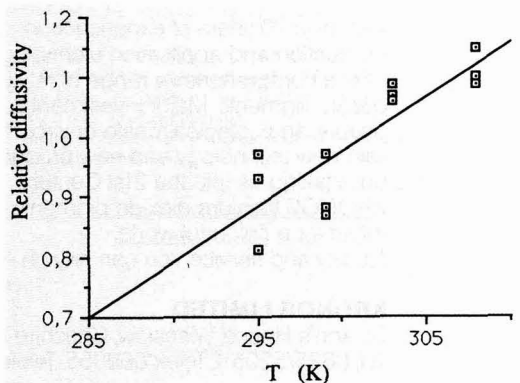
**Mean diffusivities dependency on temperature.** According to Blandin et al<sup>3</sup>, diffusivity in the solid phase depends on the absolute temperature according to the following:

$$D \propto \exp(-2921/T) \quad (7)$$

This represents a 3.4%/K increase in diffusivity at room temperature.

Experiments were performed in which paint consisting of alkyd resin, toluene, xylene and n-butyl acetate were used in order to investigate the effect of temperature in this case. Air velocity was 0.094 m/s. The results are shown in Figure 7 where mean diffusivity for the different solvents is shown as a function of temperature. The results suggest that diffusivity is somewhat less temperature-dependent than Equation 7 indicates.

**Figure 7**  
 $D_1/s$  (relative mean value for samples) as a function of temperature for toluene, n-butyl acetate and xylene at 0.1 m/s. The regression line for the solvents is show in the Figure.



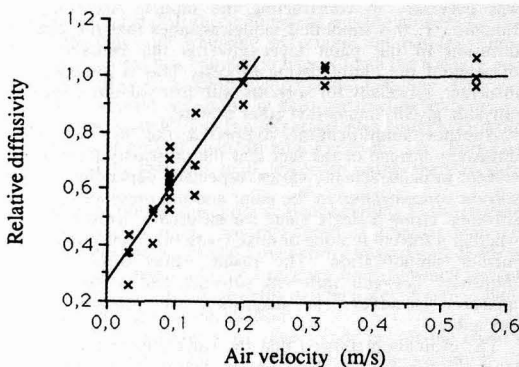
**Mean diffusivities dependency on air velocity.** According to the model, the emission of solvents is independent of conditions outside the paint layer. Since an effect exerted by air velocity cannot be precluded, a number of experiments were performed in which air velocity was varied within the framework of normal values.

The experiments were performed using a mixture of alkyd resin, xylene, toluene and n-butyl acetate at a temperature of 22°C. The results are shown in Figure 8.

The results clearly show that  $D_1/s$  is dependent on air velocity at velocities up to 0.2 m/s and remains constant thereafter.

**Figure 8**

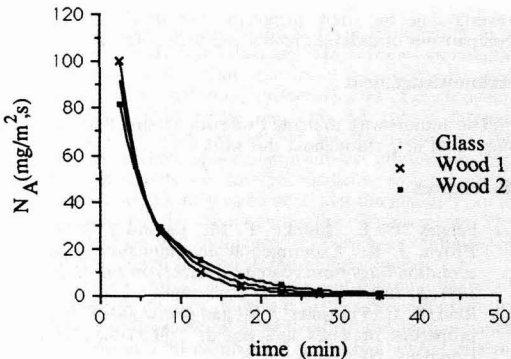
Relative, mean diffusivity as a function of air velocity across the paint surface. The lines in the diagram are regression lines for data between 0 and 0.2 m/s and 0.2 to 0.6 m/s respectively.



**Effect of the substrate.** The described experiments were performed with glass as the substrate for the paint layer. Since mean solvent emission might be different if the substrate absorbs solvents, experiments were performed with wood (beech-veneered plywood) serving as the substrate. The results are shown in Figure 9. The air velocity was 0.1 m/s, and the temperature was 25°C. The paint used consisted of alkyd resin and xylene. The paint was applied with a brush. About 100 g/m<sup>2</sup> of wet paint was applied. The results show only small differences in evaporation rate when different substrates were used.

**Figure 9**

Solvent emission from paint recently applied to different substrates. The substrates were glass, untreated wood (Wood 1) and previously treated wood (Wood 2).



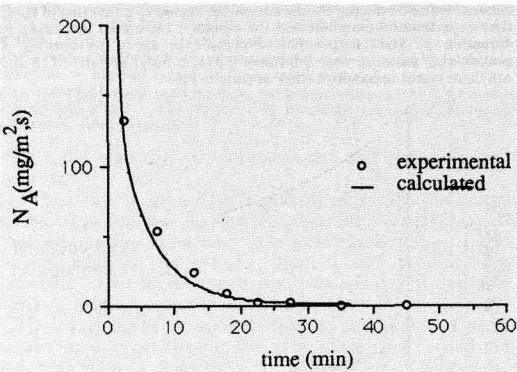
**The model's usefulness**

The usefulness of the employed model in estimating the emission of solvent from a paint with a known composition is illustrated in Figures 10a to 10d. The Figures show typical examples of measured mean emission ( $N_A$ ) at different times compared to calculated emissions. Air velocity in the experiments was 0.03 m/s, and the temperature was 22°C. The analysis was performed with gas chromatography.

One experiment was also performed employing an industrial, acid-curing paint. The paint contained both alkyd and amino resin, n-butyl acetate, ethanol, ethyl acetate and propylene glycol methyl ether acetate. The paint was diluted to the viscosity used in spray painting. The temperature was 22°C and air velocity 0.1 m/s. The analyses were performed using gas chromatography. The results as regards the first three solvents, are shown in Figure 11.

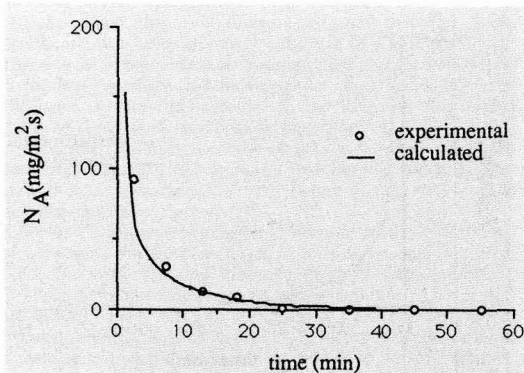
**Figure 10a**

Solvent emission during the measurement period as a function of time. The experimental emission and the emission calculated according to Equation 1. The composition, expressed in kg of solvents/kg of non-volatile materials was: iso-butanol 0.103, n-butyl acetate 0.116, toluene 1.033 and xylene 0.088.



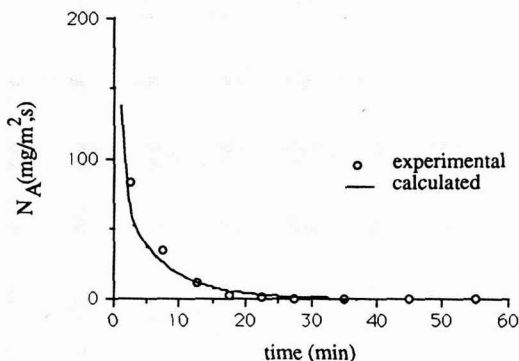
**Figure 10b**

Solvent emission during the measurement period as a function of time. The experimental emission and the emission calculated according to Equation 1. The composition, expressed in kg of solvents/kg of non-volatile material was: iso-butanol 0.106, n-butyl acetate 0.258, ethyl acetate 0.111 and toluene 0.231.



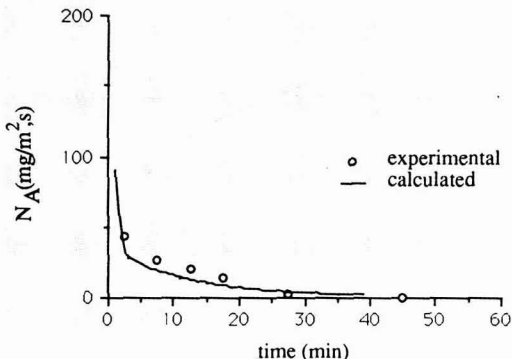
**Figure 10c**

Solvent emission during the measurement period as a function of time. The experimental emission and the emission calculated according to Equation 1. The composition, expressed in kg of solvents/kg of non-volatile materials was: n-butanol 0.082, n-butyl acetate 0.876, ethanol 0.112 and xylene 0.083.



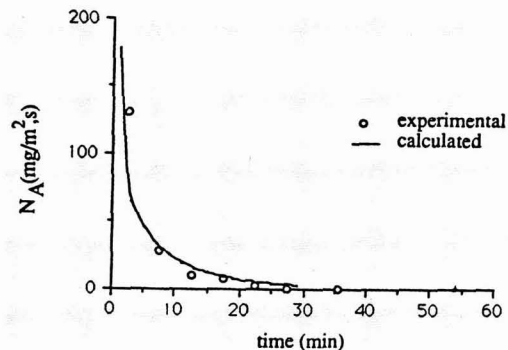
**Figure 10d**

Solvent emission during the measurement period as a function of time. The experimental emission and the emission calculated according to Equation 1. The composition, expressed in kg of solvents/kg of non-volatile material was: n-butanol 0.321, n-butyl acetate 0.118 and ethylene glycol monoethyl ether acetate 0.120.



**Figure 11**

Solvent emission during the measurement period as a function of time. The experimental emission and the emission calculated according to Equation 1. The studied paint consisted of pigmented alkyd-amino resin, n-butyl acetate, ethanol, ethyl acetate and propylene glycol methyl ether acetate.



Propylene glycol methyl ether acetate could not be evaluated because of the unavailability of information on  $D_1$ . Since the concentration was low, this circumstance did not affect the results to any great extent.

The results show that emission can be approximated with good accuracy in most instances, even in the case of industrial paint. The largest deviations were recorded in instances in which ethylene glycol monoethyl ether acetate was one of the solvents and present at a relatively high concentration. This is natural, as the employed model was less accurate here.

## Discussion

The results show that Equation 1 is capable of describing the drying process for most solvents during the drying of model paints as well as an industrial paint.

A number of simplifications of the actual circumstances was necessary in constructing the model. According to Equation 1, this simplified model assumes that the rate of diffusion in the paint layer governs the emission rate throughout the entire drying process. This is undoubtedly incorrect, especially for solvents with low volatility, such as ethylene glycol monoethyl ether acetate.

Another simplification comprised the use of mean diffusivity instead of the fact that the diffusivity for a given solvent in paint actually varies, especially depending on the solvent concentration in the paint and the presence of other solvents. Using a single value for diffusivity, irrespective of whether a solvent is alone or mixed with other solvents, was a further simplification. The results show differences in diffusivity between different solvents and solvents in a mixture. However, the magnitude of differences was negligible.

The evaluation showed that the calculation model in the studied cases can be used for predicting, with acceptable precision, the emission of solvent from a freshly painted surface. The information required, in addition to diffusivity, is paint thickness, paint contents, the density of the solid phase, temperature and air velocity. The calculations apply when the temperature is 20 to 30°C and air velocity is 0.03 to 0.5 m/s. The model offers excellent opportunities for comparing the emission of solvent from different paints, thus facilitating the choice of a paint which is best from the industrial hygiene point of view.

## Conclusions

The described model makes it possible to calculate solvent emission from freshly painted surfaces with acceptable accuracy. The calculations require knowledge of the paint's composition and thickness, temperature and the velocity of air flowing across the paint surface. The model assumes a flat surface and an air flow parallel to the surface. Calculated results can be used primarily for industrial hygiene comparisons of different paints and their solvent emission.

## Acknowledgement

The authors wish to thank Professor Fredrik Setterwall for important help throughout this work.

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## Bulk handling and storage of granular & powdered materials

by W. Brogden, Portasilò Ltd, Huntington, York YO3 9PR, UK

The largest of companies which handle powdered and granular materials have been quick to realise the economies to be gained from bulk storage and handling. These economies also apply to many smaller companies who have been slower to appreciate the benefits to be gained. The benefits are not just the obvious savings to be obtained from buying in bulk, as against the cost of individual bagged material, but also the hidden savings such as the factory space saving which can be employed for other purposes, utilisation of equipment, saving to be made in material losses, reduction in material contamination, labour saving and waste disposal and certainly not least, health and safety of employees.

Portasilò Ltd which is one of Europe's leading suppliers of bulk handling and storage equipment was the pioneer for the bulk handling and weighing of cement on building sites. Hitherto cement was handled in bags with all the wastage and insecurity of stock accompanying manual handling. This was a very important milestone in the construction industry as prior to the launch, only the largest of sites could afford the advantage of bulk storage. In addition to the silo, Portasilò introduced the first bulk road tankers to supply the silos with cement.

A natural progression from cement handling to the storage and handling of almost any powdered or granular material quickly followed and today, over thirty years later, there is hardly a particulate solid or a process industry which cannot benefit from the advantages afforded by a well designed bulk storage and handling installation.

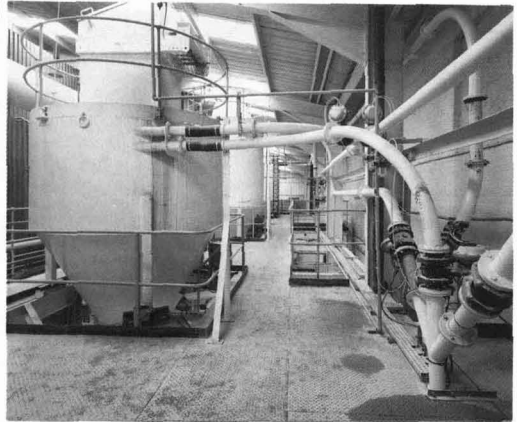
Bulk handling systems are tailor-made to suit the client's individual requirements and plant layout. The versatility of this type of installation is such that the prospective user can select from a range of equipment that best suits the requirements of his process plant. Installations can range from a simple storage silo, conveyor and weighing system to a fully automatic integrated turn-key project.

Silos are manufactured by Portasilò in mild steel, aluminium alloy and, in special cases, stainless steel. For factory built units there is a standard range of diameters from 2590mm to 4115mm. Larger units are regularly manufactured but due to road traffic restrictions these are piece manufactured and built on site. The silos incorporate a variety of discharge aids to ensure a consistent flow of material from the cone outlet.

Accuracy of the material flow is an essential requirement for the consistency of the final product. This is a complex subject and a satisfactory solution requires expert attention. In order to ensure consistency of mix, an efficient discharge is of utmost importance and it is therefore treated as an integral part of the storage silo.

The basic silo has a cylindrical body terminating in a tapered cone of which the discharge aid becomes an integral part. Material flow within the vessel requires a detailed knowledge of the materials' properties and characteristics. Information of this nature can only be gained through experience over many years and by the testing of the materials' properties. Major manufacturers of bulk handling systems have material testing facilities to ensure for themselves, and to satisfy customers, that the material can in fact be handled to the clients' throughput requirements. The completed tests will influence the designer's choice of ancillary equipment to achieve these requirements.

Design of the storage silo must take into account the space available to site the unit. Its size is further dependent on the bulk density of the material to be handled, the amount which has to be stored and its physical properties. Other criteria which must be taken into consideration are the material



Bulk storage and transfer system supplied by Portasilò for Crown Paints, Darwen, Lancs. plant for titanium dioxide and other pigments feeds material alternatively via a bag feed conveyor and bag splitting machine or big bag system. Fully aerated material is transferred via two rotary blowing seals to three securing hoppers which feed into associated mixers. The process is remotely controlled from an automatic control panel.

usage, the regularity of bulk deliveries and any site access restrictions.

Once physical size has been established possible associated problems can be investigated. It cannot be over-emphasised that one of prime importance is that of consistent flow. If this is not achieved successfully, there could be disastrous economic consequences as a result of spoilt and unusable batches, leading to wasted materials and lost production time.

However, most flow related problems can be solved at the design stage providing suitable tests have been carried out together with a knowledge of the materials' particular characteristics gained through years of experience.

The problems encountered with material flow within a silo are many and varied. One of the most common is that of the material bridging within the silo cone causing an interruption of flow.

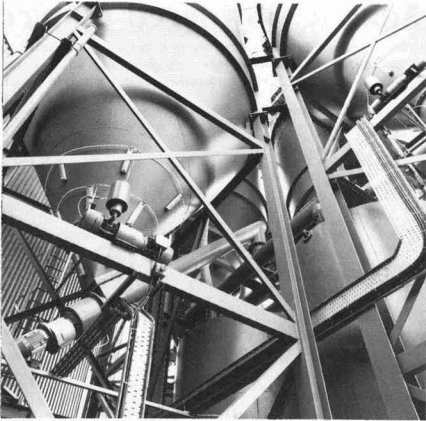
One of the reasons for this could be that an inexperienced designer had provided too small an outlet on the cone.

Another common problem is that the material may be discharging at the rate for which the system was designed but that this rate is insufficient to meet the requirements of the process. Again, this could indicate too small an outlet. Such problems must be overcome by the use of a discharge aid. These come in many varieties ranging from mechanical means in the form of flight-in-tube trough or screw conveyors and elevators, pneumatic systems of the ring main or fully fluidised cone types or vibratory equipment.

A feeder regulates the flow of material to the extent of ensuring adequate and continuous flow but in itself cannot be classed as a discharge aid, even though it may well have a bearing on the feed pattern.

When a designer has taken into account all the constraints of a system, the flow required is considered and designed according to the system's theoretical output requirements.

There is no hard and fast rule as to which type of discharge aid should be selected and the designer's preference, gained from experience, is often the deciding factor. Whichever item is selected, great care must be taken to ensure that it effectively discharges the correct amount of material in its



**Aeration pads fitted to a silo cone on equipment installed at Buckingham Coatings Ltd.**

most difficult form, for example sand or salt becoming damp. Generally, discharge aids are available in three main forms: mechanical, vibratory and pneumatic.

The most common form of mechanical discharge aid is the screw conveyor which is mounted on the horizontal or inclined plane of the vessel's outlet cone. It is a particularly efficient means of discharging free flowing materials from a silo. The versatility of the screw conveyor becomes apparent as at the design stage the length, diameter and operating angle are flexible to suit the installation requirements. Coating the internal walls of the silo to permit material flow with ease provides further assistance.

Some materials react admirably to simple vibration and a vibrator mounted on the side of the cone may well prove to be a simple, inexpensive and effective solution to the problem of inconsistent flow. Yet care must be taken to ensure that its use does not create a 'too efficient' solution and cause the material to flood into the outfeed equipment. An alternative method is the use of Bin Activator fitted on to the cone of the silo to promote a consistent feed rate.

As an alternative to mechanical and vibratory methods, a regulated supply of air can be introduced into the material. This is achieved by a number of methods from simply fitting aeration pads mounted on to the side of the cone of the silo to a fully aerated ring main surrounding the cone, or specially designed fully fluidised cones. Portasilos has successfully employed these methods for many years to promote accurately controlled flow of difficult-to-handle materials.

So much for bulk handling options and methods of solving the associated technical problems.

- Are they cost effective?
- What are the benefits?

Large companies appreciate that a good automated bulk material handling system is cost effective and they have benefitted from its advantages over manual systems for many years.

However, there are many small to medium-sized companies less easily convinced of the benefits of replacing manual systems.

The aim is of course efficient utilisation of plant and reduction of costs. These are the bottom line benefits. Let us now consider in more detail seven main areas of space saving, plant utilisation, material losses, material contamination, health and safety, labour saving and waste disposal.

Factory and warehouse space is a valuable commodity and

often at a premium. A bulk handling system will assist in space saving and best utilise the available space.

Bagged material is usually delivered on pallets in 25kg bags, each pallet carrying 1 tonne. A pallet measures 4' x 4' and the average height 5'. They are typically stored two high. Thus a floor area of 800ft<sup>2</sup> is needed to store 100 tonnes. By contrast a 100 tonne capacity storage silo would need a floor area of under 150ft<sup>2</sup> and since the silo is weatherproof it can be located outside the building. In the case of bagged deliveries, free access routes for fork lift trucks must be allowed for, using more valuable floor space. Perhaps up to twice the storage area will be needed. The use of a storage silo can make large areas of factory space available for production use, thereby increasing output capabilities.

The automatic bulk system provides consistency in mixing and dispensing.

Stock level control is easier.

Hold ups whilst material is brought in manually are eliminated.

The continuous monitoring capabilities of automated systems allow changing production requirements and available material quantities to be synchronised far more easily and accurately.

Since material storage silos can be outside the factory and remote from the processing area, vehicle access is easier for refilling thus eliminating production interruptions.

An automated system removes many reasons for material losses. Many manual systems lose up to 10% of material due to overlooked bags exceeding their shelf life, bags being damaged, ingress of damp in inefficiently temperature controlled areas, a small percentage of material being left in each empty bag and material contamination. It is therefore far easier to minimise material losses in a sealed, automatic bulk handling system than in a manual system.

Since purity of product is normally vital, contamination during the production process cannot be tolerated as this leads to further wastage.

During the bag emptying process, which is usually done in haste, pieces of bag often enter the material flow, causing more contamination which an automated process eliminates.

Manual handling of bags is heavy work and the risk of back

**Installation by Portasilos of five 64 tonne capacity Cellulose Acetate silos, mounted on vehicle access structures, at the Lancaster plant of Nelsons Acetate Ltd.**





and other injuries to operatives is high. A dusty, polluted environment causes more health problems. The cost of absenteeism, industrial compensation and extra labour can be formidable and are largely avoidable by using an effective bulk handling system.

Special care should be taken to ensure all installations have health and safety features incorporated.

Thus the sealed bulk handling system improves and protects the factory environment. In the era of increasingly stringent health and safety legislation and increased concern about the environment, the alternatives could be very costly indeed. A manual system also has to be provided with a means of waste disposal of empty bags.

To summarise, a fully automated bulk handling scheme is worthy of serious consideration with all the benefits of space saving, plant utilisation, reduction of material losses and contamination, health and safety, labour savings and elimination of waste disposal all as relevant to the smaller company as they are to the large operations. ■

## New highly compact pallet trucks

by M. Shaffer, Barlow Handling Limited, Airfield Estate, Maidenhead, Berkshire SL6 3QN, UK

Barlow Handling has introduced an all-new pallet truck range designed for operation in confined spaces. Available with a choice of either 1400kg or 2000kg load capacities, the new Barlow PBC offers exceptional manoeuvrability and high productivity in applications such as loading bays.

The new compact design has been achieved by reducing the length of the drive unit to a minimum and redesigning the tiller arm. With a turning radius of little over 1.5m, the 2000kg Barlow PBC20 is able to turn through 180° whilst operating within a container.

To ensure optimum traction — essential for loading-ramps — the drive wheel takes the weight of the battery and load. Articulation is provided by two further stabilising casters. The PBC 20 features a 2kw motor which raises the forks independently of the battery compartment to increase battery shift life. A battery discharge indicator is fitted as standard.



To reduce cycle times, the tiller arm enables all truck functions to be controlled from the hand grip. The length of the tiller, coupled with a low fixing point, reduces steering effort and keeps the user at a safe operating distance. The tiller also features both dead-man and anti-pinning safety devices for further operator protection. These trucks are also available for use in environments involved with the handling of volatile solvents. ■

Rosén et al, continued from p.208

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## Call for papers

JCOCA is seeking technical papers for possible publication in the November 1990 issue on **Application & Film Formation**.

Papers which discuss the differences in the physical properties of paint and resin films after they have been applied by various methods and the effect on their ultimate performance and film build will be of interest. These methods should include both laboratory and full-scale applications including the requirements of electrode position, hot and cold, electrostatic and airless spraying, roller and brushing, dipping, doctor blade. The effectiveness of the latest laboratory apparatus now available for application could be a subject for a paper. The change in film formulation obtained from these different methods of application would be of interest as would be the change in the PVC, pigment shape and constitution, molecular weight and polymer type, and the solvent balance of a coating with their effect on the film life and performance.

Papers should be a maximum of ten pages (in double-spaced lines) and may include up to ten tables and graphs (combined total). To be considered please send a 50-word abstract or brief outline by 1 August 1990 to the Honorary Editor, John Taylor, BSc, CChem, FRSC, FICorrSt, FPRI, FTSC, The Wolds, 51A Porth-y-Castell, Barry, S Glamorgan CE6 8QD. Deadline for the November issue is 15 September 1990.

For further information contact Dr Peter Fyne Tel: 081-908 1086; Fax: 081-908 1219.

# Chester Conference Discussions

Edited versions of the discussions that followed the presentation of a paper at the OCCA Chester Conference 1989 are published below. Only those questions are published for which discussion slips have been received.

## Preservation of Quality Image — Development of an Alternative Method of Can Decoration

by Mr J. B. Emerson, CMB Packaging Technology plc, UK

Published in May 90 JOCCA

**Mr D. Lyons, BP Chemicals:** What sort of solvent systems are used for the gravure printing process?

**Mr J. B. Emerson:** Standard gravure solvent systems such as alcohol/ester mixtures or aromatic hydrocarbons are used.

**Dr. S. G. Lawrence, Ciba Geigy Pigments:** How do the fastness properties of such printed cans compare with conventionally printed cans?

**Mr J. B. Emerson:** The same standards apply to the lightfastness characteristics of the cans decorated by this method as apply to conventionally printed cans. Absolute values depend, of course, on dye concentration and shade.

**Mr J. Gent, Fulmer Yarsley:** At the production speeds quoted, there is inevitably large quantities of 'used' paper. What happens to this paper?

**Mr J. B. Emerson:** The used paper carrier is baled and scrapped. Consideration has been given to re-use as a fuel source but this was not found to be economic.

**Mr A. G. North, Cray Valley Products:** Can one use the paper print twice by, for example, extending the transfer time on the second occasion?

**Mr J. B. Emerson:** Very little additional dye can be transformed once the paper has been used the first time. In any case the paper is glued into a cylindrical sleeve around the can and would need to be removed without damage before being re-fed to the can for use the second time.

**Mr J. Calderbank, Ciba Geigy Pigments:** In his paper Mr Emerson commented that there are two particular problem areas with the dyes/inks: 1) the % of dye/ink transferred from the original is not as great as it could be, and 2) the temperature at which the dyes sublime varies from dye to dye. Which of these causes most concern?

**Mr J. B. Emerson:** Better transfer efficiency is desirable but provided the percentage is consistent it is not a major problem. The variability of diffusion temperature between dyes is a more difficult problem, necessitating complex alterations to the ideal reproduction curves. Positive development areas could be: 1) Lower temperature (100-140°C) diffusion (retaining stability at ambient temperatures), 2) Wider colour range (stronger reds, golds, blacks) and 3) Cheaper ink systems.

## The Development of a New Pigment from Initial Research to Full Commercial Production . . .

by Mr E. V. Carter, Cookson Laminox Ltd, UK and Dr R. Laundon.

Published in January 90 JOCCA

**Mr J. R. Kelsey, BP Chemicals:** Has any work been done to

establish if it is possible to sacrifice the improved performance of formulations containing the synthetic MIO (back to the level of conventional MIO formulations) by using either a smaller proportion of MIO in the overall pigment blend or a lower PVC?

**Mr E. V. Carter, Cookson Laminox:** Yes. One can replace the 85% or so of  $Fe_2O_3$  contained in natural MIO with the purer synthetic MIO and make up the remainder with chosen extenders, antissettling agents etc. Better still, one can obtain improved protection by slightly reducing the total PVC (eg. by about 10%) bearing in mind the higher oil absorption of the Synthetic MIO and therefore its lower CPVC.

**Mr M. Heuts, ICI Chemicals & Polymers:** 1) Were MIO pigments also tested in waterborne systems? and 2) Is the optimum shape (dimensions) of the pigment particles stable enough to withstand the high shear dispersion process used in waterborne resins?

**Mr E. V. Carter, Cookson Laminox:** 1) Synthetic MIO has been tested in water based acrylic and "Haloflex" systems with excellent results. The absence of carbonates and other pH sensitive salts is of particular benefit here. 2) It is part of paint technologists' folk-lore that MIO pigments are easily broken down into non-lamellar fragments by most dispersion processes. In fact, even quite thin MIO flakes are strong enough to withstand fairly high forces. However the Synthetic MIO is more easily dispersed than Natural MIO so there is even less danger of particle breakdown.

## Letters

### Underfilm corrosion

Dear Honorary Editor,

In relation to the interesting comments of D. A. Bayliss (JOCCA, 1990, 73(1), 129) about our paper.

"Underfilm corrosion of steel induced by saline contaminants at the metal/paint interphase" (JOCCA, 1990, 73(1), 24), I would like to state the following.

We are in agreement in the sense that the experimental conditions in which the research is carried out do not coincide exactly with real practice. However, the conclusions could be applicable to certain practical situations: new steel incidentally exposed before painting to atmospheres heavily contaminated with sulphur dioxide and/or sodium chloride, blasted steel with residual saline contamination, etc.

The subject presented is of considerable practical importance, but it is extraordinarily difficult to reproduce exactly the real conditions. Let us hope that new research coming up throws new light on the subject.

Yours faithfully  
Dr Manuel Morcillo

Centro Nacional de Investigaciones Metalurgicas,  
Avenida de Gregorio del Amo, 8  
28040 Madrid  
Spain

23 February, 1990

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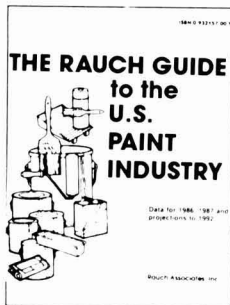


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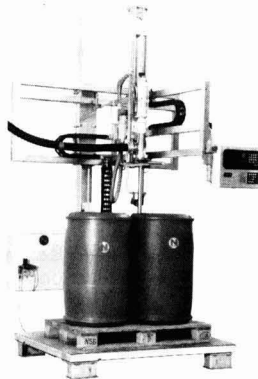
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## AGM

The Association's Annual General Meeting will this year be held at The Naval Club, Hill Street, in Central London. The Club is now the regular venue for all meetings of the London Section and has proved to be a popular meeting place for the Section's technical meetings and social events.

The AGM will be held on Thursday 14 June and will commence at 4.45pm. The meeting will take place in the downstairs Gun Room, to be followed by a buffet to which all members and guests are invited to attend. UK members will find enclosed with this issue an Agenda and further details, including a tear off form for registration for the meeting and buffet.

The principal items to be considered at the AGM are the Annual Report of Council and Accounts for 1989 and election of officers and members of Council. The Annual Report and Accounts is enclosed and I commend it to your attention. This is now the third year that Council has used the new format for the Report, with the intention of making it more attractive and readable and to use it to promote the Association to potential members, companies and sister organisations. This approach has been adopted by many organisations and will be further developed for next year's report. Please make the effort to study the Report and Accounts. This is your Association and you should be proud of its achievements.

I do hope that as many

members as possible will attend the AGM; please complete and return the form as soon as possible.

## Subscriptions

The response to requests for subscription renewals for 1990 has been most successful, with the majority of members now having paid. It is an equally good response from the overseas Ontario and South African Sections, with the Ontario Section reporting a record level of renewals.

Despite this good news, a number of members have still not renewed, despite continuing to receive the benefits of membership, including the receipt of JOCCA. All these members have now been contacted on an individual basis and will also be approached through the Section and Branch network.

If you have forgotten to pay, omitted to pay or intend to pay later, please send your remittance and subscription notice to Priory House as soon as possible. If you have lost your notice, please contact Jacqui Raynaud, Membership Secretary, who will send you a duplicate.

Although we do not have firm data, I suspect that more employers are willing to pay subscriptions to JOCCA. If your company does not pay your subscription it may be worthwhile to ask the question. I would also remind those UK members in employment that OCCA subscriptions are allowable by the Inland Revenue as an agreed deduction against PAYE.

Finally, if there are any members who are unable to meet their subscription payment, for whatever reason, please contact me, on a confidential basis. If the Association is able to help it will. I would also like to hear from any member who does not intend to renew their membership. The Association never likes to lose a member, but accepts that there are reasons leading to a decision to resign. If you are in this category I would like to know

why; maybe I can persuade you to remain in membership; at least we will discover what the problem is and learn from our mistakes.

Council has already considered the level of subscriptions for 1991 and, subject to confirmation at the AGM, an increase of 5% over the 1990 levels will be implemented. This modest increase, certainly below the expected increase in many of our costs, reflects the buoyancy of the Association.

## Priory House telephone number

May I remind you that with effect from 6 May the Priory House telephone and facsimile numbers will change to: telephone **081 908 1086** and facsimile **081 908 1219**. The telex number will however remain unchanged at 922670 (OCCA G). ■

### MANCHESTER SECTION SYMPOSIUM

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20-21 September 1990

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## Manchester/West Riding Section

### ICI Fine Chemicals Visit

On Monday, 19 March, 1990, Manchester Section concluded its 1989/90 session with a works visit to ICI Fine Chemicals, Huddersfield, in conjunction with West Riding Section.

After a short introduction, the party was split in half. One half of the party was conducted round part of the plant with particular emphasis on dye production, by Mr Dransfield, whilst the other half of the party was shown around a small exhibition, showing the type of products manufactured at Huddersfield, and the model room, where using a model of the whole Huddersfield site, Mr Mackie outlined the history of production on the site from establishment by the Government in the 1st World War, through to the present day. After about an hour, the two halves of the party were able to reverse roles, the whole tour taking 2 to 2½ hours to complete.

The Huddersfield site is roughly "L" shaped and is about one mile long by one mile wide. It is purely a production plant, and is not involved in research, or sales/marketing of the products. Over the years there has been a slow decline in the number of products, capacity and workforce at the plant, but currently there is expansion at the site, with new plant being installed, and extra employees being taken on. There is an extensive laboratory unit, but its sole purpose is to develop production methods, to manufacture, on a cost-effective basis, new research products, introduced from outside.

On completion of the tour, the party were able to participate of a buffet courtesy of ICI, and the two Sections would like to thank Mr Mackie and Mr Dransfield for conducting such an interesting tour, ICI Huddersfield for allowing us to visit the plant, and Mike Nixon for arranging the visit.

M. G. Langdon ■

## Manchester Section

### Titanium dioxide

The January meeting was held at the Mechanics Institute, 103 Princess Street, Manchester.

Sixty-eight members and guests attended.

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A lecture was presented entitled "Titanium Dioxide – an Overview" by Dr R. D. Amberg of KRONOS Titan GmbH.

Initially, a short review was given on the raw material situation for the TiO<sub>2</sub> industry. The known deposits of TiO<sub>2</sub> ore that can be exploited economically were estimated to last for more than 200 years.

The two processes for the production of TiO<sub>2</sub> pigments were described, ie sulphate and chloride. The cessation of barging waste acid from the sulphate process has become a matter of necessity to survive, at least for the European TiO<sub>2</sub> industry. A change to the chloride process or a waste acid concentration plant are the main environmentally friendly alternatives. A video film gave an insight into a modern chloride process plant.

Production and demand have grown strongly over many years. However, the capacities were insufficient to fulfil all the TiO<sub>2</sub> demands in recent years. The increase in TiO<sub>2</sub> demand is estimated to grow at a rate of 3% per annum. On the basis of the present consumption of 3 million tonnes per annum, about 90,000 tonnes of additional capacity will be needed per year. Announcements for green field plants have been made but only a few projects have reached the construction stage.

Basically, no substitutes have been found for TiO<sub>2</sub> pigments, with the exception of some organic opacifiers that are offered in combination with TiO<sub>2</sub> pigments for emulsion paints.

A new TiO<sub>2</sub> application for the removal of nitrogen oxides in flue gases of power stations fired with fossil fuels has been identified. By and large, the growth of TiO<sub>2</sub> pigments will depend upon the growth of the present end-use markets, of which coatings is the most important one.

This well illustrated lecture was brought to a close after a lengthy question and answer session, concerning both technical and environmental issues.

The lecture was preceded by a buffet, courtesy of NL Chemicals (UK) Ltd.

A vote of thanks was proposed by Mr Mike O'Neill. J. Kelly ■

### Solvent free emulsion paints

The last technical meeting of the session was held at the Mechanics Institute, Manchester, on Monday, 5 March 1990. Sixty members and guests attended the meeting, at which a

paper entitled "Solvent Free Emulsion Paints" was presented by Dr B. R. Lothian, European Paint and Building Business Manager of Vinamul Ltd, the lecture being preceded by a buffet sponsored by Vinamul.

The lecturer introduced his talk by discussing the impact of environmental issues on the chemical industry. These are likely to be the major factors affecting the paint industry in the next ten years, the paint industry is responsible for a substantial proportion of the total VOC emitted into the UK atmosphere, and although only 7,000 tonnes per year, the amount of coalescing solvent from emulsion paints is not insignificant.

The green trends in the paint industry are likely to be towards water based gloss finishes, and solvent free emulsion paints. The reasons for adopting solvent free emulsion paints are:

- (a) The products are available
- (b) 7,000 tonnes/year of coalescing solvent is significant
- (c) Possible threat from environmental pressure groups
- (d) Increased profit margins. In Germany, this type of paint sells at a 50% premium over normal emulsion paints.

There are two approaches to solvent free emulsion paints, the use of low odour aromatic free white spirit at a reduced level of coalescing solvent, and completely solvent free, with emulsions with very low monomer content. The problem in the latter case is that currently pigment pastes contain solvent, and therefore only white can be considered.

To achieve solvent free emulsion paints requires low residual monomer, a low film forming temperature, and high binding power for matt finishes, which makes it difficult to obtain good block resistance in glossier materials. Current technology makes a silk finish just about possible, although the balance between low film forming temperature and block resistance has not yet been mastered.

In designing the polymer, the choice of surfactants in the water phase has to take into account particle size, surface chemistry, water resistance, and the polymerisation process, the composition/MW of the polymer, film forming temperature, and residual monomer content. Varying the process can have a big impact on molecular weight, and how this can effect the properties of the polymer was outlined. The new developments allow changes in the chemistry of softer types of polymer, the advantages and disadvantages of the various binder types being outlined.

In formulating low solvent emulsion paints, conventional softer binders can be used in conjunction with some plasticiser, and reduced coalescing solvent. For full solvent free materials, a much softer binder, with some reduction in PVC is used, there is no coalescing solvent, but the binder is of higher cost, and therefore high opacity is also incorporated.

The lecture was followed by a lively question and answer session, and the meeting closed with the vote of thanks presented by Ted Payne.

M. G. Langdon ■

## Natal Section

### Thermogravimetry as an analytical tool in the paint laboratory

Conventional methods of analysis for the paint industry such as IR, Atomic Absorption or XRF Spectroscopy have the shortcomings of long analysis time, large samples are required and sample preparation can be lengthy (ashing, digestion and separation).

The ideal method is one which can give an overall fingerprint of the whole formulation. The method should be rapid, applicable to small samples, capable of unambiguous interpretation, preferably quantitative and above all be cost effective.

Mr Naresh Singh of S A Tioxide (Pty) Ltd presented his paper at an OCCA Natal meeting held on 6 March 1990 at the Master Builders Centre, Westville.

Thermogravimetry fulfils most of the requirements of an ideal method.

Thermal analysis consists of:

- Thermogravimetry (TG)
- Enthalpimetry (DTA and DSC)
- Thermomechanical Analysis (TMA)
- Evolved Gas Analysis (EGA)

All these have a common principle. The sample is heated via a temperature programme and a certain physical property is measured as a function of temperature. These records are made continuously and automatically. The resulting plot is referred to as a Thermogram. A Mettler TA Thermal Analysis system was used.

After explaining the theory, Mr Singh demonstrated his results using slides to depict thermograms obtained on a latex paint of known composition. The results were in close conformity to the known composition of the paint.

Thermogravimetry can thus play a useful part in the quality and process control in the paint industry.

After questions were answered by the lecturer, Mr Les Fisher proposed a vote of thanks to Mr Singh. S A Tioxide (Pty) Ltd were also thanked for sponsoring the meeting.

E. Puterman ■

## Newcastle Section

### Resins for aqueous printing inks

Twenty-four members and guests braved Arctic conditions to attend the sixth session of the 1989/90 programme at St Mary's College, University of Durham. The speaker on this occasion was Mr J. Clarke of Allied Colloids, who gave a lecture entitled "Development of Alkali-Soluble Resins for use in Aqueous Printing Inks".

He began with a short review, starting from the first legislation to reduce solvent emissions from coatings (Rule 66, Los Angeles), hastened further by the 1973/4 Oil Crisis. Continuing legislation on VOC by the USA, and general European/Scandinavian trends, are ensuring the development of aqueous systems. The Flexible Packaging Industry, in particular, is actively switching from organic solvent-based inks wherever possible and has been committed to this for some years. Initially aqueous inks based on rosin or shellac, neutralized for solubility, were used, but these have been largely superseded by modern addition copolymer resins. Mr Clark indicated that his lecture would be restricted to those solubilized with alkali – essentially acrylic/methacrylic esters.

Currently 1,000,000 tonnes of these resins are used per annum in inks. They are characterized by excellent water-resistance, clarity and UV resistance. Practically, the acrylic monomers co-polymerise readily and alkali-solubility is obtained by including acrylic/methacrylic acid monomers in the process. A wide variety of physical properties are possible, depending on polymer-composition. The effect on glass transition temperature was demonstrated by showing the T<sub>g</sub> values of a selection of homopolymers, from -60°C for polyethylhexylacrylate to 105°C for polymethylmethacrylate or polyacrylonitrile. Within a homologous series of copolymers, individual T<sub>g</sub> values can be forecasted using a simple equation based on the homopolymer T<sub>g</sub> values. Cost and availability normally determines monomer choice to begin with.

The basic skeleton of the copolymer might be formed from a

polymethylmethacrylate or polystyrene backbone, modified in toughness and solubility by the inclusion of other monomers and functional groups. Styrene promotes gloss, alkali/water-resistance, whilst reducing UV and fat/oil-resistance. Acrylate monomer reduces stiffness, and the inclusion of a hydroxyl/carboxyl – containing monomer gives acid/alkali solubility. Carboxyl functionality allows crosslinking with zinc/zirconium compounds or UF/MF resins to improve toughness and water/heat-resistance. Molecular weight and molecular weight distribution are obviously important. High molecular weight imparts flexibility, adhesion and hardness, but high viscosity resulting in low solids solutions: this problem can be overcome by supplying the resin in emulsion form, although other difficulties might develop from this. Narrow distribution of molecular weight results in better pigment wetting, whilst the degree of linearity, branching and crosslinking affect "blocking" characteristics.

Early work concentrated on matching the rosin/shellac-based resin properties with lower molecular weight solid polymers solubilized in alkali. Further development concentrated on higher molecular weight types in emulsion form, reducible with alkali. Much effort has gone into optimising monomer selection and molecular weight/distribution to give ideal viscosity and reducibility with water, relatively unaffected by variation of pH within the alkaline region. In practice the neutralizing base, ammonia, or one of several amines, can be critical.

To date most success has been achieved with inorganic pigments in emulsion paints. A series of slides showed the maximum pigment content possible in dispersions using various copolymers of different average molecular weight or degree of ionisation. Development of resins for use with organic pigments has followed and currently dispersion formulations are available with higher pigment contents than are possible with some surfactant-based formulations.

The gloss of inks and substrate adhesion depend on vehicle composition. Mr Clark discussed the relevance of these properties, together with heat/block/scuff/slip/chemical-resistance, according to end use. Adhesion to difficult surfaces, such as polythene bags for supermarkets, can be a problem. Softer resins are better here but "blocking" can result from excessive softness. Adhesion is not a

problem with absorbent substrates but drying is important. It is noteworthy that two large circulation newspapers use aqueous inks with excellent resistance to rub-off.

Pre-print liners form an expanding use of aqueous inks. The drive for cheaper substrates and faster press speeds present increasing problems for the ink supplier. Higher binder levels give better hold-out and build, but glossy overprint varnishes are also used to solve hold-out problems. Further improvements are possible in print quality using polymers to improve ink transfer to the print roller.

Summing up, Mr Clark said that improvements in gloss, adhesion and heat-resistance are still sought in the face of faster production methods and continual substrate changes. Much work remains to be done by resin suppliers but he is confident that these demands will be met in the future.

Question time brought queries on the truth of odour resulting from styrene copolymers (the Cadbury test was cited in reply), the relative sizes of the US and UK markets, national differences in accepting neutralizing amines and the difficulty of polythene substrates.

The vote of thanks was given by the Section Chairman, Mr D. Neal, after which the assembly enjoyed an excellent buffet with wines sponsored by Allied Colloids.

*J. Bravey* ■

## Scottish Section

### Plastics

**M**IR McCallum, a past Scottish Section Chairman and Managing Director of P. W. Hall Ltd, Manufacturers of Plastisols, Organosols and specialised Plastic Components, gave a talk on "Make it with Plastics" at the Hospitality Inn, Glasgow, on 15 February.

The talk started by showing the development of plastics from the early Bakelite type to the modern plastics based on Ethylene. The many uses of modern plastics were shown ranging from coatings for Electrical Cables, through coatings for Cloth to rigid plastics for Building purposes.

The process used in the manufacture of modern plastic was examined demonstrating the large amount of energy required in producing these materials. From here the talk went on to discuss the environmental impact of plastics and the problems associated with their disposal.

1990(5)

After answering questions from the audience Mr McCallum was thanked for stepping in at short notice due to the cancellation of the advertised lecture.

*H. Jess* ■

## Transvaal Section

### Debate

**T**he first meeting of 1990 took the form of a debate under the Chairmanship of Mr Tom Edward between representatives of raw material suppliers and paint manufacturers.

Mr Robin Archer of S A Titanium Products opened the discussion. He covered the supply of titanium dioxide to the industry. While titanium dioxide was exported S A manufacturers were provided for first. Problems did however arise when predicted production figures were incorrect. In regard to cost, the price of titanium dioxide in South Africa was low by world standards and that the price had risen less than that of paint.

Mr Klaus Dienst of AECI Paints was the first speaker for the paint manufacturers.

He drew attention to the fact that the South African paint manufacturers were faced with single source suppliers for many raw materials. While many of these suppliers were responsible and put the needs of local manufacturers first, certain of them had behaved in a rapacious manner that did them no credit.

Protective duties were being eased and both the paint manufacturers and raw material suppliers should encourage the authorities to remove such duties to allow more free competition.

While price increases in raw materials were passed on by paint manufacturers every effort should be made to contain price increases since the paint industry was reaching a point where price tolerance could impinge adversely on quality paints and lead to substitution by materials not requiring paint.

Mrs C. de Villiers of Shellchem addressed the problems of availability and price. Apart from Sasol the local petrochemical industry depended on imported feed stock. Variations in quality and price of these materials had to be accommodated.

Many users depended on the raw material supplier for technical support, research findings and financial bridging.

Mr G. Stead of Plascon paints

emphasised the fact that paint users were aware of alternative materials to paint and that the paint industry should take care not to price themselves out of the market. It was also necessary to ensure quality and customer support.

Mr G. van Eck of Servochem discussed the problems of fluctuating exchange rates and the steady devaluation of the Rand against the currencies of our trading partners. This led to difficulties in establishing long term supply prices and he drew attention to the need for frequent negotiations between suppliers and users.

Mr T Ashmore of Advanced Coatings supported the comments of previous speakers in regard to financial aspects. He was critical of the manner in which raw material suppliers provided formulations to unstable manufacturers who were not established in the industry. A further problem was the shortage of qualified personnel.

After an active discussion period the vote of thanks proposed by Mr L. Saunders was heartily endorsed by the audience.

The acting Chairman thanked AECI Paints for their sponsorship of the evening.

### Shop floor management

**A**t a meeting held on 21 February 1990 the Section was addressed by Mr W. Middleton of Nissan (SA).

The subject covered shop floor management and the approach of Nissan to this subject. The address covered the so called Green Area Concept.

The Green Area Concept is one of the many "people programmes" used by Nissan SA. It was conceived by the parent company in Japan and then adapted by the South African company.

A Green Area is basically a table with benches, surrounded by partitioning, where every morning the foreman meets with his operators.

During these meetings in the Green Area's the foreman reviews the previous day's performance, efficiency etc.

This will be followed by a two way discussion of the problems encountered and what corrective action is necessary to counteract them.

A supervisor then puts forward the daily target and a discussion will take place on the team plan to achieve it, i.e. absenteeism, late coming etc.

The Green Area meetings last for a period of 10 minutes. The foreman

uses an agenda, i.e. volume targets, quality problems, damages, attendance, housekeeping etc. Everything discussed is recorded on an agenda sheet.

All the information relating to production and the working environment which is necessary for the team is displayed in the Green Area, i.e. attendance boards, housekeeping, C.P.U. graphs, quality, sales volumes etc.

These boards and graphs displayed in the Green Area are updated daily, weekly, monthly by the foremen in order to give up-to-date feedback to the operators in visual displays. Since many of the operators are unfamiliar with English and may be illiterate all displays are presented in a form that does not require a language for understanding.

The Green Area concept is basically a communications centre for each particular section.

Finally, the Green Area can also be utilised for other purposes:

1. They are used by the foreman to do most of his administrative duties.

2. It is used for management feedback as required using the foreman as spokesman.

3. As smoking is strictly restricted, the Green Areas are used for this purpose.

4. To keep and maintain a high standard of cleanliness on our assembly lines and in the manufacturing areas, operators do not eat or drink while working, and lunch and tea breaks are taken in the Green Area. A water urn containing boiling water is also supplied.

5. Under no circumstances are union matters discussed.

The introduction of the concept has resulted in a marked improvement in labour relations, production and quality.

The address dealing with a serious matter was presented in an excellent manner by Mr Middleton and after an interesting discussion period the vote of thanks by Mrs P Lind was heartily endorsed by the audience.

The Chairman thanked Nissan SA for sponsoring the evening whereafter snacks and refreshments were enjoyed by the audience.

R. E. Cromarty ■

## Trent Valley Branch

### Metallic Pigments

At the Trent Valley Branch meeting on 8 March, a total of

twenty-three members and guests enjoyed a presentation by Tom Barry of Shamrock Aluminium, titled "Metallic Pigments - An Overview".

Having chosen the most challenging presentation method of talking to an audience for over an hour without visual aids, he successfully kept the audience interested on the history, methods of manufacture, quality control, and application of metallic pigments.

The production of metallic pigment dates back to the mid 1800s when a mechanical method was developed by Bessemer used on flake bronze. Because aluminium is a reactive metal, it was not until the 1930s that E. J. Hall developed a wet ball mill process for aluminium flakes.

Depending upon the alloy used, the addition of solvent content and the cycle time, flakes with various properties can be produced. These can then be mixed to extend the property range, and if required in the dry state vacuum dried in special equipment before final deagglomeration by ball polisher.

The quality considerations cover test methods and procedures for establishing leafing or non-leafing properties, particle shape, size, thickness, surface area, and leafing power.

Aluminium flake finds applications in solar reflective roof coatings, inks, paints, protective coatings, plastics and many more. Health and Safety during the manufacture of aluminium flake taxes the ingenuity and the design capability of all those involved in works management, but happily it is largely non-toxic in use.

Mention was also made of the other metals that can be flaked, brasses, copper, stainless steel, etc.

At the conclusion of a lively question and answer session, the vote of thanks was moved by Paul Alexander and received with acclamation.

I think our Chairman summed up the feelings of the lecture attenders to our meeting when he commented that Tom Barry's presentation was one of the most interesting we had ever received.

D. Grantham ■

## West Riding

### Pigment workshop - an open forum

The first lecture of the new decade took place on 16 January 1990 at the usual venue of the Roundhay Mansion, Leeds. The session was

attended by some 44 people, who were treated to some excellent questions and answers in this open forum.

In the hot seat were:

Mr A. G. Abel of Hoechst (UK) Ltd  
Mr R. J. Gross of ICI Colours & Fine Chemicals Ltd

Dr M Husbands of Sandoz Products Ltd

Mr J. Jarvis of Haeflner & Co Ltd

The Group managed to get through some 20 questions on a range of topics from the basic "Difference between a Pigment and Dye" and "Selection of a Pigment" to areas such as "Colour Science" and Environmental issues - their effect on the industry.

The area of Environmental issues proved to be one of the most interesting questions of the night. Each of the speakers gave a view, all emphasising the improvement in plant required, the cost to the buyers and the effect of legislation - testing on development. Indeed, it was suggested that it would now cost in the region of £1.5m to bring out a new pigment. Obviously this restricts development to highly specialised and expensive materials.

The questioning switched to comparison of various pigments before the final question was asked "If you could see a new pigment in the 1990s what would it be and for what application". The main wish would be for a Lightfast Yellow/Red replacement for Lead Chromate pigments. Indeed Mr Cross went further to suggest that it should also be manufactured from simple ingredients in a single stage reaction.

The vote of thanks followed proposed by Brian Widdop, the audience showing their appreciation in the usual way. A sponsored bar and buffet followed, courtesy of Hoechst, ICI, Sandoz and Haeflners.

S. Birkett ■

### Do we really need to get on with people to be effective?

This rather unusual theme attracted an audience of 30 people to the Roundhay Mansion Hotel, Leeds, on 20 February. The lecture was presented by Richard Nicholson, Training Manager at Hoechst UK, who concentrated on a theory originating from the USA which enables us to understand better the factors which affect our everyday exchanges.

This theory is known as Transactional Analysis and is based on the premise that each of us can occupy one of three different ego states, these



problem with absorbent substrates but drying is important. It is noteworthy that two large circulation newspapers use aqueous inks with excellent resistance to rub-off.

Pre-print liners form an expanding use of aqueous inks. The drive for cheaper substrates and faster press speeds present increasing problems for the ink supplier. Higher binder levels give better hold-out and build, but glossy overprint varnishes are also used to solve hold-out problems. Further improvements are possible in print quality using polymers to improve ink transfer to the print roller.

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*J. Bravery* ■

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### Plastics

**M**RI R McCallum, a past Scottish Section Chairman and Managing Director of P. W. Hall Ltd, Manufacturers of Plastisols, Organosols and specialised Plastic Components, gave a talk on "Make it with Plastics" at the Hospitality Inn, Glasgow, on 15 February.

The talk started by showing the development of plastics from the early Bakelite type to the modern plastics based on Ethylene. The many uses of modern plastics were shown ranging from coatings for Electrical Cables, through coatings for Cloth to rigid plastics for Building purposes.

The process used in the manufacture of modern plastic was examined demonstrating the large amount of energy required in producing these materials. From here the talk went on to discuss the environmental impact of plastics and the problems associated with their disposal.

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After answering questions from the audience Mr McCallum was thanked for stepping in at short notice due to the cancellation of the advertised lecture.

*H. Jess* ■

## Transvaal Section

### Debate

**T**he first meeting of 1990 took the form of a debate under the Chairmanship of Mr Tom Edward between representatives of raw material suppliers and paint manufacturers.

Mr Robin Archer of S A Titanium Products opened the discussion. He covered the supply of titanium dioxide to the industry. While titanium dioxide was exported S A manufacturers were provided for first. Problems did however arise when predicted production figures were incorrect. In regard to cost, the price of titanium dioxide in South Africa was low by world standards and that the price had risen less than that of paint.

Mr Klaus Dienst of AECI Paints was the first speaker for the paint manufacturers.

He drew attention to the fact that the South African paint manufacturers were faced with single source suppliers for many raw materials. While many of these suppliers were responsible and put the needs of local manufacturers first, certain of them had behaved in a rapacious manner that did them no credit.

Protective duties were being eased and both the paint manufacturers and raw material suppliers should encourage the authorities to remove such duties to allow more free competition.

While price increases in raw materials were passed on by paint manufacturers every effort should be made to contain price increases since the paint industry was reaching a point where price tolerance could impinge adversely on quality paints and lead to substitution by materials not requiring paint.

Mrs C. de Villiers of Shellchem addressed the problems of availability and price. Apart from Sasol the local petrochemical industry depended on imported feed stock. Variations in quality and price of these materials had to be accommodated.

Many users depended on the raw material supplier for technical support, research findings and financial bridging.

Mr G. Stead of Plascon paints

emphasised the fact that paint users were aware of alternative materials to paint and that the paint industry should take care not to price themselves out of the market. It was also necessary to ensure quality and customer support.

Mr G. van Eck of Servochem discussed the problems of fluctuating exchange rates and the steady devaluation of the Rand against the currencies of our trading partners. This led to difficulties in establishing long term supply prices and he drew attention to the need for frequent negotiations between suppliers and users.

Mr T Ashmore of Advanced Coatings supported the comments of previous speakers in regard to financial aspects. He was critical of the manner in which raw material suppliers provided formulations to unstable manufacturers who were not established in the industry. A further problem was the shortage of qualified personnel.

After an active discussion period the vote of thanks proposed by Mr L. Saunders was heartily endorsed by the audience.

The acting Chairman thanked AECI Paints for their sponsorship of the evening.

### Shop floor management

**A**t a meeting held on 21 February 1990 the Section was addressed by Mr W. Middleton of Nissan (SA).

The subject covered shop floor management and the approach of Nissan to this subject. The address covered the so called Green Area Concept.

The Green Area Concept is one of the many "people programmes" used by Nissan SA. It was conceived by the parent company in Japan and then adapted by the South African company.

A Green Area is basically a table with benches, surrounded by partitioning, where every morning the foreman meets with his operators.

During these meetings in the Green Area's the foreman reviews the previous day's performance, efficiency etc.

This will be followed by a two way discussion of the problems encountered and what corrective action is necessary to counteract them.

A supervisor then puts forward the daily target and a discussion will take place on the team plan to achieve it, i.e. absenteeism, late coming etc.

The Green Area meetings last for a period of 10 minutes. The foreman

uses an agenda, i.e. volume targets, quality problems, damages, attendance, housekeeping etc. Everything discussed is recorded on an agenda sheet.

All the information relating to production and the working environment which is necessary for the team is displayed in the Green Area, i.e. attendance boards, housekeeping, C.P.U. graphs, quality, sales volumes etc.

These boards and graphs displayed in the Green Area are updated daily, weekly, monthly by the foremen in order to give up-to-date feedback to the operators in visual displays. Since many of the operators are unfamiliar with English and may be illiterate all displays are presented in a form that does not require a language for understanding.

The Green Area concept is basically a communications centre for each particular section.

Finally, the Green Area can also be utilised for other purposes:

1. They are used by the foreman to do most of his administrative duties.
2. It is used for management feedback as required using the foreman as spokesman.
3. As smoking is strictly restricted, the Green Areas are used for this purpose.
4. To keep and maintain a high standard of cleanliness on our assembly lines and in the manufacturing areas, operators do not eat or drink while working, and lunch and tea breaks are taken in the Green Area. A water urn containing boiling water is also supplied.

5. Under no circumstances are union matters discussed.

The introduction of the concept has resulted in a marked improvement in labour relations, production and quality.

The address dealing with a serious matter was presented in an excellent manner by Mr Middleton and after an interesting discussion period the vote of thanks by Mrs P Lind was heartily endorsed by the audience.

The Chairman thanked Nissan SA for sponsoring the evening whereafter snacks and refreshments were enjoyed by the audience.

R. E. Cromarty ■

## Trent Valley Branch

### Metallic Pigments

At the Trent Valley Branch meeting on 8 March, a total of

twenty-three members and guests enjoyed a presentation by Tom Barry of Shamrock Aluminium, titled "Metallic Pigments - An Overview".

Having chosen the most challenging presentation method of talking to an audience for over an hour without visual aids, he successfully kept the audience interested on the history, methods of manufacture, quality control, and application of metallic pigments.

The production of metallic pigment dates back to the mid 1800s when a mechanical method was developed by Bessemer used on flake bronze. Because aluminium is a reactive metal, it was not until the 1930s that E. J. Hall developed a wet ball mill process for aluminium flakes.

Depending upon the alloy used, the addition of solvent content and the cycle time, flakes with various properties can be produced. These can then be mixed to extend the property range, and if required in the dry state vacuum dried in special equipment before final deagglomeration by ball polisher.

The quality considerations cover test methods and procedures for establishing leafing or non-leafing properties, particle shape, size, thickness, surface area, and leafing power.

Aluminium flake finds applications in solar reflective roof coatings, inks, paints, protective coatings, plastics and many more. Health and Safety during the manufacture of aluminium flake taxes the ingenuity and the design capability of all those involved in works management, but happily it is largely non-toxic in use.

Mention was also made of the other metals that can be flaked, brasses, copper, stainless steel, etc.

At the conclusion of a lively question and answer session, the vote of thanks was moved by Paul Alexander and received with acclamation.

I think our Chairman summed up the feelings of the lecture attenders to our meeting when he commented that Tom Barry's presentation was one of the most interesting we had ever received.

D. Grantham ■

## West Riding

### Pigment workshop - an open forum

The first lecture of the new decade took place on 16 January 1990 at the usual venue of the Roundhay Mansion, Leeds. The session was

attended by some 44 people, who were treated to some excellent questions and answers in this open forum.

In the hot seat were:

Mr A. G. Abel of Hoechst (UK) Ltd  
Mr R. J. Gross of ICI Colours & Fine Chemicals Ltd

Dr M. Husbands of Sandoz Products Ltd

Mr J. Jarvis of Haeflner & Co Ltd

The Group managed to get through some 20 questions on a range of topics from the basic "Difference between a Pigment and Dye" and "Selection of a Pigment" to areas such as "Colour Science" and Environmental issues - their effect on the industry.

The area of Environmental issues proved to be one of the most interesting questions of the night. Each of the speakers gave a view, all emphasising the improvement in plant required, the cost to the buyers and the effect of legislation - testing on development. Indeed, it was suggested that it would now cost in the region of £1.5m to bring out a new pigment. Obviously this restricts development to highly specialised and expensive materials.

The questioning switched to comparison of various pigments before the final question was asked "If you could see a new pigment in the 1990s what would it be and for what application". The main wish would be for a Lightfast Yellow/Red replacement for Lead Chromate pigments. Indeed Mr Cross went further to suggest that it should also be manufactured from simple ingredients in a single stage reaction.

The vote of thanks followed proposed by Brian Widdop, the audience showing their appreciation in the usual way. A sponsored bar and buffet followed, courtesy of Hoechst, ICI, Sandoz and Haeflners.

S. Birkett ■

### Do we really need to get on with people to be effective?

This rather unusual theme attracted an audience of 30 people to the Roundhay Mansion Hotel, Leeds, on 20 February. The lecture was presented by Richard Nicholson, Training Manager at Hoechst UK, who concentrated on a theory originating from the USA which enables us to understand better the factors which affect our everyday exchanges.

This theory is known as Transactional Analysis and is based on the premise that each of us can occupy one of three different ego states, these

being the Parent, Adult and Child states. Depending on which ego state we are in we tend to encourage the appropriate ego state in the person to whom we are talking. For example, if we talk to someone from the Parent ego state we tend to encourage a reply from the Child ego state.

Richard went on to show how an understanding of our transactions can enable more effective communications and also prevent the building up of bad feelings which are quite often vented on some undeserving party.

Throughout the lecture there was much involvement from the audience to the extent that the traditional question and answer session was not needed. The vote of thanks was presented by Andrew Donkin and the audience showed its appreciation of a very well presented and thought provoking lecture before adjourning to the buffet.

A. Donkin ■

## OCCA News

### West Riding Section

#### Annual Dinner Dance

The West Riding Section Dinner Dance was held at the Crown Hotel in Harrogate on 24 November 1989. The event was attended by some 300 people, although there were some held up on the M1 who could not make the reception at 7.00pm. Included in these was, unfortunately, Graham North President of OCCA who subsequently missed the top table guests photograph.

The very enjoyable meal was followed by speeches from the top table. Rob Lewis, Chairman of the West Riding Section presented Graham North and Chris Pacey-Day with a cheque for £2,000 donated by the West Riding section towards the purchase of computer equipment for OCCA Headquarters.

The traditional raffle was drawn by Miss Sarah Lewis, the prize of the THF weekend break for two presented by Rob Lewis.

The committee also decided to Raffle a Capo Demonte flower, worth over £100 to help raise money for the Queens Park School. Queens Park School in Lincoln caters for Boys-Girls from 2 to 19 years who have handicaps resulting in severe learning difficulties. The money raised is to go towards the repair of the school swimming pool. Tickets were sold during the interval and a staggering £672.17 was raised. The item was won by Mrs Wright, wife of ex

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West Riding Dinner Dance — Top Table Guests: (Back row, L to R) R Hill (Scottish Chairman), R. Lewis (West Riding Chairman), C Pacey-Day (General Secretary), D Neal (Newcastle Chairman) and P Thukral (London Chairman). (Front row, L to R) Isobel Hill, Miss Sarah Lewis, Dorothy Neal and Varsha Subramuniam.



Mrs Wright winner of the Capo Demonte Rose.



Queens Park School.

chairman Terry Wright. A cheque was later presented to Mrs Joan Webb and the children by Paul Bennett.

The dancing was as enjoyable and the band was persuaded, for a small fee, to play for an extra half an hour. This was followed by the customary soup before retiring.

Throughout the evening the West Riding committee wore White Rose buttonholes to make them easily identifiable to deal with problems, however, thankfully there were very few.

S. Birkett ■

### Scottish Section

#### Annual Dinner Dance

The Annual Dinner Dance of the Scottish Section was held on the 19 January at the Hospitality Inn, Glasgow. Over 300 members and their guests attended including Graham North, the President, and his wife along with the Chairmen and wives from the Bristol, Manchester and Thames Valley Sections.

As usual, the meal included haggis with the address being given by Raymond Hill, the Scottish Section Chairman. The Roast Barron's of Beef were piped in with the first slice being cut by the President.

Following the meal, Raymony Hill toasted the health of the guests with Mr North replying on their behalf. The presentation of the Ellinger-Gardoni medal for the best Technical Paper at

the Chester conference was made to Prof. Ian MacPherson of Ciba-Geigy for his paper entitled "Profitable Research and Development". This was the first such occasion at the Annual Dance. Dancing followed and continued until the small hours.

As always, an excellent night was had by one and all and Alistair Hunter is to be congratulated on his effort in organising the event.

H. Jess ■

## Ontario Section

### 1990 Dinner Dance

The Fourteenth Annual Dinner Dance was held on February 17 at the Valhalla Inn, a location which was new to this event a few years ago but is now pleasantly familiar. The arrangements were made by Ursula and John Ambury who were assisted at the podium by Wendy and Gordon Parker.

The Valhalla staff outdid even its usual excellent effort. The dinner centred around *poulet Ballotine* accompanied by vegetables in a pastry shell, which was preceded by *consommé en croute* and a fresh salad and was followed by Grand Marnier cheesecake with tea and coffee. A fine selection of table wines and liqueurs was available.

In keeping with the festive nature of the event the speeches were few and brief. Following the Convenor's welcome to the guests, Mr Alan Gray presented the engraved silver tray and framed certificate of the Ontario Section Commendation Award to Mr Bob Purnell. Mr Purnell's long and valuable service to the Section and the Association in several capacities was cited. It was also noted that he had initiated this Award some four years earlier as a way of recognizing members whose contributions were exceptional.

Next came another eagerly awaited tradition: the selection by the ladies of their gifts from the riches of the prize table. The gifts were made available



Scottish Annual Dinner Dance (L to R): Chris and Peg Shaw (Bristol), Graham and Jean North (President), Raymond and Isobel Hill (Scottish Chairman), Norman and Betty Seymour (Manchester), Richard and Hilary Stephens (Thames Valley).

through the generosity of over fifty donating firms.

The evening continued into the early morning with hours of fast and slow dancing, with music and spot prizes being presented by Dave Newfeld of 'MacMillan and Wife'. It was again a fine party and a memorable occasion for all participants.

J. F. Ambury ■



Alan Gray (L) presenting the Ontario Section Commendation Award, 1990, to Robert H. Purnell.



Ontario Section committee members at the 1990 Dinner Dance. (L to R) Peter Birrell, John Ambury, Walter Fulton, John Pitt, Gordon Parker and James Glynn.

**OCCA AGM**  
**Thursday 14 June 1990**  
**Naval Club, Hill Street, London**  
**4.45 pm**

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