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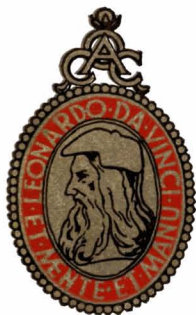
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JOURNAL OF THE IL & COLOUR CHEMISTS' ASSOCIATION

JOCCA-XXVII PREVIEW ISSUE

Evaluation of polyurethane systems as clear lacquers on four types of wood
K. Borgin, A. Lowe and P. A. J. Gate

Trends in petrochemical raw materials
A. L. Waddams

Some aspects of the industrial application of the Egyptian rice germ oil in the field of surface coatings. Part I Separation and modification of rice germ wax
A. M. Naser, M. A. El-Azmirly and A. Z. Gomaa

Part II: Preparation and evaluation of rice germ and rice germ/linseed oils alkyds
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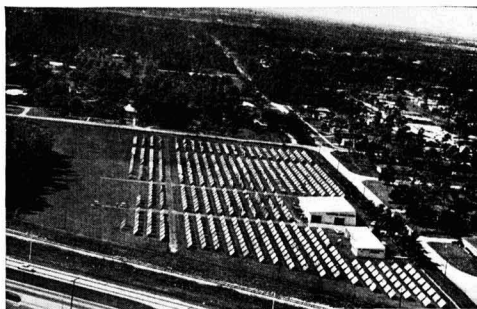
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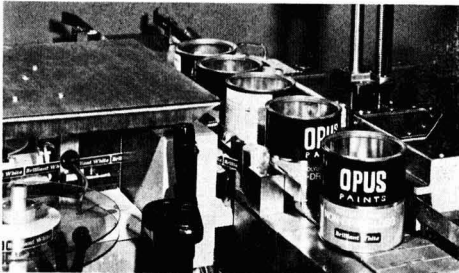
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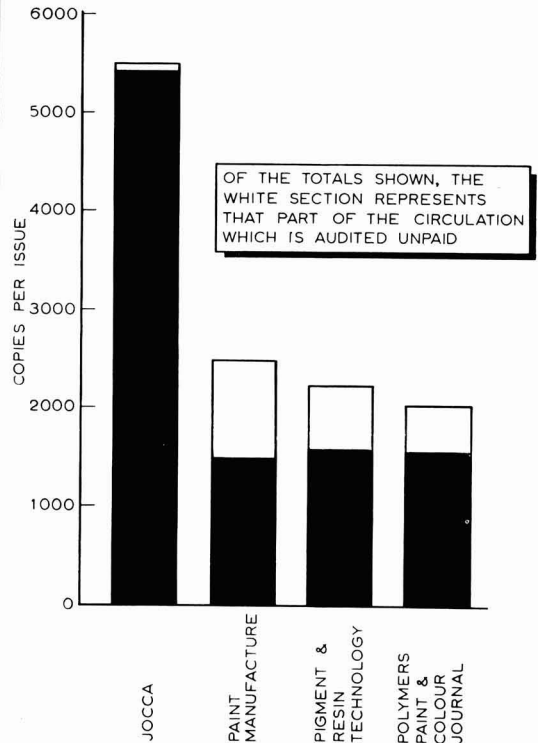
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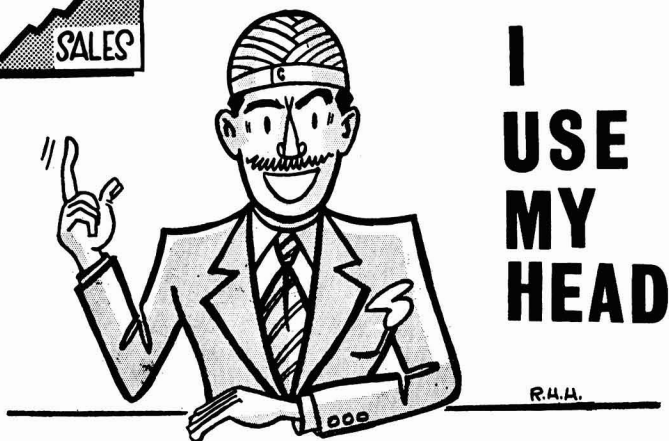
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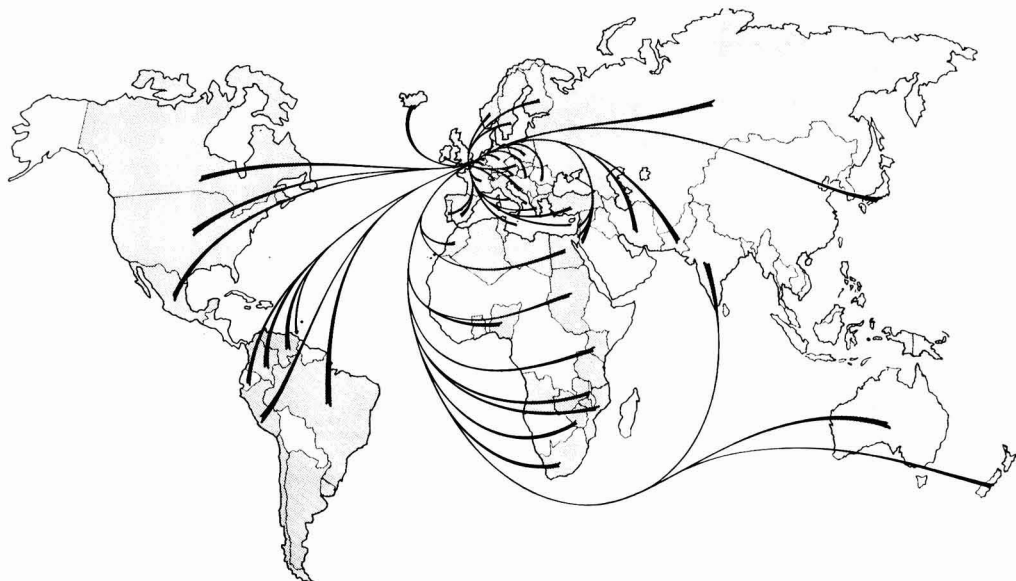
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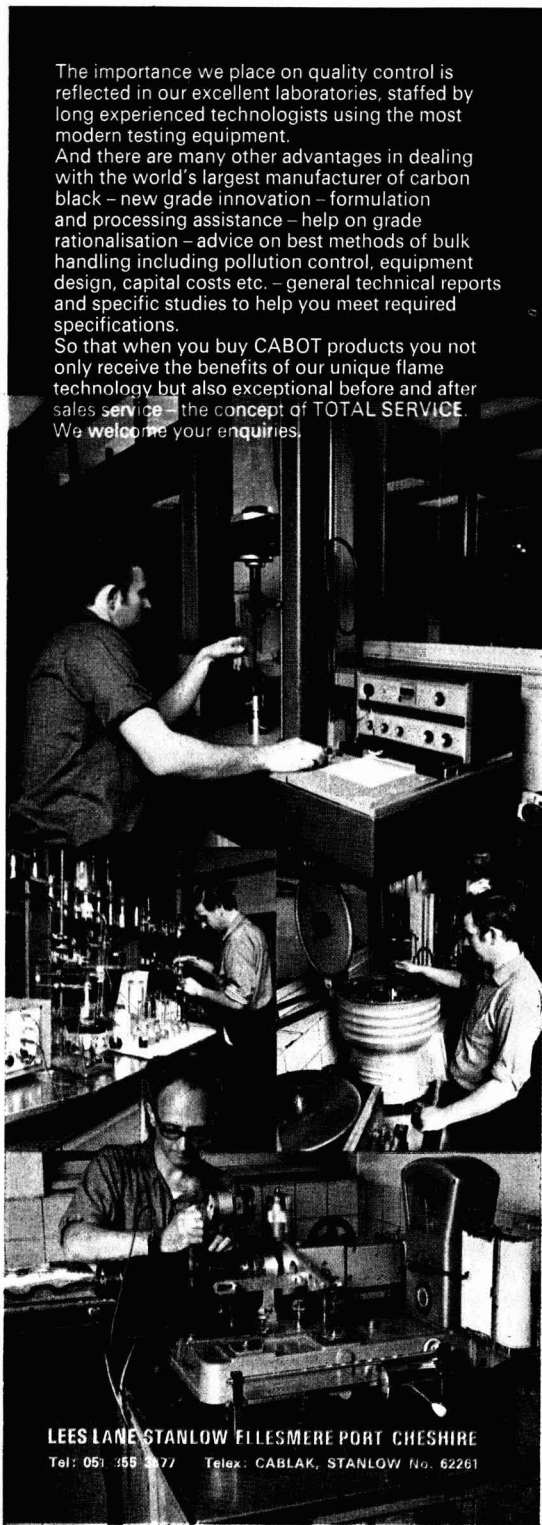
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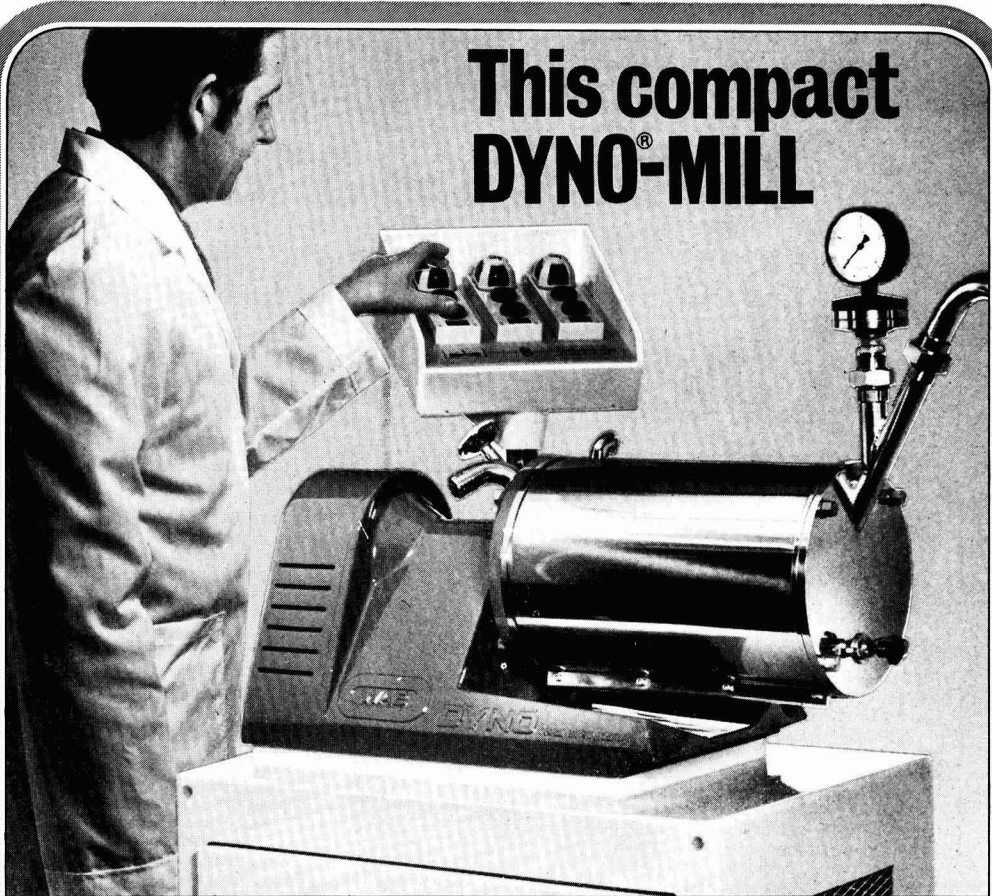
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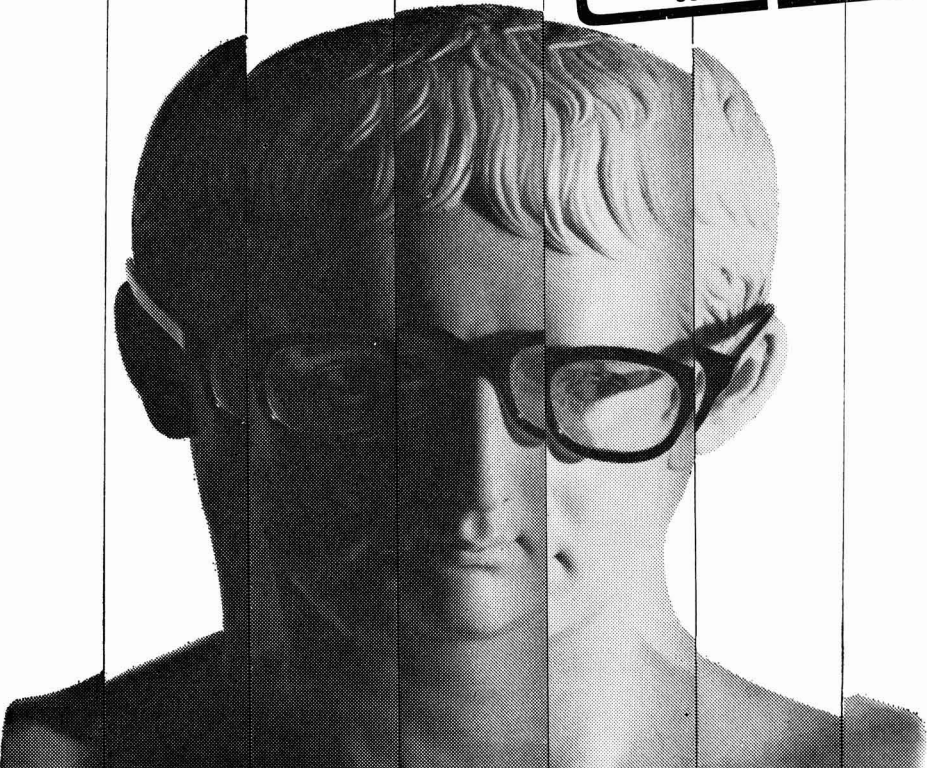
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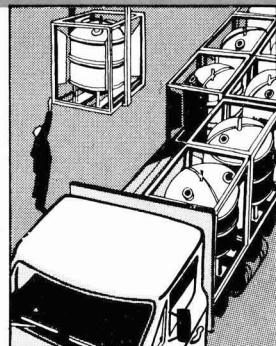
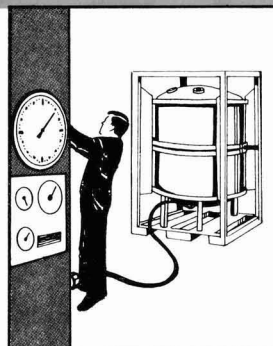
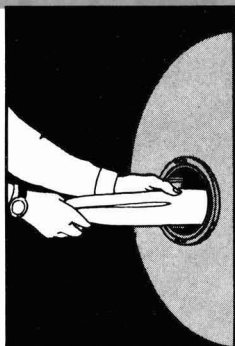
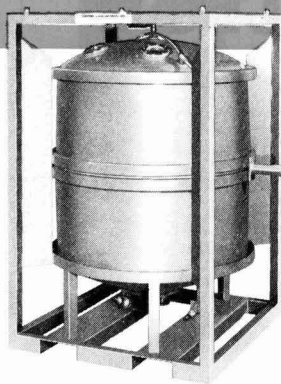


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(audited figures based on average monthly data from 1. 7. 1973 to 30. 6. 1974)

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No. of copies sold 5336 = 90,9 %

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East Germany	178 = 3,0 %
Abroad	1980 = 33,7 %

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(1980 = 100 %)

Europe	1511 = 76,3 %
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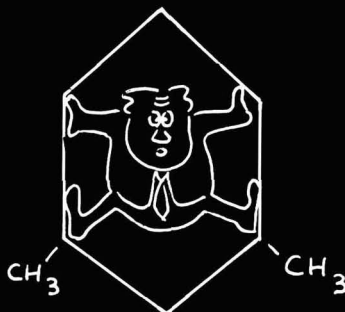
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Evaluation of polyurethane systems as clear lacquers on four types of wood

By K. Borgin*, A. Lowe† and P. A. J. Gate‡

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Summary

The investigational work describes the evaluation of two experimental polyurethane prepolymers consisting of a mixture of a linear chain extended aromatic isocyanate and an isocyanurate isocyanate. A further series of three prepolymers consisting of a mixture of a linear chain extended aliphatic isocyanate and an isocyanurate isocyanate have also been examined.

All the above systems were evaluated by exterior exposure at two sites in South Africa, namely Stellenbosch and Johannesburg, and at Holford in England. They were also examined using techniques specially developed by the Department of Wood Science at the

University of Stellenbosch, South Africa, which included microscopic investigation and water permeability on wood samples coated with the surface coatings.

The correlation between the accelerated test results and exterior exposure results are discussed, and the unexpected poor results of the linear chain extended aliphatic isocyanate-containing systems as clear lacquers on wood are detailed, in contrast to the many satisfactory features of the chain extended aromatic isocyanate-containing types.

Keywords

Types and classes of structures or surfaces to be coated
wood

Raw materials: binders (resins, etc)
urethane moisture cure resin
urethane resin

Processes and methods primarily associated with service or utility
weathering

Properties, characteristics and conditions primarily associated with:

dried or cured films
crazing
gloss retention
water resistance

structures or surfaces being coated
wood grain

Une appréciation effectuée sur quatre espèces de bois des systèmes polyuréthanes en tant que vernis.

Résumé

L'étude décrit l'appréciation de deux prépolymères de polyuréthane expérimentaux, comprenant d'un mélange d'un isocyanate aromatique à chaîne linéaire et d'un isocyanurate isocyanate. D'ailleurs on a examiné une série supplémentaire de trois prépolymères comprenant d'un mélange d'un isocyanate aliphatique à chaîne linéaire et d'un isocyanate.

Tous les systèmes précédents ont été appréciés à deux emplacements en Afrique de Sud, c'est-à dire à Stellenbosch et à Johannesburg, et également à Holford en Angleterre. D'ailleurs ils ont été examinés au moyen des techniques spécialement mises au point par le

Department of Wood Science à l'Université de Stellenbosch, Afrique du Sud. Ces techniques comprennent l'examen microscopique et la mesure de la perméabilité à l'eau des éprouvettes en bois revêtues des vernis.

On discute la corrélation entre les résultats à partir des essais accélérés et ceux de l'exposition aux intempéries. On donne les détails de l'infériorité inattendue des résultats mis en évidence par les vernis basés sur le système contenant de l'isocyanate aliphatique à chaîne linéaire en comparaison auprès des maintes caractéristiques satisfaisantes des types contenant de l'isocyanate aromatique.

Bewertung von Polyurethanolackern auf vier Holzarten

Zusammenfassung

Die beschriebenen Versuchsarbeiten befassen sich mit der Bewertung zweier experimenteller Polyurethanpolymerer bestehend aus einer Mischung von einem durch eine lineare Kette vergrößerten aromatischen Isozyanat und einem Isozyanurat-Isozyanat. Ebenfalls geprüft wurde eine Serie von drei Präpolymeren bestehend aus einer Mischung von einem durch eine lineare Kette vergrößertem aliphatischen Isozyanat und einem Isozyanurat-Isozyanat.

Alle die oben erwähnten Systeme wurden durch Aussenwitterung in zwei Stationen in Südafrika, und zwar Stellenbosch und Johannesburg, sowie in Holford in England bewertet. Sie wurden ebenfalls unter Anwendung der vom Department of Wood Science an der

Universität Stellenbosch, Südafrika speziell entwickelten Techniken geprüft, welche mikroskopische und Wasserpermeabilitätsuntersuchungen an mit den Lacken überzogenen Holzmustern einschlossen.

Die Korrelation zwischen den Resultaten nach Kurzprüfung und Freibewitterung wird besprochen, und die schlechten Resultate mit dem durch die lineare Kette vergrößerten aliphatischen isocyanathaltigen System als Klarlacke auf Holz, im Gegensatz zu den vielen befriedigenden Eigenschaften der durch die Kette vergrößerten aromatischen isocyanathaltigen Sorten, genau beschrieben.

Introduction

Ref. 1, 2

The purpose of the joint investigation described in this paper was twofold:

1. To ascertain how microscopic investigations and water permeability tests on wood samples coated with experimental surface coatings could be used to predict the performance of these systems on different types of wood exposed under different climatic conditions.
2. To determine the optimum formulation of certain aliphatic/aromatic isocyanate-based prepolymers to be used as clear lacquers on wood under different climatic conditions of exterior exposure.

A high proportion of the early development work in the polyurethane surface coatings field was devoted to two-pot systems, which sought to exploit the high reactivity of the aromatic isocyanate group towards materials containing a multiplicity of reactive hydrogen atoms. The most readily available and economically viable sources of such reactive groups were polyhydroxylic bodies, derived for the most part by reaction of simple low molecular weight polyols with propylene oxide polycarboxylic acids. The former were characterised by low viscosity, but unless the latter were based mostly on diols and dibasic acids, the viscosities tended to impose some restrictions in use.

The application of such two-pot systems is not difficult, but the inevitable problem of a limitation on pot life did prove an obstacle to their widespread adoption and this criticism, coupled with the differing results obtained from time to time as a result of variation in atmospheric humidity, focused attention on other methods of cure.

Previous papers^{1,2} have laid considerable stress on the importance of the role of water in the curing mechanism of formulations containing free isocyanate groups. Once a full appreciation of this factor had been realised, it became clear that the way was open to coating systems in which performance variability could be cut to a minimum. Since atmospheric humidity will always be variable, it was logical to use the reaction of water with the isocyanate as the major curing reaction and confine the urethane reaction itself to the manufacturing process of the isocyanate.

Considerable experience has been accumulated to show that a large isocyanate molecule containing a multiplicity of isocyanate groups need be no less stable than the simple isocyanates commonly used in two-pot systems. There is, therefore, no obstacle to the manufacture and utilisation of such materials in the production of clear lacquers on a variety of substrates.

Certain rules in the design of these large polyisocyanates are applicable:

1. At all times excess isocyanate must be present to prevent gelation, so that the initial polyol is always added to the isocyanate.
2. Side reactions (such as allophanate formation) should be avoided in order to obtain good reproducibility. In consequence, temperatures are usually controlled to below 100°C and, if necessary, the reactions are slowed by increasing the acidity with small additions of hydrochloric acid generators.
3. If the -NCO/-OH ratio is too low gelation will occur; if it is too high the molecular weight of the product will be

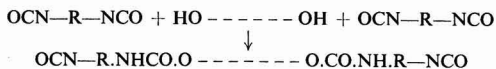
too low. The optimum -NCO/-OH ratio is related to the functionality of the polyol, that is the ratio of diol to triol. Increases in the proportion of the latter necessitate higher -NCO/-OH ratios if gelation is to be avoided.

4. The -NCO/-OH ratio also has a profound effect on the level of low molecular weight isocyanate remaining in the final product. It is, therefore, often advantageous to start prepolymers derived from isocyanates such as tolylene diisocyanate (TDI) by using TDI adducts in which the free TDI has already been reduced to a low level.
5. The molecular weight of the polyol used is also important and experience suggests that it should probably not exceed 2 000 to 3 000, and may be as low as 800.

The application of these rules impose certain practical restrictions on the final moisture curing prepolymers. Thus the viscosity of the original polyol is bound to affect that of the final material and if it is high, the end result may be unacceptable in application. The hydroxyl-ended polyethers derived from the reaction of propylene oxide and simple diols and triols have acceptable low viscosities and have, therefore, been studied extensively. On the other hand, the viscosity of hydroxyl-ended polyesters derived from polyols and dibasic acids is critically dependent on the functionality of the polyol or mixture of polyols used. Indeed, only small quantities of triols can be used if the viscosity is not to be too great and in consequence curing rates too low.

However, work carried out in the field of urethane rubbers demonstrated the need for linear hydroxyl-ended polyesters as raw materials in the production of high strength elastomers. It was necessary to maintain linearity as far as possible in order to achieve high tensile and tear strengths, the small amount of cross-linking needed arising from traces of moisture or ancillary reactants. Rubbers of this type are characterised by good abrasion resistance and "toughness", a term most difficult to define in physical terms. Since they are also resistant to cutting, they have considerable value as floor surfacing materials, if they can be formulated to give lacquers which can be applied readily.

Certain linear hydroxyl-ended polyesters are characterised by an acceptably low viscosity and these can easily be converted to longer chains, but linear diisocyanates still remain by addition excess of a diisocyanate

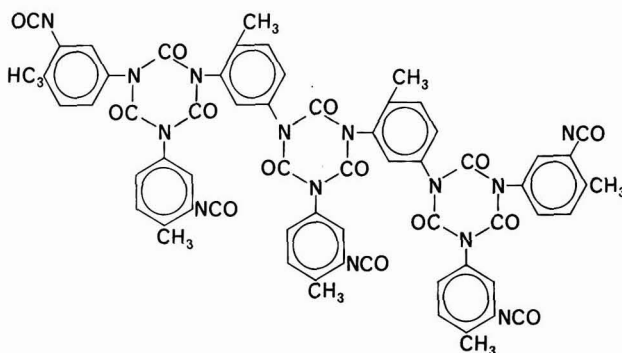


Unfortunately, the long chain isocyanates of this type are extremely slow to cure simply by exposure to atmospheric moisture. The incorporation of catalysts creates a pot life problem, so that long storage in the can is impracticable and normal isocyanate reactive cross-linking agents cannot be incorporated for the same reason.

These considerations do not apply to the incorporation of other polyisocyanates since in the absence of catalysts, moisture or other reactive materials, combination does not occur. If a linear polyester is chain extended by reaction with a diisocyanate, the final isocyanate can be mixed with polyisocyanates to give lacquers with acceptable viscosity and curing characteristics. The speed of cure is increased in proportion to the amount of polyisocyanate added and the abrasion resistance, although progressively reduced, can be controlled to give a balance of properties suitable for a multiplicity of purposes. Combination of the two types of isocyanate occurs

only after the mixed solution is applied to the substrate, since the sole curing material is water derived from the atmosphere. This initial reaction produces amine end groups from the isocyanate in the linear material or from the polyisocyanate and this in turn combines with the other isocyanate groups.

This technique can be applied to polyisocyanates of all types, but is particularly effective with those produced by the polymerisation of diisocyanates. It has already been shown that these materials containing a multiplicity of isocyanate rings have high reactivity and the cured films have very good resistance to discolouration on exposure to light².



Practical trials have established that mixtures of diisocyanates derived from linear hydroxyl-ended polyesters with isocyanates containing a multiplicity of isocyanurate rings give the type of attractive coatings postulated above. The speed of cure is governed by the proportion of isocyanurate/polyisocyanate present and the film hardness is increased in the same way. Conversely, for the highest degree of abrasion resistance and film flexibility, the isocyanurate/polyisocyanate must be kept to the minimum commensurate with adequate curing rate.

A further advantage accrues from this approach. It will readily be seen that if a diol is reacted with less than twice the stoichiometric equivalent of a diisocyanate, chain extension will take place and if the reaction is carried to completion, a much larger diisocyanate will result. In practice, this affords a mixture of chain-extended diisocyanates and reduces the proportion of original diisocyanate to a low level. The method, therefore, affords a means of controlling the average molecular weight of chain extension and at the same time decreases the application hazard by reduction of the volatile original isocyanate to a safe level. It is, therefore, of particular value in the case of isocyanates, such as tolylene (TDI) or hexamethylene diisocyanates (HDI).

If the polyisocyanurate-isocyanates to be added to these chain extended materials also contain minimal amounts of these volatile diisocyanates, then the final mixture will have a minimal application hazard.

The application of a mixture of the foregoing types has been studied extensively over a number of years. Particularly interesting results have been obtained by the combination of isocyanurate-isocyanate with products of the reaction of polyalkylene adipates and tolylene- and hexamethylene diisocyanates.

Systems adopted for investigation

Earlier unpublished work carried out by ICI (South Africa) Ltd had indicated that optimum durability results on wood exposed under South African conditions were obtained using polyurethane prepolymers which gave films with greater flexibility than that found to be optimum under European conditions. Thus, it was decided to include prepolymers with a lesser degree of branching than would be expected to give optimum results in Europe.

As already stated, the proportions of the linear chain

extended diisocyanates and isocyanurate-isocyanates affect the speed of cure and the flexibility of the final film.

The number of isocyanate groups in the isocyanurates available for cross-linking is a direct function of the degree of polymerisation and can be calculated simply from the NCO value. If the proportion of the NCO value arising from the free TDI is allowed for, it will be seen that isocyanurate *C* (see below) contains between 5 and 6 isocyanurate rings and, therefore, between 7 and 8 isocyanate groups. Isocyanurate *D* is a much smaller molecule and contains only 2 isocyanurate rings and 4 isocyanate groups. It is to be expected, therefore, that compositions containing isocyanurate *C* will be more highly cross-linked and less flexible than those containing isocyanurate *D*.

Linear chain extended diisocyanates

	NCO value	Free diisocyanate
<i>Prepolymer A</i>		
1 mol polyalkylene adipate (MW 2 000) plus 1.6 mols tolylene diisocyanate	3.0%	0.5% (TDI)
<i>Prepolymer B</i>		
1 mol polyalkylene adipate (MW 2 000) plus 1.6 mols hexamethylene diisocyanate	2.0%	0.4% (HMDI)
<i>Isocyanurate C</i>		
Polymerised tolylene diisocyanate	15.0%	0.3% (TDI)
<i>Isocyanurate D</i>		
Polymerised tolylene diisocyanate	20.0%	1.0% (TDI)

For the investigation the following mixtures of the above were used:

Resin nomenclature	Composition	Non-volatile content at which applied (per cent)
Exp. Resin 158	4:1 of Prepolymer A/Isocyanurate C on 100% solids	40
Exp. Resin 341	5:1 of Prepolymer A/Isocyanurate C on 100% solids	35
Exp. Resin 340	2:1 of Prepolymer B/Isocyanurate D on 100% solids	35
Exp. Resin 339	3:1 of Prepolymer B/Isocyanurate D on 100% solids	35
Exp. Resin 338	4:1 of Prepolymer B/Isocyanurate D on 100% solids	35

To each of the five varnishes above, 0.02 per cent of a silicone fluid flow agent (Silicone Fluid Fl60 obtained from ICI) was added as flow agent. As a control, a clear lacquer based on a linseed oil modified long oil pentaerythritol alkyd (Paralac 10W obtained from ICI) was included. This was applied at the following composition:

	Per cent by weight
Paralac 10W	64
White spirit	36
Driers: Cobalt 0.02%, lead 0.25% and calcium 0.25%.	

Experimental

Refs. 3-6

Wet samples of the varnishes described above were supplied by the Organics Division of Imperial Chemical Industries Ltd. to Professor Borgin's Research Group in the Department of Wood Science, University of Stellenbosch, South Africa. At the same time four sets of wooden panels were coated in Manchester with these lacquers. The panels used were 45.5cm × 15cm (18in × 6in). Four woods were chosen with special emphasis on the types of wood used extensively in the building industry in South Africa.

These woods were:

- Sapele Mahogany
- Burma Teak
- Pinus Sylvestris
- Pinus Patula

All six varnishes were applied by brush, making 24 panels in every series. Four coats of varnish were applied by brush and all were backed with Exp. Resin 158 except those which were coated with Paralac 10W. These last named were backed with Paralac 10W in contact with Exp. Resin 158 on the edges of the panels.

One set of coated panels was exposed to natural weathering at Stellenbosch inclined at an angle of 45° facing north alongside an uncoated set. Another set of the coated panels was exposed at Johannesburg, South Africa, also at a 45° angle facing north. The third set was exposed at Holford, near

Manchester, U.K. at a 45° angle facing south. The fourth set was used as a control. The Stellenbosch exposures were commenced on 28 April 1969, those at Johannesburg on 29 April 1969 and those at Holford on 19 February 1969.

The exposure panels at Stellenbosch and Johannesburg were exposed for one year and those at Holford for three years.

The various panel numbers are listed below:

Panel No.	Lacquer	Type of wood
7663	Exp. Resin 158	Sapele Mahogany
7664	Paralac 10W	
7665	Exp. Resin 338	
7666	Exp. Resin 339	
7667	Exp. Resin 340	
7668	Exp. Resin 341	
7669	Exp. Resin 158	Burma Teak
7670	Paralac 10W	
7671	Exp. Resin 338	
7672	Exp. Resin 339	
7673	Exp. Resin 340	
7674	Exp. Resin 341	
7675	Exp. Resin 158	Pinus Sylvestris
7676	Paralac 10W	
7677	Exp. Resin 338	
7678	Exp. Resin 339	
7679	Exp. Resin 340	
7680	Exp. Resin 341	
7681	Exp. Resin 158	Pinus Patula
7682	Paralac 10W	
7683	Exp. Resin 338	
7684	Exp. Resin 339	
7685	Exp. Resin 340	
7686	Exp. Resin 341	

Exposures

S = Stellenbosch; J = Johannesburg; H = Holford

At Stellenbosch the breakdown of the coating on the large panels referred to above was not only followed by visual observation, as at the other centres, but also by microscopic investigations and water permeability by determining absorbed water at intervals of exposure. The most interesting samples were studied with a scanning electron microscope at different magnifications.

Water permeability of surface coatings on wood can be measured conveniently by determining the water absorption and desorption of the wood itself. If the wood is coated completely as in the present case, water in liquid or vapour form must diffuse through the surface coatings or pass through mechanical imperfections of the film. Since the moisture content of wood as well as the absorption and desorption of water is a function of the relative moisture of the air, the efficiency of any surface coating can be expressed as the ratio between the water absorption of untreated and coated wood samples. This method is described and used by Professor Borgin in several publications³⁻⁶.

The ability of a surface coating to prevent moisture absorption and desorption by the wood is expressed as "degree

of efficiency" (DE) per cent. A perfect surface coating will have a degree of efficiency of 100 per cent, whilst a very poor and ineffective treatment will exhibit values approaching nil.

Since the slightest imperfection of a surface coating, including microscopic and submicroscopic cracks and fissures, will allow water to penetrate through the film, the determination of moisture absorption and desorption is an extremely sensitive method for evaluating the behaviour of coatings, both during natural weathering tests and in laboratory tests where wood is exposed to a series of wetting and drying cycles. In the present investigations this method was used on the large panels exposed at Stellenbosch and coated in Manchester and also on the small samples prepared at Stellenbosch. (See below.)

Swelling and shrinking of wood has the most detrimental effect on any surface coating, since the swelling and shrinking process tend to fracture the coatings. This process is self-accelerating since the development of any initial fracture, crack or fissure allows water to come in direct contact with unprotected wood through capillary penetration of liquid water or as absorption of water vapour.

The swelling of coated samples exposed to liquid water was compared, therefore, to that of untreated controls. To study the effect of weathering, the same samples were treated

after repeated weathering cycles. The quality of the surface coatings was in this case expressed as degrees of efficiency (DE) in preventing swelling of treated wood.

Specimens prepared at Stellenbosch

At Stellenbosch, four sets of small samples of each wood were prepared. The specimens were 2.54cm × 2.54cm × 0.635cm (1 inch × 1 inch × 0.25 inch). They were completely coated on all sides with the lacquer concerned. One coat was applied to two sets and to the other sets, two coats were applied. Duplicate uncoated sets were also prepared. The samples were used for determining the degree of efficiency of the coatings in preventing water absorption and swelling initially and after six weeks' and three months' exposure. They were also used for microscopic investigations.

Results

Exposed panels at Stellenbosch, Johannesburg and Holford

The condition of the surface coatings on the large panels was judged at regular intervals and the final comments after completed exposure are given in Tables 1-4. As previously stated, the panels in Johannesburg and Stellenbosch were exposed for one year and those at Holford were exposed for three years.

Table 1
Exposure results (Wood: Sapele Mahogany)

Resin	Gloss rating			Film breakdown			Comments		
	S	J	H	S	J	H	S	J	H
Exp. resin 158	2	4	3	5	5	4	D.F.	SD	—
Exp. resin 341	2	4	2	5	5	2	D.F.	—	B
Exp. resin 340	4	5	5	4/5	4/5	3/4	SD	—	B
Exp. resin 339	1	4	4	5	4/5	2/3	E.F.B.	E.SB.	SB.L.
Exp. resin 338	1	2	1	4	5	1	E.B.F.	SB.E.	WB.SB.
Paralac low	2	4	5	3/4	3/4	5	SD.F.	—	L.B.

SD = Slight darkening of wood D = Darkening of wood F = Fungal attack
 B = Bleaching of wood E = Erosion of film
 SB = Strong bleaching of wood WB = Wood breakdown L = Lifting of film

Sites

S = Stellenbosch J = Johannesburg H = Holford

Table 2
Exposure results (Wood: Burma teak)

Resin	Gloss rating			Film breakdown			Comments		
	S	J	H	S	J	H	S	J	H
Exp. resin 158	2	4	3	4/5	5	2	D.F.	SD	SD
Exp. resin 341	2	5	1	5	4/5	1	D.F.	SD	B
Exp. resin 340	3	5	5	3	4	4	F	SD	SD
Exp. resin 339	1	4	4	3	4/5	1/2	B.F.	SB.E.	L.WB.
Exp. resin 338	1	2	1	3	5	5	SB.F.	SB.E.	L.WB.
Paralac 10W	2	3	5	3/4	3/4	2/3	D.F.	D	SD

SD = Slight darkening of wood D = Darkening of wood F = Fungal attack
 B = Bleaching of wood E = Erosion of film
 SB = Strong bleaching of wood WB = Wood breakdown L = Lifting of film

Site

S = Stellenbosch J = Johannesburg H = Holford

Table 3
Exposure results (Wood: *Pinus Sylvestris*)

Resin	Gloss rating			Film breakdown			Comments		
	S	J	H	S	J	H	S	J	H
Exp. resin 158	2	4/5	3	5	4/5	2	SY.F	Y	L
Exp. resin 341	2	5	2	5	4	2	SY.F	Y	Y
Exp. resin 340	4	5	5	4	3/4	3	SY.F	Y	L.WB
Exp. resin 339	1	4	4	4	3	2	SY.F	Y	L.B.WB
Exp. resin 338	1	3	2	3	4	1	SY.F	SY.E	L.B.WB
Paralac 10W	3	4	5	4	3	2/3	SY.F	SY	L.WB.

SY = Strong yellowing of wood Y = Yellowing of wood F = Fungal attack
 E = Erosion of film WB = Wood breakdown B = Bleaching of wood
 L = Lifting of film

Site
 S = Stellenbosch J = Johannesburg H = Holford

Table 4
Exposure results (Wood: *Pinus patula*)

Resin	Gloss rating			Film breakdown			Comments		
	S	J	H	S	J	H	S	J	H
Exp. resin 158	4	4/5	3	4	4/5	4	SY.F	Y	Y
Exp. resin 341	4	5	3	4	4/5	2	SY.F	Y	Y
Exp. resin 340	3	5	5	4	3/4	3/4	SY.F	Y	WB.L
Exp. resin 339	1	4	4	3	4/5	1/2	SY.F	Y.E	WB.L
Exp. resin 338	1	3	2	4	5	2	SY	SY.E	WB.B.L
Paralac 10W	3	4	5	3	3	1/2	SY.F	SY	WB. L

SY = Strong yellowing of wood Y = Yellowing of wood F = Fungal attack
 L = Lifting of film WB = Wood breakdown E = Erosion of film
 B = Bleaching of wood

Site
 S = Stellenbosch J = Johannesburg H = Holford

It was considered, owing to the much more destructive climate in South Africa than in the U.K., that in order to get the same order of breakdown, it would be necessary to expose for longer in the U.K. than in South Africa. Results indicate, however, that two years in the U.K. would have been a more suitable period. Many of the panels showed such excessive film breakdown after three years that assessment was difficult. Two arbitrary ratings were used for gloss and film breakdown. Final gloss was rated on an arbitrary 1–5 scale; Gloss 5 indicating no loss of gloss during exposure and Gloss 1 indicating virtually complete loss of gloss. Film breakdown was also rated on an arbitrary 1–5 scale; no film breakdown being indicated by 5 and complete film breakdown by 1.

Exposure results with respect to site

Stellenbosch In all cases, Stellenbosch exposures showed loss of gloss to an extensive degree. Fungal attack to a greater or lesser extent was present in virtually all samples. There was very considerable darkening or yellowing of the wood, depending on the particular wood. The mahogany and teak darkened and the pines yellowed. Generally, there was very considerable loss of gloss.

Johannesburg Except in the case of Exp. Resin 338, gloss retention of the urethane coatings was extremely good, as was

the lack of film breakdown. So far as the latter was concerned, the control alkyd was worse than any of the urethane coatings.

Holford The three-year exposure, as compared with one year in South Africa, resulted in much greater film breakdown generally. Loss of gloss was of the same order as at Stellenbosch after one year's exposure but the virtual complete retention of gloss of the control alkyd is very noteworthy. The retention of gloss was superior to that after one year's exposure in Johannesburg and contrasted sharply with the Stellenbosch results.

Exposure results with respect to systems

Exp. Resins 158 and 341 At Stellenbosch these resins gave the best performance of the whole series with regard to film breakdown. In Johannesburg, Exp. Resin 158 gave the best overall performance of the whole series. Film breakdown was nil on mahogany and teak, with only slight incipient isolated film breakdown on the pines. Exp. Resin 341 was only slightly worse. At Holford, these two systems were notable in that no breakdown of the wood was evident, which was the case with other systems on most woods. Exp. Resin 158 showed up better than Exp. Resin 341 in all cases in Holford.

Exp. Resins 338, 339 and 340 At all exposure sites, Exp. Resin

340 was outstanding in that it showed less loss of gloss than any other system. At Stellenbosch, Exp. Resins 338 and 339 gave the worst dulling of all systems with either film breakdown or erosion. With both resins on the two pines there was strong yellowing. On teak there was bleaching of the wood. At Johannesburg, Exp. Resin 339 gave inferior gloss to Exp. Resin 340 but approximately equal to Exp. Resin 158. Film erosion was present with Exp. Resins 338 and 339 on mahogany and teak. Exp. Resin 338 had a markedly worse gloss retention than Exp. Resin 339 but film breakdown was better. Within the series Exp. Resins 338, 339 and 340, the dominant result was the strong bleaching of mahogany and teak in the case of Exp. Resins 338 and 339 with the former giving the worse result. With the pines, strong yellowing of the wood occurred, being extremely bad with Exp. Resin 338. In general, however, the yellowing was less, but bleaching worse than at Stellenbosch, presumably due to a higher incidence of ultra-violet light. At Holford wood breakdown, loss of adhesion and lifting of film was very marked with Exp. Resins 338 and 339: In the case of the pines, breakdown of wood under the film was evident with Exp. Resins 338, 339 and 340. There was also lifting of the film.

Paralac 10W At Stellenbosch, this control alkyl was very similar in performance to Exp. Resins 341 and 158 so far as dulling was concerned. Film breakdown was very marked with darkening of mahogany and teak and yellowing of Pinus Sylvestris and Patula. In Johannesburg, the control alkyl had a gloss retention inferior to Exp. Resins 158 and 341 and a more marked film breakdown. At Holford, this resin performed very well. There was virtually no loss of gloss even after three years' exposure and in this respect it was equal to or better than the urethanes. As far as film breakdown was concerned, Paralac 10W was better than Exp. Resins 338, 339 and 341, but not as good as Exp. Resins 158 or 340.

Water absorption of coated and untreated exposed panels

Apart from the observations reported in the previous section on the large panels exposed at Stellenbosch, the amount of water absorbed by the coated panels was determined at intervals for one year and compared with the amount of water absorbed by the untreated panels. The results of water absorption quoted in per cent by weight are shown in Figs. 1-4.

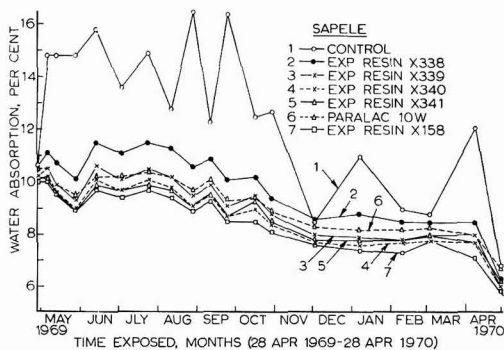


Fig. 1. Water absorption variation with time for Saapele; exposure at Stellenbosch

It will be seen that all the coated samples absorb much less water than the untreated control. During the rainy season, the control absorbs a considerable amount of water whilst all the treatments reduce the water uptake to a fraction of that of the untreated wood.

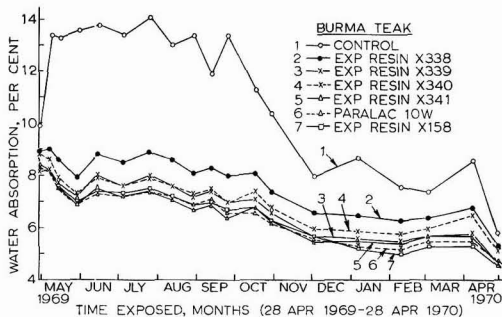


Fig. 2. Water absorption variation with time for Burma teak; exposure at Stellenbosch

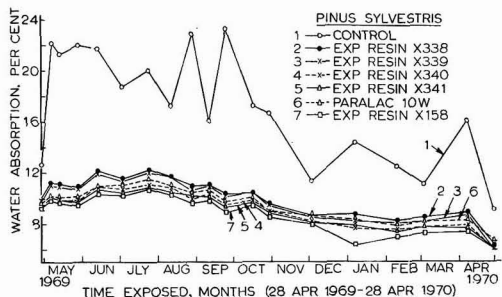


Fig. 3. Water absorption variation with time for Pinus Sylvestris; exposure at Stellenbosch

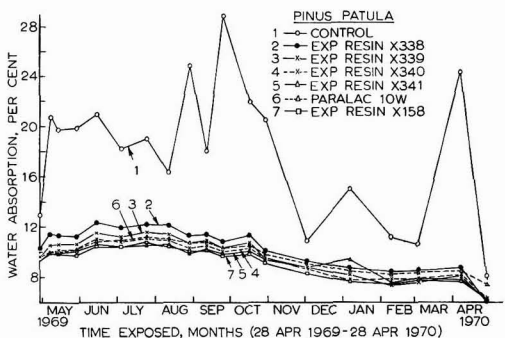


Fig. 4. Water absorption variation with time for Pinus Patula; exposure at Stellenbosch

Degree of efficiency in preventing water absorption of small samples

From Table 5 it can be seen how the degree of efficiency is reduced after several exposure cycles. It will be noted that the period of exposure chosen is relatively short due to the fact that the deterioration of small samples is much more rapid than that of the larger exposure panels.

After the second and third cycles it will be noticed that some samples with only one coat have deteriorated considerably. The efficiency of Paralac 10W was very much reduced. In the exterior exposure tests, however, this coating behaved reasonably well.

Table 5
*Efficiency of coatings in preventing water absorption**

Resin	Number of coats	Degree of efficiency as per cent		
		Initial	After six weeks' exposure	After three months' exposure
Exp. resin 158	1	93.6	64.7	54.3
	2	97.7	97.1	97.9
Exp. resin 341	1	97.1	95.8	88.8
	2	99.0	98.6	97.8
Exp. resin 340	1	95.1	80.3	43.5
	2	97.9	97.4	96.8
Exp. resin 339	1	95.1	86.4	71.0
	2	98.4	98.1	97.8
Exp. resin 338	1	92.1	77.0	72.1
	2	97.1	97.8	97.7
Paralac 10W	1	90.9	47.5	39.2
	2	96.3	95.7	94.1

*Exposure at Stellenbosch

The two-coat system was, as expected, much better but Paralac 10W was still the most inferior product.

Degree of efficiency in preventing swelling of small samples

From Table 6 it can be seen that, in this case also, the Paralac 10W is inferior to the other coatings in preventing water uptake and swelling of the wood.

Two coats improved the Exp. Resin 158 up to 100 per cent efficiency whilst Paralac 10W was only 59.2 per cent.

Table 6
*Efficiency of coatings in preventing swelling**

Resin	Number of coats	Degree of efficiency as per cent		
		Initial	After six weeks' exposure	After three months' exposure
Exp. resin 158	1	97.1	41.4	8.6
	2	100.0	100.0	100.0
Exp. resin 341	1	100.0	42.7	55.8
	2	100.0	100.0	100.0
Exp. resin 340	1	100.0	84.8	31.1
	2	100.0	100.0	96.5
Exp. resin 339	1	97.4	91.9	75.3
	2	99.4	100.0	100.0
Exp. resin 338	1	94.6	98.0	53.3
	2	100.0	98.4	98.9
Paralac 10W	1	100.0	22.3	2.5
	2	100.0	93.7	59.2

*Exposure at Stellenbosch

Cracking of the wood and fracturing of the surface coatings

Initial cracks in the surface coatings develop rapidly as soon as the wood is exposed to the weather. These cracks are caused by the cracking of the underlying wood.

It is possible to formulate surface coatings with sufficient elasticity to bridge or span the microscopic and sub-microscopic cracks and fissures. The macroscopic cracks,

which are visible to the eye, are of such a magnitude that they will tear openings in the surface film. How fast such cracks can develop is illustrated in Figs. 5 and 6 which show the end grain of coated samples of pine (coatings applied at Stellenbosch) exposed for only five weeks to the weather.

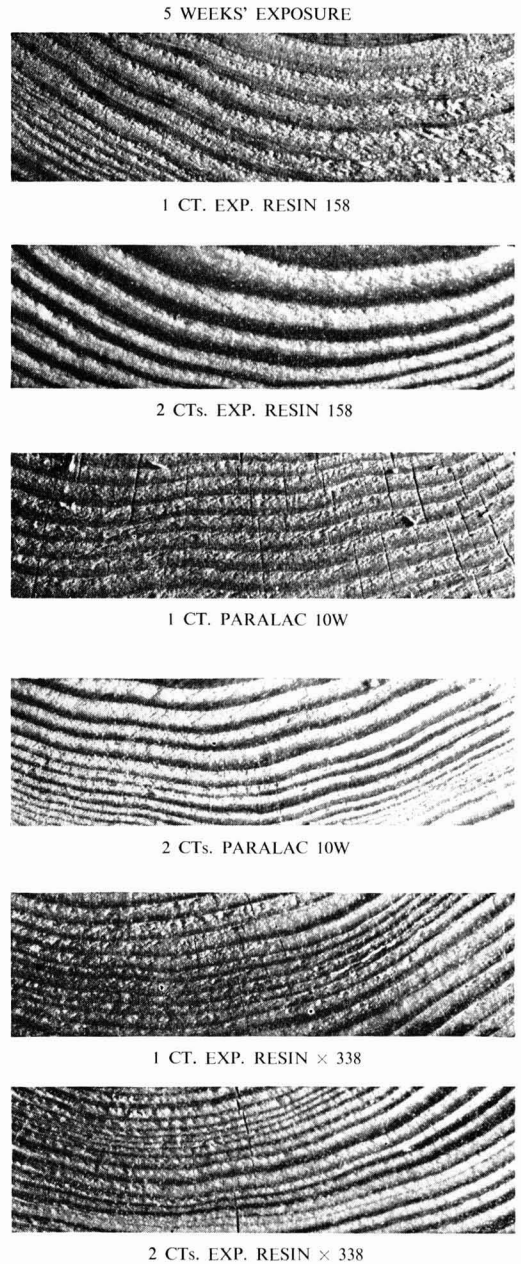
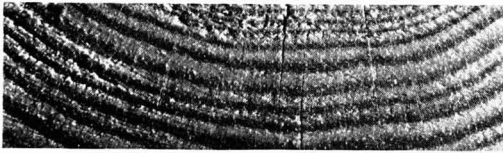
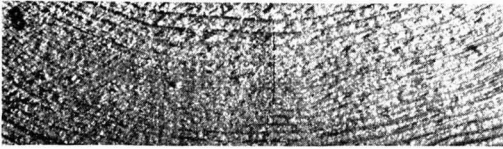


Fig. 5. Examples of end grain of pine coated at Stellenbosch, after five weeks' weathering

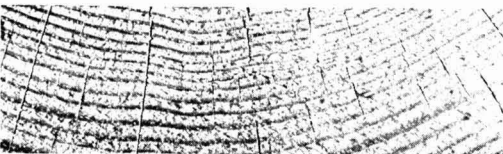
5 WEEKS' EXPOSURE



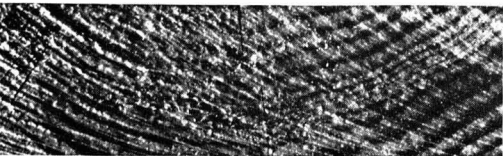
1 CT. EXP. RESIN $\times 339$



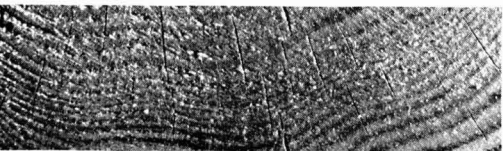
2 CTs. EXP. RESIN $\times 339$



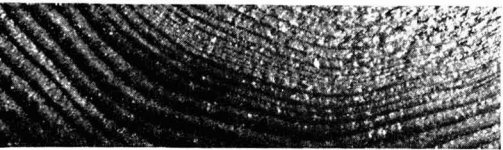
1 CT. EXP. RESIN $\times 340$



2 CTs. EXP. RESIN $\times 340$



1 CT. EXP. RESIN $\times 341$



2 CTs. EXP. RESIN $\times 341$

Fig. 6. Coated pine after five weeks' weathering at Stellenbosch

Such a rapid development of macroscopic cracks indicates the early presence of microscopic or sub-microscopic fissures. These allow water to penetrate to such an extent that macroscopic, visible cracks develop soon after the exposure to the weather.

Confirmation of this is obtained from the electron photomicrographs which show that extremely small fissures are

found even in the unexposed films. Fig. 7 shows sub-microscopic cracks of Exp. Resin 339 at about 12 000 times magnification. These minute cracks are not present in coatings on an inert material, like glass. They are caused by the swelling and shrinking of wood due to water vapour absorption and desorption taking place before the exposure to the weather. This is obvious from the fact that the fissures run parallel to the main fibre direction of the wood.

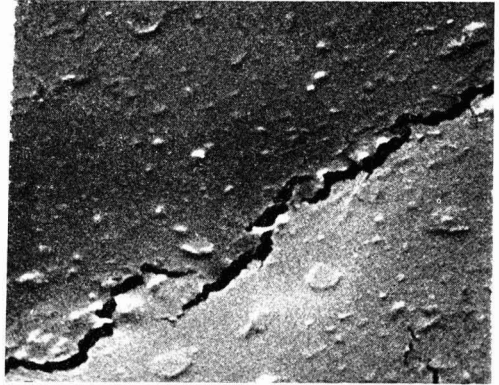


Fig. 7. Sub-microscopic cracks on Exp. Resin 339 at approximately $\times 12\ 000$ magnification

From the above it will be seen that an initial, but very serious failure of the surface coatings takes place irrespective of whether the wood is exposed or not. The adhesion to the wood seems to be very good but the elasticity of the synthetic resins is not high enough.

The visible cracks seen in Figs. 5 and 6 which look quite alarming are, in themselves, not the primary cause of the film breakdown but are on the contrary, the results of sub-microscopic fissures developed at an earlier stage. Electron micrographs of surface coatings exposed for a very long time show the development of deep fissures and complete open cracks. It is interesting that, at this stage, no further sub-microscopic fissures are developed since the stresses in the wood and the surface coatings are relieved by the formation of long, macroscopic cracks. Around these cracks (as in Figs. 8 and 9) the surface coating will deteriorate by loss of adhesion, lifting-up and flaking of the film.

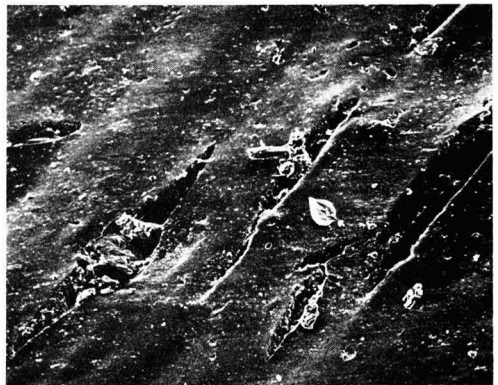


Fig. 8. Cracks in Exp. Resin 341 at $\times 240$ magnification

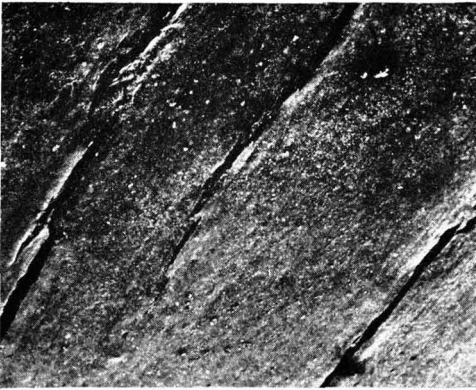


Fig. 9. Cracks in Exp. Resin 339 at $\times 26$ magnification

Electron microscope investigation of the exposed and unexposed samples

Surface coatings on wood usually break down by forming microscopic cracks which allow water to penetrate and to displace the coatings from the surface of the wood with the consequent lack of adhesion.

Preferential wetting^{3,4} plays an important part in the displacement of the surface coating and is probably more detrimental to the durability of surface coatings on wood than any other phenomenon. This process is irreversible and is accentuated by the swelling and shrinking of wood caused by absorption and desorption of water. Repeated wetting and drying cycles are very effective, therefore, in breaking down coatings of insufficient elasticity.

It is of considerable interest to study the formation of cracks in the surface coatings of exposed and unexposed wood. Since any sizeable opening in the film will allow water to penetrate into the wood, it is obvious that light microscopy will not reveal structural defects in the surface coating when they are very small. The coatings were studied with the scanning electron microscope. ("Stereoscan" from Cambridge Scientific Instruments.)

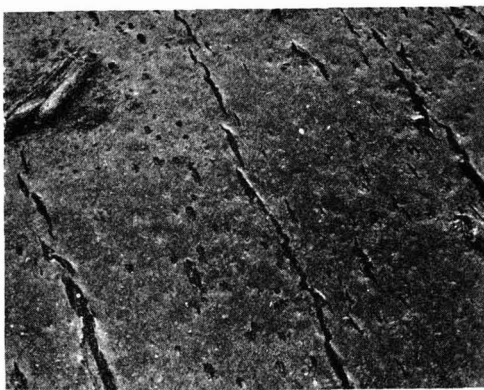


Fig. 10. Exp. Resin 341 at $\times 23$ magnification

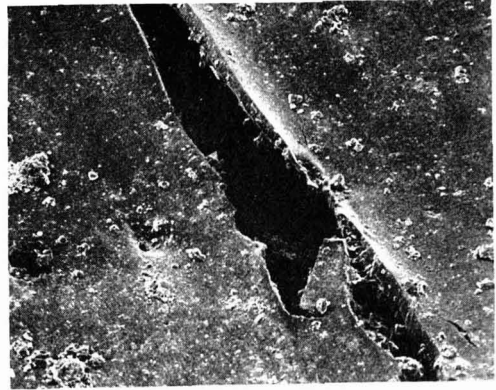


Fig. 11. Exp. Resin 341 at $\times 230$ magnification

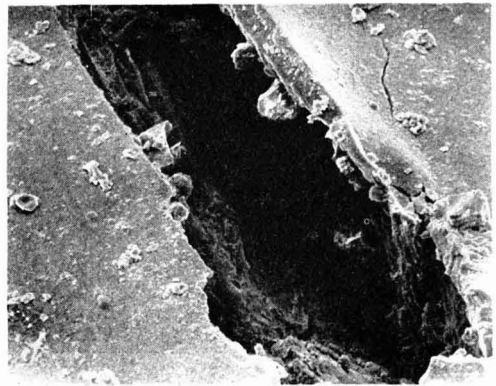


Fig. 12. Exp. Resin 341 at $\times 580$ magnification

Some of the most interesting results are shown in Figs. 7-12.

The fissures in the coating in Fig. 7 are of different order of magnitude than the cracks in Figs. 11 and 12.

The fissures shown in Fig. 7 might even be formed by thermal stresses in the unexposed sample, whilst the cracks in coating shown in for example Figs. 11 and 12 are forced open by the swelling of the wood.

The coating is exposed to maximum stresses over the denser part of the year rings. The surface coatings are, therefore, split open at regular intervals parallel to the year rings as clearly shown in Figs. 8-10.

Discussion

Exterior exposures

Exp. Resin 158 and Exp. Resin 341 show up the best in general, although gloss retention of Exp. Resin 340 appears to be better than that of the former coatings. Dulling was much worse for all systems in Stellenbosch than at other exposure sites and fungal growth was usually present. In Johannesburg there was much better gloss retention, in general, and it can be

said that Exp. Resin 158 and Exp. Resin 341, after one year's exposure under the very high ultraviolet (UV) incidence in Johannesburg, behaved extremely well. Exp. Resin 340 gave the best gloss retention. After three years' exposure at Holford in the U.K., Exp. Resin 158 showed up best with Exp. Resin 341 second. Exp. Resin 340, however, as at other exposure sites, gave the best gloss retention.

These results are in line with the postulation that a more flexible film is required under South African conditions where there is greater contraction and expansion of the wood than is the case in the U.K. climate. Hence best results tend to be shifted to a polymer (Exp. Resin 341) containing a higher percentage of the linear chain extended material.

Exp. Resins 338 and 339, contrary to expectations, generally behaved the worst of the systems. In some cases the film remained intact, but badly eroded and in others film breakdown was no less than with the aromatic systems. In general, on the pines there was serious yellowing of the wood, whereas on teak and mahogany the wood was badly bleached. The introduction of the hexamethylene diisocyanate containing systems in these resins led to very considerable breakdown of the wood beneath the film and usually either yellowing or severe bleaching of the wood.

Clearly the greater UV absorptive properties of the aromatic isocyanate containing resins are beneficial in protecting the wood beneath the film merely because the UV is absorbed before reaching the wood surface. The aliphatic isocyanate containing systems have greater ultraviolet transmission. The Exp. Resin 339 was markedly better than Exp. Resin 338 in respect of gloss retention, thus showing a very definite trend in gloss extending from Exp. Resin 340 as maximum through Exp. Resin 339 to Exp. Resin 338.

The control long oil alkyd resin, Paralac 10W, when exposed at Stellenbosch, behaved very similarly to Exp. Resin 341 and Exp. Resin 158 so far as dulling and fungal attack were concerned, but film breakdown was very marked.

Similar results were obtained in Johannesburg so far as film breakdown was concerned. However, at Holford, Paralac 10W showed up well in comparison with its performance under South African conditions. Gloss retention was better than the urethane systems, but film breakdown was worse than Exp. Resin 340 and Exp. Resin 158 although better than the aliphatic isocyanate containing resins.

Accelerated tests—degree of efficiency in preventing water absorption and in preventing swelling in small samples

Tables 5 and 6 show that Paralac 10W, after the second and third cycles, gave a rapidly decreased water impermeability and was found also to be markedly inferior to the other coatings in preventing swelling of the wood. On exterior exposure, however, Paralac 10W behaved rather better than these results would have predicted.

The degree of efficiency in preventing water absorption and swelling of all the urethane coatings was of a high order when two coats were applied. It is noted from Table 6 that two coats improved the degree of efficiency in preventing swelling of all the urethane systems to between 90 and 100 per cent as compared to 59.2 per cent with the alkyd. There would seem to be little to choose in this test between the various urethane systems, but they would all be expected to give good exterior exposure results. This, in fact, was found to be the case except for the linear chain extended aliphatic isocyanate/isocyanurate

isocyanate containing systems where the wood breakdown effect masks and destroys the good weather protection. From Table 5 it will be seen that there is no such difference in the efficiency of the coating to prevent water absorption between the alkyd and the urethane surface coatings.

There was a surprisingly low value of efficiency in preventing swelling for Exp. Resin 158 when one coat was applied although, with two coats, 100 per cent was achieved. Exp. Resin 341, as Exp. 158, is a linear chain extended aromatic isocyanate/isocyanurate with the latter containing the greater proportion of chain extended isocyanate. Results given in Tables 5 and 6 show that Exp. Resin 341 has a markedly better resistance to swelling and water absorption than Exp. Resin 158.

Water absorption of large panels on exposure

From Figs. 1–4 it can be concluded that, whilst all treatments reduced the water absorption of the panels, Exp. Resin 158 was the best on all four woods tested followed by Exp. Resins 341 and 340. In these tests Exp. Resin 338 is probably the worst. From a study of Figs. 1–4 it is particularly significant that within 4 to 6 weeks the water absorption results had already achieved the pattern so far as order of magnitude is concerned which is maintained throughout the twelve-month period.

Conclusions

Visual exposure results clearly show that Exp. Resin 158 and Exp. Resin 341, namely the 4:1 and 5:1 polyalkylene adipate tolylene diisocyanate/isocyanurate isocyanate mixtures, give the best results when used as a clear lacquer on each of the woods tested at the exposure sites. The more flexible film produced by Exp. Resin 341 containing the higher proportion of the linear chain extended polymer gave marginally better results in South Africa where, undoubtedly, its greater extensibility accommodated the greater contraction and expansion of the wood experienced. The expected greater resistance to heat degradation of the resin containing the higher isocyanurate content does not appear to improve performance in the warmer climate.

Water absorption tests carried out on the large panels confirm Exp. Resin 158 and Exp. Resin 341 are the best systems and it is noteworthy that this conclusion can be drawn within six weeks of the exposure date, thus forming a reliable accelerated test. Results of "Degree of Efficiency" tests of these two coatings in preventing swelling and water absorption predict that these systems will behave well on exposure, provided at least two coats are applied. It is also of interest that in both cases the Degree of Efficiency tends to be better with the resin containing the higher proportion of the linear chain extended polymer.

Degree of Efficiency tests in preventing swelling and water absorption on the polyalkylene adipate hexamethylene diisocyanate/isocyanurate isocyanate mixtures Exp. Resins 340, 339 and 338, which contain progressively more of the aliphatic chain extended system, would indicate that these should be good surface coatings. However, visual exposure results and water absorption results on large panels show clearly that these coatings are not successful as clear lacquers for wood, particularly not the two resins 339 and 338 containing the higher proportion of chain extended system. These results are perhaps surprising owing to the established better resistance to yellowing of aliphatic based isocyanate systems

when subjected to UV light. Practical results on Exp. Resins 339 and 338, however, show that they offer little protection to the wood itself, which is either bleached or turns strongly yellow depending on the wood used. There is eventual breakdown of the wood which, if bad enough, breaks up the surface coating itself. It is believed that the reason for the above results is that as the aliphatic content increases, so the UV transmission of the film increases (the aromatic systems behaving as UV absorbers) and whilst the film often remains intact although eroded, the wood below is unprotected from the ultraviolet light and this results in bleaching, yellowing and breakdown of the wood itself. This, if bad enough, accelerates the breakdown of the protective film. Thus it is suggested that, whilst pigmented aliphatic isocyanate containing systems have excellent resistance to yellowing and weathering, the aliphatic isocyanate containing systems, which are the subject of this paper, have been shown to be unsuitable for use as clear lacquers on wood for outdoor exposure and inferior to the aromatic isocyanate based systems.

The gloss retention of the 2:1 polyalkylene adipate hexamethylene diisocyanate/isocyanurate isocyanate (Exp. Resin 340) is the best of all the systems tested and it is of note that

as the percentage chain extended polymer is increased through Exp. Resin 339 (3:1) to Exp. Resin 338 (4:1), so the gloss retention decreases. This is as would be expected in view of the fact that as the polymer flexibility is increased, so normally is the film flexibility and gloss.

The control alkyd, Paralac 10W, forms resistant films, but on the whole, shows inferior adhesion to the wood. This is confirmed from the low efficiency of the alkyd coating in preventing swelling.

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Trends in petrochemical raw materials*

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In considering the use and availability of resources in the field of petrochemicals, we are bound to take a preliminary look at the overall energy scene and, in particular, the availability of oil. Whilst the emphasis of this symposium is centred on the relatively brief span of perhaps ten years, we have already received indications that longer-term effects in the energy field may cast some disconcerting shadows in the shorter term. Furthermore, in order to make any sensible appraisal of what is happening today we must also take a backward look at the complex of factors that has brought us to our current situation.

Whatever may be the prospective limitations in future oil supplies, we have certain reassuring considerations when we look at petrochemicals. These could include:

1. That many influential authorities, including those speaking from such diverse viewpoints as the Shah of Iran and Sir Eric Drake (Chairman of BP), have expressed the view that making chemicals is just about the best use for our oil resources.
2. Only something like 5 per cent of world oil is used to make chemicals. Iranian sources have suggested that if the right future balance is struck about 55 per cent of world oil should be used to make chemicals by the turn of the century. This implies tremendous limitations in oil for other applications, but at least indicates the sort of priority which oil-producing nations might attach to the chemical business.
3. Known and proven resources of oil would supply the world at its present rate of usage for 30 to 40 years.
4. The discovery of new oil sources has not stopped and there will be many further important oil discoveries.
5. There are other sources of natural hydrocarbons in the world as well as oil wells.

It is perhaps necessary to elaborate on the latter items dealing with the oil business as a whole. The more gloomy predictions of drastic restrictions in oil supply being really imminent were based not on the current rate of demand but on the assumption that this rate would increase at perhaps 7 per cent compound each year. The essential short-term problem is that it will be difficult, with existing and immediately prospective technology to sustain a growth in reserves of more than 5 per cent per year, and even that figure may prove marginally optimistic. If growth were, therefore, to continue at 7 per cent each year, a critical position would be reached after a relatively few years, at which time production capability would drop sharply.

The great immediate challenge is, therefore, to contain this growth in consumption. This is, of course, where the crisis of a few months ago has had some beneficial effects in that the higher level of energy costs has completely revised the cost benefit analysis of energy consumption in almost every sphere. In the immediate sense this will encourage the use of smaller cars at lower mileages and the improvement

of building insulation. In the somewhat longer term, there will be an incentive to switch to other forms of energy. In Europe, our scope for switching to alternative resources is limited. We have not the tar sands, the shale deposits, and the easily accessible coal that may be found elsewhere in the world. We may develop our natural gas resources to a slightly greater extent than we expected, we may import more coal from such countries as Australia or South Africa, we may even develop our own European coal resources rather more effectively, but there will still be a residual necessity to control the growth or oil demand by means of various economies.

It is not unreasonable to suppose that Europe's growth in oil consumption could be limited to 4 per cent per annum or less. This immediately paints a different picture of forward oil supplies, suggesting that the fundamental supply "crunch" which could happen in perhaps ten years at the pre-1974 rate of growth, could be staved off for possibly 30 years.

"What of North Sea oil?" The most optimistic forecasts of the ultimate total of oil recoverable from the North Sea would indicate that about 6 per cent of the world's oil reserves might be found there. The present discoveries would amount to little more than 2 per cent of the current world's reserves. This is indeed a most valuable resource, particularly for the UK and Norway within whose waters most of the discoveries have been made, but the British reserves might allow us to be self-sufficient for about 30 years at the anticipated 1980 level of demand. We might find oil also in the areas west of the Shetlands or in the Celtic Sea, but here again we would have to be fortunate indeed to make much impact on the overall world supply.

The conclusions from all this could be:

1. The fate of oil supplies in the immediate future will depend upon political considerations. We might expect that highly desirable efforts to find alternatives for oil reserves will be deferred until rather later than the last possible moment.
2. Emphasis will be placed on finding alternatives to oil in energy applications, e.g. nuclear, solar and other forms of energy, which can be translated directly into electricity and heat.
3. Efforts will be made to exploit other forms of fossil fuel, e.g. tar sands, shale oil, which will keep the world supplied with hydrocarbons for some considerable additional time to come. Most of such deposits are outside Europe.
4. The use of oil for chemical production is probably its most valuable application and the one least able to be replaced by alternatives.
5. The UK will be in a relatively favourable position in Europe for oil supplies from 1978 onwards.

On some of these points, I will have more to say later. This outline should be a preliminary reassurance that there

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is no imminent danger of the supplies of petrochemicals petering out.

Coal is clearly high on the list of alternatives needing consideration. It is for the moment more favourably placed in comparison with other energy sources than for many decades. An instant switch to vast-scale chemical production from oil is not practical, and by the time it is practicable, it will probably no longer be an economic proposition. Some factors involved here are the following:

1. Coal recovery is labour-intensive and we did not have long to wait for the argument to develop that in the new order of energy values, the miner is increasingly valuable and should be paid correspondingly more.
2. The mining of coal using present technology is a thoroughly unpleasant job which will, and indeed should, command the appropriate compensation to offset the disadvantages. In the longer term new technology may reduce this effect, but this will take considerable time and experience to develop. It must be added that on the basis of current technology the outlook for underground gasification of coal is not very favourable.
3. Coal does not lend itself readily to modern technological trends. It is a solid containing incombustible ash, so that totally continuous large-scale operations are rendered difficult. In most cases the extraction of anything like the full potential energy value of coal is impossible.

On the assumption that coal will tend to align itself at an energy value no more favourable than that of oil, there will be no natural economic incentive to turn to coal as a chemical raw material. Artificial incentives may, of course, be introduced, but here again the effect is not likely to be felt for a considerable time. The trends of exploration I would expect in this area would include the re-assessment of ammonia and methanol production from coal, and the maximising of the recovery of aromatics from coal carbonisation. Attention will probably be paid again to coal-based acetylene, but with the possible exception of areas favoured with easily won coal, such an energy-hungry development does not look hopeful. Once again it is necessary to emphasise that much further reconsideration will be necessary in the long long term—which may be 50 to 100 years hence—to meet a situation where liquid hydrocarbons may be limited even as feedstocks to chemicals. In such a circumstance, however bizarre it may look today, coal-based acetylene may be a route, not only to established acetylene derivatives, but also to ethylene and benzene. It may be noted here that of all the petrochemical processes, those involving ethylene production are the most significant energy users¹. Publicity is occasionally given to alleged coal-based ethylene processes, but these always seem to resolve themselves into processes for vast quantities of synthesis gas or liquid hydrocarbons which, incidentally, make a certain amount of ethylene.

An obvious possible alternative route to ethylene without using oil is through the medium of fermentation alcohol. Indeed, the case has been publicly canvassed for the use of potato peelings from a potato crisp factory to be applied to this very purpose. We conducted a very modest exercise on this, and found that the quantities of peelings mentioned would suggest that 25 per cent of our entire potato consumption was being fed to this one crisp factory and that, even so, the quantity of ethylene that could be expected to be derived was less than 20 000 tonnes/year compared with our current usage approaching 1.5 million tonnes/year.

Looking at fermentation in a more general sense as a source of ethanol, one is faced with the fact that the most valuable and readily available sources of fermentable material are already being used, producing either industrial alcohol or what is technically termed "potable alcohol". The development of alternative waste materials for fermentation would add to the cost and difficulty of collection. An outline of the effort involved is suggested by the fact that to produce perhaps 3 per cent of the world's 1980 ethylene requirement in this way would require a mountain of 50 million tonnes of fermentable material. If much of this were produced seasonally and required storage for continuous plant operation the size and objectionable nature of this proposition become starkly obvious.

An alternative could obviously be the growth of grain crops specifically for fermentation, but here one meets another basic objection, that chemical raw materials would be competing directly with food for the limited availability of arable land.

Regrettably, the conclusion which has to be made is that for the foreseeable future there is no serious alternative to the continuance of producing most of our organic chemicals from petroleum. We must, therefore, consider what are the problems today, how did they arise, and what solutions are possible.

It would be quite wrong to suggest that the present supply and economic problems of petrochemicals derive primarily from the after-effects of the Arab/Israeli war in the autumn of 1973 and the oil price escalations associated with this conflict.

Amongst the threads of events which have led to our present difficulties, one stems from the conclusion that the exhaust emissions from cars were giving rise in certain areas (notably Los Angeles and Tokyo) to unacceptable smog conditions. The emissions from car exhausts include unburnt hydrocarbons, carbon monoxide, minute solid particles of carboniferous matter with some lead content, oxides of nitrogen, and finally, the things which ought to be there, carbon dioxide and water vapour. The mechanism for some of the reactions which take place remains remote. The trouble arises from a combination of oxides of nitrogen, unburnt hydrocarbons, carbon monoxide and strong sunlight. When this is incorporated in a heavily built-up, highly motorised area wholly or partially surrounded by mountains, the smog effect is highly unpleasant. It must be borne in mind that such conditions arise only in a very limited number of places, but the effects in Los Angeles, for example, were sufficient to spark off legislation, firstly in California and subsequently in the form of the 1970 Clean Air Act of the Federal Government of the USA. This stipulated extremely sharp reductions in the allowable obnoxious contents of car exhausts in steps, the main steps taking effect at the beginning of 1975 and 1976.

It is still not certain if these standards can, in fact, be met. The main hope lies in the treatment of exhaust gases, firstly in a reactor to remove oxides of nitrogen and, secondly, in a catalytic after-burner to complete the combustion of the hydrocarbons and carbon monoxide. Such operations (which are costly in any case) can only be carried out, so far as present knowledge takes us, using gasoline without lead in it. This immediately and sharply reduces the quality and efficiency of the gasoline. It is not possible to restore completely the "octanes" that are lost by the elimination of lead, but the main contenders are alkylate gasoline (consuming butanes and lower olefins) and aromatics (notably toluene and xylenes).

In the inevitable period of uncertainty before such solutions were worked out it was not possible to proceed with refinery building in the USA. Uncertainty was followed by a period in which the ecology lobbies enjoyed an almost hysterical prestige and which further hampered attempts to construct refineries. When some success was achieved in meeting the limitations imposed by the ecologists, price control was enforced, causing "second thoughts" yet again.

One effect of this was that the USA entered 1974 short of overall refining capacity, and with new and unprecedented demands for aromatics and lower olefins. The immediate prospect, too, is that the newer car engines designed to consume the newer lower octane fuel will need 12 to 20 per cent more gasoline per mile travelled—all in the interests of avoiding air pollution.

The smog problem, in the sense of Los Angeles or Tokyo, does not arise in Europe. Indeed, almost all the major characteristics of gasoline usage in Europe are different from those of the USA. We are not so highly motorised, we import most of our oil, our cars are smaller and engines differently designed, alkylate gasoline is virtually unknown in Europe (and the butane feedstock relatively unavailable). So we have much less to gain and more to lose by moving along the American route to non-lead containing gasoline. A Government publication has estimated the cost of removing lead from our gasoline at £250 million (1971 prices)².

Ecology is fashionable and good politics, so that a gesture in this direction was called for by European countries, too. Limitations in lead contents of gasoline have been imposed by most European countries. It may be noted that the argument here is quite different from that used in USA—in Europe it is the lead emissions themselves which are represented to be the problem. The use of the catalytic afterburner in the American style will not be possible with our gasolines, and the increased use of aromatics which lead reduction has occasioned may even cause a marginal increase in toxicity levels of the gasoline and of pollution by the exhaust gases. There is virtually no evidence of lead exhaust emissions causing any damage and, indeed, most of our lead intake arises from food and water rather than polluted air. Indeed, in their recent admirable book "The Chemical Economy", Reuben & Burstall³ advance the comment "dispassionate examination would suggest, therefore, that legislators in the UK would do better to concern themselves with cigarette smoking and coal fires than to worry about car exhausts". The fact remains that legislation is being proceeded with and that this has the effect in Europe, as in the USA, of accentuating the demand for aromatics.

You may feel that I have spent a long time dealing with the oil industry, but it is quite impossible to arrive at any sort of feeling for the current petrochemical situation without looking first at this oil background.

It would seem that we can give favourable answers to two basic questions—firstly, petrochemical feedstocks will exist to meet foreseeable demands as far ahead as it is possible to look, and, secondly, there is a fair consensus suggesting that, of all the uses to which energy in the form of petroleum can be put, that of making chemicals is perhaps the most favoured. There is another vital element in meeting our prospective demand, and that is the question of plant capacity.

Here again, in order to see today's problems clearly, we must look first to the past. The growth of petrochemicals world-wide has been spectacular and this growth has been characterised by the ability to use technical innovation and

increasing scale of operation to bring prices down against all the trends of society in general. This was done, moreover, with relatively little pain to the producer, at least up to the middle 1960s. At this time the pace became a little hectic, and a rather alarming symptom was the tendency to offer price reductions on the basis of large new plants shortly to come into operation. If the calculations were right, and the plant performed well, this was a praiseworthy and desirable move. A number of companies learnt, however, in the most painful possible way, that the increasing scale of plants, above a certain point, brought an increasing scale of risk of malfunction quite out of proportion to the further reductions in cost.

These hard lessons were being absorbed at a time when capital costs were beginning to escalate rapidly and business was far from buoyant. This involved a further increase in costs, in a period of some over-capacity which prevented price increases being made on a scale which the cost position demanded. In short, in the period from 1970-71 and for much of 1972 there was virtually no profit to be made in basic petrochemicals. This was, moreover, a world-wide phenomenon.

In business cycles it is quite common for the US conditions to precede those of Europe by a few months. In 1971 it was already clear that by the end of 1973 ethylene capacity would be limiting in the USA. It did, at that time, look as though some surplus European capacity would exist. In practice, the positively savage upsurge in demand from early in 1973 strained not only the US resources but also those of Europe.

Even with a clearly defined ethylene shortage on the horizon, no very significant price moves were effected until the shortage actually occurred. A fairly simple calculation could show that at the prices in 1971-72 new capacity for ethylene, and indeed many other products, was not a sound economic proposition. There was as a result a tendency to shelve investment programmes from 1970 onwards, pending visible indications that more favourable prices were on the way.

When the lull in demand came to an end, both in USA and the UK, the problems of the petroleum chemical industry were further compounded by price control, and of course, this price control is still with us in the UK.

The year 1973 in its earlier stages saw a world-wide surge in demand for almost all chemicals, which rapidly overtook the capacity limit. This might otherwise not have been reached until 1974 or 1975. On top of this the intervention of price control had distorted UK chemical commodity markets in particular.

It was into this already confused situation that the Arab-Israeli war of October 1973 introduced further explosive elements. In retrospect we may see the impact of this forewarning of impending limitations in world resources as a highly desirable indication that we must re-think some of our policies.

The direct petroleum shortages occasioned by the oil embargo at the turn of the year now belong to the past. What we are left with is a totally new set of values for a wide range of energy-consuming products. Furthermore, we are left with a feeling of uncertainty. The OPEC people have had a taste of power which may easily prove to their liking. Almost certainly threats and conditions of various kinds will emerge from time to time from developing countries producing raw materials which will plague us and make our

production plans more difficult. In general, however, I am making the assumption that, apart from relatively minor harassments, which may stem from the governments of oil-producing countries (and not least, our own), the petrochemical feedstock supply in the foreseeable future should be reasonably stable.

To put prices to crude oil, let alone the oil products or chemical derivatives, is a complex business. As is generally known, the overall effect of the period from January 1973 to January 1974 was to multiply crude oil prices by a factor of about four. Actual prices paid do not always accord with the posted prices, but this factor is in reasonable accord with reality. This increased cost is not distributed exactly evenly over the whole barrel of oil. At the heavy end of the barrel, residual fuel oil is likely to meet the heaviest competition from alternative energy sources. Indeed, it is most necessary that it should do so if our dependence on petroleum as a source of energy is to diminish. These other sources of energy will, at least, not be subject to quite the same inflationary trends as petroleum, so that where fuel oil retains its markets it will not be at a price which reflects the increased cost factor of four. Moreover, fuel oil markets should be reduced as a proportion of the total barrel, since the alternative energy sources are nearly all concentrated on these markets. This will mean there will be a need for substantial investment in such facilities as catalytic crackers and hydro-crackers to balance out the supply/demand pattern of the spectrum of oil products. Petroleum is a wonderfully flexible and versatile raw material, but adjustments of this kind can only be made at an additional cost. For these reasons the cost of naphtha is likely to go up by a factor marginally above the crude oil factor. Taking the most favourable view, let us accept for a moment a fourfold increase in the price of naphtha feedstock as a basis of further consideration.

At first sight, to rely on an industry whose feedstock costs have just risen fourfold might seem an alarming prospect. The effects are, however, mitigated to a large extent by the phenomenon of "technological dilution".

In the first stage of processing, say, of naphtha to olefins, the energy requirement plays a major part in the overall economics, and a fourfold increase in naphtha feedstock must give rise to a cost increase for ethylene of some 3 to 3.5 times. At each subsequent stage in processing this factor is reduced as other elements, not subject to quite such a sudden inflationary effect, play a greater part. First stage ethylene and propylene derivatives might, therefore, be subject to cost escalations to around 2-3 times the figure of early 1973. The more sophisticated and elaborate the product, and the longer the processing chain, the less the percentage increase in cost. This may, incidentally, have the effect of giving a boost to some of the comparatively expensive resins, solvents and chemicals as their economic position may be relatively improved.

As an illustration of this effect, progressing through and ultimately out of the chemical industry, we have calculated that the effect of a fourfold cost increase for energy (in the form of both feedstock and processing) on man-made fibres is to increase the fibre cost by between 10 and 35 per cent. It was surprising and significant that the impact on cellulosic man-made fibres was of the same order as that on fully synthetic fibres. The higher cost attributable to this tremendous increase in energy cost amounted to no more than a very few pence on a £5 shirt—though it should be emphasised that this calculation is specifically limited to energy input and there will be many other inflationary influences.

The same dilution effect arises in the field of plastics and resins. According to various calculations, a similar fourfold increase in energy cost applied to simple fabricated plastics in pipe or sheet form would cause an increase in the fabricated product cost of around 20 to 40 per cent. It is interesting to note that other fabrications involving metals, paper or glass would increase to a very similar extent if the processing energy input alone were subject to this fourfold increase.

It is interesting, therefore, to note that in such cases where natural and synthetic products come into competition, it has been the natural products whose prices have tended to shoot through the ceiling; one may cite wood, natural rubber, cotton and wool in this connection. Part of these astronomical increases may have been due to marketing euphoria on the part of the producers and speculators who over-estimated the inevitable cost increases arising from the oil crisis. No doubt for this reason some of these speculative prices for natural products have passed their peak and are now heading downwards.

Over a wide spectrum of product groups, therefore, the inevitable price increases which must follow from the increased cost of feedstocks should be manageable, and it is not to be expected that many petrochemical derivatives will be priced out of the market.

There remains the question of product supply. It is all very well to offer soothing remarks about the overall feedstock position and the overall price position, but neither of these cut much ice if the products are not available in adequate quantities.

Looking first at one of the worst problem areas of the past eighteen months, the aromatics, there are grounds for belief that the position has begun to improve. The worst of the madness is over, but it still seems that a shortage of benzene capacity in the USA and feedstock in Europe will keep the position reasonably tight for some time to come. As I have already mentioned, government policies have an important bearing on the alternative uses and alternative values of aromatics, so that no one can positively guarantee the future. As the benzene supply loosens up a little, I would expect *o*-xylene to do the same. Capacity for benzene production is not a problem at the present time in Europe. It would prove limiting in 1977-78 following current trends, but there is now evidence that capacity will be introduced in time to maintain a reasonable balance.

In the case of the olefins, ethylene and propylene, the building of new capacity in the USA was halted until price movements finally reflected the requirements of new investments. The US position seems likely to remain tight for some considerable time, as there is no evidence yet of the rate of building catching up on the existing deficit. Uncertainty about feedstock availability has been another important factor delaying US companies' decisions in this field.

On paper there should have been sufficient capacity in Europe in 1973, but the situation was affected by three factors: an extra demand arising from the US shortage; the failure of some plants to operate successfully; and some slight feedstock limitation. We are now heading inexorably in the same direction as the USA in that European capacity growth (due to the halting and shelving of investment since 1971) can scarcely keep pace with the growth in demand until the next major round of building takes effect in 1977. We would expect supplies of ethylene and propylene to be adequate but not plentiful in the immediate future and then

to deteriorate to a fairly critical situation in late 1976 and early 1977.

Butadiene, the co-product of ethylene and propylene, should be available in sufficient quantity to meet European demand, but there is likely to be a continuing deficit in the USA which will be on the look-out for any surplus availability.

When we look down the line at product capacity a number of products will reach their capacity ceiling in the near future and may present a problem even when the basic chemicals are in adequate supply. Friends in the marketing field are shaking their heads over the forward picture of a variety of solvents together with such products as cumene/phenol. In a few cases, so long as raw materials are available, old plants can be taken out of mothballs (acetone and cumene, for example).

Hydrocarbon solvents represent a perfect illustration of the effects of distorting the supply/demand balance. There is no shortage of hydrocarbon solvents, but as imports, which have always supplied an important share of the market, are not price controlled, whilst local production remains controlled; obviously an artificial extension of demand for the local product develops and hence this material is on allocation.

This whole story is largely one of past opportunities lost; of low prices, low profitability, low investment. Plants were either not built, were built too small, or were built too cheaply. In each case we pay the price now in limited supplies. Moreover, the producing companies have had a chastening experience which will cause them to be very wary of making new investments which could create a return to over-capacity.

There is, at the present time, a noticeable freeing of supplies of many petrochemical products. This has been occasioned by a combination of factors:

- (a) a slowing down of the rate of growth to a point, in some areas of business, of positive stagnation;
- (b) the seasonal effects typical of the holiday period; and
- (c) a certain de-stocking arising from the lessening of the panic on the supply front.

The stocking-up arose not least, of course, from the impression that a delay in purchasing would almost certainly involve buying at a higher price later. As most of the costs arising directly from the increase crude oil price have now passed through the system, this thought perhaps occasions rather less concern; on the other hand, at today's interest rates a high level of stocks is an expensive luxury.

It would be extremely premature to believe that this heralds the breaking of the market and a renewed era of major price-cutting. The underlying supply position is not well covered by capacity and a whole range of products are likely to remain in pretty tight supply for some time to come.

Everything I have said, you will note, assumes a continuing measure of growth for the chemical process industries. In a sense it is rather remarkable that the countries of the western world have so far shrugged off the enormous extra bill for oil. Such comments as I have made about capacity limitations are based on the general assumption that growth in this area will continue, at possibly a marginally reduced rate compared with the forecasts of a year ago. It would seem prudent to expect that in the next two years or so there

will be a tendency to stay on an economic plateau before further significant surges of growth occur. The alternative prospect of a raging recession for a year or two on a global basis would be a drastic and unhappy way of solving the raw material problems.

Three remaining questions arise:

1. How will the price of oil move in the future?
2. If the economic conditions are right for new investment, will the engineering capability be sufficient?
3. Will the OPEC countries play a significant part in meeting future petrochemical demands?

Answering the first question is an intensely difficult matter. It is obvious that the normal economic criteria will not necessarily apply. Oil is a political weapon and will remain so. The further we go into the future, however, the more economic importance attaches to the alternative sources of energy. The OPEC countries have indicated that their intention is to hold the price of oil reasonably stable, but they are likely to stipulate that inflationary movements in consumer countries are reflected in the price they pay for oil. There will be the political opportunists who would like more than this, but increasingly the sober facts of life may hold the price down marginally below the overall inflation of our economies. At least, it would seem unlikely that there would be another convulsion like those of last autumn and winter. It has become fashionable to be extremely cynical about oil supply and to assume that the alarmist cries of shortage will herald an unparalleled glut of supplies in a few years. It is obviously not possible to deny utterly the possibility of new oil finds on a larger scale than any we have known before, but my guess is that the really cheap oil has gone for ever.

The other two questions may be, to some extent, inter-linked. The first point to be made is that price control conditions are still not such as to generate any broadly-based enthusiasm for widespread investment here in the UK. If one assumes that the facts of economic life ultimately take charge, the engineering requirements of the plant whose need can be foreseen in Europe will have to compete with a steady level of investment in the USA and the newly-developed demand for such services in the OPEC areas. Doubts have been expressed whether the engineering capability of the industrialised world can cope with all these demands up to 1980 and, indeed, this may be an arbitrary factor which holds back effective demand in the late 1970s. This is more likely to be expressed by the construction industry in terms of increased costs and longer delays rather than a total refusal to proceed, but the effect may be much the same. Here again the discipline of the market place is likely to provide the best answer, but such subtle problems as delays in hardware deliveries, skimpy engineering work, diluted supervision and so on, might for a time conceal a basic inadequate capability whilst having the same ultimate effect of failing to meet effective demand.

The OPEC countries certainly have considerable aspirations to use their oil and their wealth to involve themselves to a considerable extent in petrochemical production. Some of the details, at least so far as the Middle East is concerned, have been spelled out in a paper by Hyde⁴. It is necessary to differentiate between realistic aspirations and mere wishful thinking. To develop a flourishing petrochemical industry, a country needs more than raw material and money. It needs also an industrial framework and basic infrastructure.

Amongst the potential leaders in this kind of direction would appear to be Iran, Algeria and Venezuela. Even here there are many difficulties in getting some projects under way. In other areas schemes have been propounded for co-operative development within a group of countries. What is lacking in a number of proposals is either a serious attempt to evaluate market prospects or a proper study of the economic basis for such production. The fact remains that a number of production plans are going forward which will ultimately contribute towards the world's petrochemical resources. I think, however, it would be wise not to expect too much international impact before 1985.

This paper has concentrated on the situation during the next ten years, which has almost become short term. To

look beyond 2000 AD is to be venturesome indeed, except to say that forms of hydrocarbon oil will still be with us, but that the petroleum industry as we know it today will have changed beyond recognition.

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Some aspects of the industrial application of the Egyptian rice germ oil in the field of surface coatings. Part I: Separation and modification of rice germ wax

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Summary

Egyptian rice germ oil, produced by solvent extraction of the rice germ, is of minor industrial importance and is characterised by relatively high contents of wax and saturated matter. Separation

of the crude wax using different methods and modifying the wax properties (softening point and hardness) are discussed.

Keywords

Raw materials used in manufacture or synthesis of ingredients for coatings

rice germ oil
rice germ wax

Certains aspects des applications industrielles de l'huile de germe de riz égyptien dans le domaine de revêtements superficiels. Ière. Partie: La séparation et la modification de la cire de germe de riz.

Résumé

L'huile de germe de riz égyptien, produit de l'extraction par solvant du germe de riz, est d'une importance industrielle assez faible, et se caractérise par une teneur en cire et également en matière non

saturée relativement élevée. On discute la séparation, par de diverses méthodes, de la cire brute et aussi la modification des caractéristiques de la cire (le point de ramollissement et la dureté).

Einige Gesichtspunkte betreffend die industriellen Verwendungsmöglichkeiten ägyptischen Reiskeimöls in Beschichtungsmitteln. Teil I: Trennung und Modifizierung von Reiskeimwachs

Zusammenfassung

Das durch Lösungsmittelextraktion erzeugte ägyptische Reiskeimöl ist von geringerer industrieller Bedeutung. Es ist durch hohe Gehalte an Wax und gesättigten Stoffen charakterisiert. Besprochen

werden Abtrennungsmethoden des rohen Wachses, wobei verschiedene Methoden benützt, und die Eigenschaften des Wachses (Erweichungspunkt und Härte) modifiziert werden.

Introduction

Ref. 1-11

Rice germ oil is among the various fat products obtained from the products and by-products of rice milling. It is obtained by extraction from the rice germ, the composition of which is given in Table 1¹.

Table 1
Average composition of the rice germ

	Water %	Protein %	Fat %	N-free extract %	Fiber %	Ash %	Sand %
Minimum	10.50	10.50	10.70	52.50	3.30	4.70	3.70
Maximum	12.50	11.80	13.40	55.80	3.90	8.90	4.10

Rice bran oil and rice germ oil are similar in their composition with respect to the type of fatty acids present. Both are characterised by the presence of palmitic, oleic and linoleic acids as the major constituents and stearic acid as the minor constituent. Their compositions are given in Table 2².

Table 2

Average compositions of rice germ and rice bran oils

Fatty acid	Rice germ oil	Rice bran oil
Palmitic (%)	22.9	14.2
Stearic (%)	0.4	2.5
Oleic (%)	60.1	45.8
Linoleic (%)	15.9	36.2

The quantity of oil extracted depends, to an unusual degree, upon the method by which it is produced and to a certain extent upon the time which elapses between milling of rice and oil removal. An extremely active lipolytic enzyme begins to act as soon as the germ is removed from the rice and causes the free fatty acids in the oil to increase during the first few hours of storage.

The rice germ oil is characterised by its high content of saturated fatty acids, wax and free fatty acids and also has dark colour. There are almost no publications in the literature describing the use of the oil in surface coatings. However, there are many articles on other uses of rice bran oil.

Most of the methods described for wax separation have been applied to rice bran oil and have been described in patents³⁻¹¹. These methods involve the use of organic solvents or an emulsifying liquid followed by wax separation either by decantation or by centrifugation.

The main purpose of this part of the paper deals with the methods of wax separation and improvement properties of the crude wax.

Experimental

Refs. 4, 7, 9, 12-16

Materials used

All reagents used throughout this work were of the purest grade available except where mentioned otherwise. The synthetic waxes used for improvement of the wax properties are manufactured by Hoechst, West Germany, and their characteristics are given in Table 3. The crude rice germ oil was obtained by solvent extraction of the rice germ and was supplied by the Paints and Chemical Industries Co., Cairo.

Methods and techniques

Wax separation. Three different methods of wax separation were used:

Method A. Rice germ oil (186g), trichloroethylene (64g) and methyl alcohol (36ml) were thoroughly mixed at 40°C. The mixture was then cooled to 0°C and left for 24 hours. The crystallised wax separated on top and was filtered. Seventy-five per cent of the solvent was recovered from the filtrate by distillation at 60°C and further wax separated from the residue upon standing. The separated wax was collected⁴.

Method B. 100ml of gelatin solution (5 per cent by weight) were mixed thoroughly with 50g of crude rice germ oil at 20°C with continuous stirring for ten minutes. The lower layer of emulsified oil was mixed with 100g ethylene glycol and heated to 40°C. The dewaxed oil separated from the mother liquor by centrifugation. The upper layer was washed with hot water, cooled and centrifuged to give the wax^{7, 9}.

Method C. The crude rice germ oil was maintained at 20°C for 24 hours. The saturated fat and most of the wax were precipitated and separated by decanting. The separated matter was washed several times with a petroleum fraction (80-110°C) which dissolved the saturated fat leaving the wax unaffected, until the wax became harder.

Blending technique

The rice germ wax (2g) was melted in a porcelain dish in an oven for half an hour. Then the selected synthetic wax was added and mixed thoroughly until a homogenous melt was obtained; the temperature should be slightly above the softening points of the materials. The melt was then allowed to solidify slowly upon cooling.

Properties of the synthetic waxes

Determination of the softening point (open capillary method¹²), acid value¹³, saponification value¹⁴, free fatty acid¹⁵ and iodine value¹⁶ were carried out according to standard methods (See Table 3).

Results, discussion and conclusions

Ref. 17

The rice germ oil was extracted from the rice germ by petroleum ether (60-80°C) in a Soxhlet. The oil yield amounted to 13-16 per cent of the weight of the germ. The characteristics of the extracted rice germ oil were determined and are given in Table 4 together with those of rice bran oil for comparison.

Table 4
Characteristics of the Egyptian rice germ and rice bran oils

	Rice germ oil	Rice bran oil
Free fatty acid (as oleic) %	51.8	55.7
Specific gravity	0.915	0.918
Acid value, mg KOH/g	40.1	65.4
Saponification value, mg KOH/g	181.0	182.3
Iodine value, cg I ₂ /g	107.1	115.1

The rice germ oil was subjected to many tests in order to separate the wax from the crude oil using the previously described methods adopted with rice bran oil. The percentage yield and the softening temperature of the separated wax are shown in Table 5.

Table 5
Yield and softening point of the separated wax

	Yield	Softening point (°C)
Method A	0.2-0.3	soft
Method B	3.0-4.0	soft
Method C	3.0-16.0	70-79

Table 3
Characteristics of Hoechst synthetic waxes

Wax	Drop point (°C)	Acid number	Saponification number	Density at 20°C	Colour	Form	Main uses
Hard wax (Acid Wax S)	78-84	135-155	155-175	1.00-1.02	Pale yellowish	Flakes	Emulsions, polishes and colour bases
Ester wax KP	82-86	20-30	130-150	1.01-1.03	Brown	Flakes	Carbon paper
Partially saponified wax	100-105	10-15	100-115	1.01-1.03	Yellowish	Flakes	Solvent based polishes and pastes
Polyethylene wax PA-190	130-140	0	0	0.95-0.97	Pale gray	Flakes	Lubricant for plastics and increasing the melting point of other waxes

It seems that the best method is to maintain a constant temperature of 20°C for 24 hours, followed by washing the precipitated wax with a petroleum fraction and press filtering. The wide range of the yield with this method was attributed to sampling difficulties due to the variable saturated fat separated upon standing.

As has been mentioned, most of the patented modifying techniques were applied to rice bran wax. Hydrogenation was the main procedure described. In fact, the hydrogenated product resembled the naturally occurring and widely used carnauba wax¹⁷. Preliminary investigation on the hydrogenation of the crude oil and crude wax showed promising results in producing harder wax: this is still under investigation.

In this study, attention was directed to other modifying techniques using some selected synthetic waxes. The synthetic waxes used were the S-, KP-, O- and PA-190 waxes manufactured by Hoechst, West Germany. These waxes were hot blended with the crude rice germ wax, at above their softening temperatures, under various experimental conditions.

Effect of blending time on wax properties

In order to show the effect of blending time (time during which the wax mixture was kept in the fused state), on the softening point of the wax, Hoechst S-Wax was blended with the crude wax in the ratio 1:1 by weight at 110°C; the results are given in Table 6.

Table 6
Effect of blending time on softening point of rice germ/S-Wax mixture

Time (minutes)	Softening point (°C)
30	73-79
60	72-79
90	74-80
120	76-83
150	78-83
180	76-80

It can be concluded that the blending time has no significant effect on the wax softening point. Similar results were obtained with the other synthetic waxes.

Effect of synthetic wax concentration on wax properties

Different blending ratios were investigated for the four types of Hoechst synthetic waxes at 150°C blending temperature and 60 minutes blending time; the results are given in Table 7.

Table 7
Blending studies of rice germ wax with synthetic waxes at 150°C

Composition ratio Crude Wax : Synthetic Wax	Softening temperature (°C)			
	S-Wax	KP-Wax	O-Wax	PA-190-Wax
4 : 4	83	80	88	123
4 : 3	80	81	79	122
4 : 2	79	80	78	121

It can be concluded from the above study that the increase in synthetic wax concentration has no effect upon the softening

temperature of the blended sample within the experimental limits, except with the O-Wax.

Effect of blending temperature on wax properties

Similar studies were conducted on various wax mixtures having a constant blending ratio (1:1 by weight) and constant blending time (60 minutes); the results are shown in Table 8.

Table 8
Blending rice germ wax with synthetic waxes at different temperatures

Temperature (°C)	Softening temperature (°C)			
	S-Wax	KP-Wax	O-Wax	PA-190-Wax
110	83	80	88	—
130	78	79	85	—
150	77	80	92	123
170	78	83	90	123
190	80	80	82	120

As indicated in Table 8 above, there is no significant change in the softening temperatures of the blended samples with increasing the blending temperature.

In addition, the study was extended to include blending the crude wax with more than one type of synthetic waxes and the results obtained are shown in Table 9.

Table 9
Blending rice germ wax with a mixture of synthetic waxes

Waxes	Blending temperature (°C)	Softening point (°C)
Rice germ Wax/S-Wax/O-Wax	110	86
Rice germ Wax/KP-Wax/O-Wax	150	78
Rice germ Wax/S-Wax/KP-Wax	110	79
Rice germ Wax/S-Wax/PA-190-Wax	170	118
Rice germ Wax/KP-Wax/PA-190-Wax	170	121
Rice germ Wax/O-Wax/PA-190-Wax	170	119

It should be noted that the blending ratio of the rice germ wax to the other two synthetic waxes was 2:1:1 by weight and the blending time was 120 minutes. It can also be noted that only mixtures containing the Hoechst synthetic wax PA-190 were of higher softening points.

In conclusion, the use of the synthetic wax PA-190, which is a polyethylene wax, to modify the crude rice germ wax greatly improves its softening temperature when hot blended at 150°C for 30 minutes in a ratio of 2:1 by weight.

The second part of this paper will discuss the preparation and evaluation of rice germ and rice germ/linseed oil alkyls.

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Some aspects of the industrial application of the Egyptian rice germ oil in the field of surface coatings. Part II: Preparation and evaluation of rice germ and rice germ/linseed oil alkyds

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Summary

Three alkyds with different oil lengths have been prepared from rice germ oil. Replacement of part of the rice germ oil by linseed oil has also been investigated. It is observed that only short rice germ alkyds are air drying, whilst medium and long rice germ alkyds dry only upon stoving at 90°C for three hours after addition

of suitable driers. This behaviour is also true for rice germ/linseed oil alkyds. Replacement of part of the rice germ oil by the drying oil leads to an improvement in the drying characteristics and better film performance of the finished alkyds relative to those made from rice germ oil alone.

Keywords

Raw materials used in manufacture or synthesis of ingredients for coatings

rice germ oil
rice germ wax

Certains aspects des applications industrielles de l'huile de germe de riz égyptien dans le domaine de revêtements superficiels. 2ème. Partie: La préparation et l'évaluation de l'huile de germe de riz et des alkydes a base des melanges huile de lin/huile de germe de riz.

Résumé

Trois alkydes a de différentes longueurs en huile ont été préparées à partir de l'huile de germe de riz. On a étudié également le remplacement d'une partie de l'huile de germe de riz par l'huile de lin. On a constaté que seulement les alkydes courte en huile de germe de riz sont capables de sécher à l'air, tandis que les alkydes de moyenne ou de forte longueur en huile de germe de riz ne séchent même avec l'addition des siccatifs commodes qu'après un étuvage de 3 heures à

90°C. Ce comportement était valable aussi dans le cas des alkydes contenant un mélange des huiles de lin et de germe de riz. Le remplacement d'une partie de l'huile de germe de riz entraîne une amélioration des caractéristiques de séchage et une augmentation du rendement des feuilés des alkydes en comparaison auprès de ceux des alkydes à partir de l'huile de germe de riz seulement.

Einige Gesichtspunkte betreffend die industriellen Verwendungsmöglichkeiten ägyptischen Reiskeimöls in Beschichtungsmitteln. Teil II: Herstellung und Bewertung von Reiskeim-und Reiskeim/Leinölkalyden

Zusammenfassung

Drei Alkyde verschiedener Öllänge wurden unter Verwendung von Reiskeimöl hergestellt. Ebenfalls untersucht wurde der Teilersatz von Reiskeimöl durch Leinöl. Es wurde beobachtet, dass nur kurzölige Reiskeimalkyde an der Luft trocknen, wohingegen mittel- und langölige lediglich nach dreistündiger Ofentrocknung bei 90°C und nach Zusatz geeigneter Trockenstoffe trockneten.

Dieses Verhalten traf auch auf Reiskeim/Leinölkalyde zu. Teilersatz von Reiskeimöl durch trocknende Öle führt zu Verbesserungen hinsichtlich der Trocknungscharakteristika und widerstandsfähigerer Filme des fertigen Alkyds, verglichen mit nur aus Reiskeimöl hergestelltem.

Introduction

Ref. 1

Although oil-modified alkyd resins have been known for quite a long time, they have shown a remarkable ability to maintain their position as one of the major types of vehicles used in surface coating industry.

The non-edible Egyptian rice germ oil, which is only of a minor industrial importance, is characterised by high contents of saturated fatty acids, wax and free fatty acids and also has dark colour. There is almost no publication in the literature describing the use of the oil in the field of surface coatings. However, there are many articles which describe the use of rice bran oil¹.

In this communication, the results are reported of trials carried out to produce and evaluate alkyd resins of different oil lengths formulated with rice germ oil and modified by the incorporation of linseed oil.

Experimental

Refs. 2-16

Materials

1. Rice germ oil. The oil used in this investigation was an Egyptian product manufactured by Paints and Chemical Industries Company, Cairo. Its characteristics are shown in Table 1.

2. Linseed oil. Local grade obtained from Tahta Oil Company. It has the characteristics shown in Table 1.
3. Glycerol. Pure grade obtained from Kafr El-Zayat factory of the Egyptian Salt and Soda Company. It is not less than 99 per cent pure. The colour according to the Gardner standard scale was 1.
4. Phthalic anhydride. Pure grade from VEB Laborchemie, East Germany (mp 129-132°C).
5. Cobalt naphthenate. Containing 8 per cent cobalt, a product of Tenneco Chemicals Inc. (Nuodex Div.), USA.
6. Lead naphthanate. Containing 32 per cent lead, a product of Tenneco Chemicals Inc. (Nuodex Div.), USA.
7. A petroleum fraction, boiling range from 147 to 203°C, total recovery 99.5 per cent.

Table 1
Characteristics of rice germ and linseed oils

	Rice germ oil	Linseed oil
Specific gravity at 15.5°C	0.915	0.933
Acid value, mg KOH/g	40.1*	1.01
Saponification value, mg KOH/g	181.0	188.0
Iodine value (Wijs), cg I ₂ /g	107.2	191.0
Free fatty acids, % as oleic	51.9	17.8

*At least two weeks after extraction

All other solvents and chemical reagents used in this work were at least of the chemically pure grade and were used without further purification or drying.

Methods of preparation

Alkyd resin preparation: Alkyd resins of different oil lengths were prepared by the monoglyceride process.

The glycerolysis process: A number of 100g portions of oil was heated with the calculated amount of glycerol in a stream of carbon dioxide free from oxygen and water vapour. Moderate stirring of the oil during the run was important. When the required temperature was reached, an exact weight of catalyst was added and this instance was taken as the starting point of the reaction. In order to follow the monoglyceride process, samples were taken periodically from the reaction flask, without interrupting the process, and tested for monoglyceride content².

The esterification process: At the end of glycerolysis, the reaction mixture was cooled to about 100°C, and phthalic anhydride was added. The mixture was then reheated as described in the conditions of the experiment. Moderate stirring and inert atmosphere were maintained throughout the reaction. Samples were analysed periodically in order to follow the cooking process quantitatively.

Analytical techniques

Turbidity method: The completion of the glycerolysis was established by ascertaining the solubility in alcohol of the samples taken from the reaction flask. The sample was mixed with twice its volume of 85 per cent methyl alcohol. A glass

rod was immersed and the mixture allowed to cool to room temperature and become thoroughly homogenised. The disappearance of turbidity means that glycerolysis is complete².

Acid value³, saponification value⁴, iodine value⁵ and free fatty acid content⁶ were determined according to standard methods.

Methods of evaluation

Measurements of colour⁷, viscosity⁸, drying times^{9, 10}, film thickness¹¹, hardness¹², gloss¹³ and the resistance against water¹⁴, alkali¹⁵ and acid¹⁶ were conducted according to standard methods.

Results and discussion

Refs. 17-22

For an alkyd to have outstanding performance, it must be processed to as high a molecular weight as possible¹⁷. At the same time, the molecular weight must not be allowed to become excessive or the alkyd vehicle's properties will not be controllable during processing (it will gel) or it will exhibit instability during shelf life in the can and convert prematurely to a gel¹⁸. Alkyds of different oil lengths were formulated¹⁸ and checked by the "alkyd constant" method¹⁷.

Short oil length alkyds

Thirty-five per cent oil length alkyds from rice germ oil (RGO)

Glycerolysis of RGO was carried out for 45 minutes at 220°C in the presence of lead oxide (0.5 per cent) as a glycerolysis catalyst; the esterification reaction too was conducted at 220°C to the end of the reaction. The time-temperature programme for the alkyd cooking is shown in Fig. 1. The reaction was followed by measuring the acid value and the data obtained are given in Fig. 2A. It is clear that the polyesterification reaction occurred rapidly. Within thirty minutes, the acid value decreased from 390.7mg KOH/g (initial acid value) to about 55mg KOH/g, but the reduction in acid value with further heating was small. The viscosity of the resultant resin (50 per cent solution in the petroleum fraction) was high at this stage, so that further heating might have led to gelation.

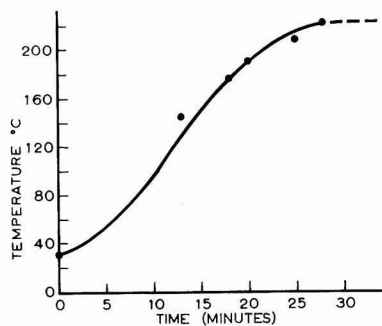


Fig. 1. Time/temperature programme for alkyds and monoglyceride formation

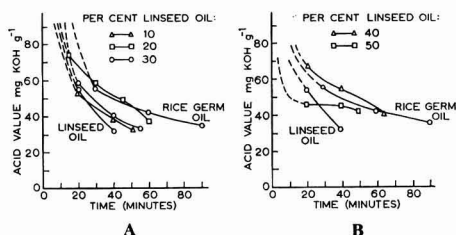


Fig. 2. Variation of acid value with reaction time for short oil length alkyds containing different proportions by weight of linseed oil

Modification of short oil length RGO alkyds with linseed oil

In the following runs, part of the RGO was replaced by an equivalent amount of linseed oil, which is known to give rise to air-drying resins of good properties. Linseed oil was incorporated together with RGO from the beginning of the alcoholysis reaction. The content of linseed oil in the oil mixture varied from zero to 50 per cent by weight. The reaction was followed by the method used previously for the unmodified RGO alkyds and the data which were collected are represented graphically in Figs. 2A and 2B.

It is interesting that in the presence of high proportions of linseed oil, the resin can be processed only to an acid value which is slightly higher than that for formulations containing low proportions of linseed oil. In the former case, the viscosities of the final resin were higher, and further heating would have led to premature gelation.

In addition, the presence of linseed oil in the oil mixture gave rise to alkyds of higher iodine value. This was expected since linseed oil is known to be a typical drying oil with a high degree of unsaturation.

Medium oil length alkyds

Fifty-two per cent RGO alkyds

Glycerolysis of RGO was first carried out, then followed by esterification under the same conditions described above. From Figs. 3A and 3B, it is clear that the esterification reaction occurs in approximately one hour, and during this time the acid value dropped from 345.8mg KOH/g to about 17.8mg KOH/g, then on further heating the reduction in the acid value was small (from 17.8 to 12.4mg KOH/g). Comparing the acid value/time curves for the two oil length alkyds, 35 and 52 per cent, it can be shown clearly that the drop in acid value occurred more quickly with the 35 per cent oil length alkyd. This was to be expected since it is well known that simple esterification is an acid-catalysed reaction and polyesterification, no doubt, follows the same course^{19, 20}.

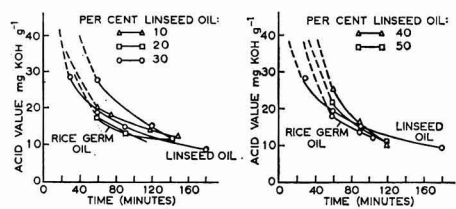


Fig. 3. Variation in acid value with reaction time for medium alkyd resins containing different proportions by weight of linseed oil

The initial acid value of the 35 per cent oil length alkyd is higher than that of the medium alkyd. This means that in the former case, excess carboxylic groups are present—a factor enhancing the polyesterification reaction. However, the 35 per cent oil length alkyds attain a high viscosity, whilst the acid value is still high, which is also in accordance with theoretical expectations. It is well established that the shorter the oil length, the higher will be the rate of viscosity increase of the resin^{21, 22}.

Modification of medium oil length RGO alkyds with linseed oil

Between ten and fifty per cent by weight of the RGO was replaced by linseed oil. The changes in acid value with time for these runs are illustrated in Figs. 3A and 3B. Studies the properties of these alkyds lead to the following general conclusions:

- In the presence of linseed oil, the alkyd can be processed to a higher viscosity and higher iodine value, but to the same acid value as a pure RGO alkyd.
- The increase in oil length leads to lower acid value and higher iodine value of the end product. This would lead to better drying alkyds with improved properties.

Long oil length alkyds

Sixty-two per cent oil length alkyds from RGO

The reaction was carried out under the same conditions as before, in two stages: glycerolysis and esterification. It can be deduced from Fig. 3A that, in this case, the polyesterification reaction was slower (about 100 minutes), and during the reaction the acid value was decreased from 317.9mg KOH/g to about 47.7mg KOH/g. Upon further heating over a period of two hours, the reduction of acid value was small (from 47.7mg KOH/g to 10.8mg KOH/g). In the light of the acid catalysed nature of the polyesterification reaction already mentioned, this behaviour of the long oil alkyd is understandable.

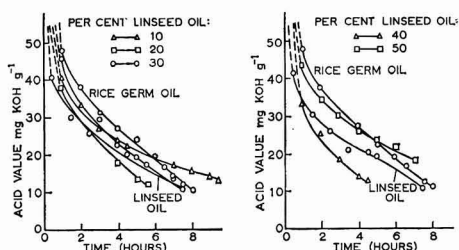


Fig. 4. Variation in acid value with reaction time for long alkyd resins containing different proportions of linseed oil

Modification of long oil length RGO alkyds with linseed oil

In the following runs, 10 to 50 per cent of the rice germ oil was replaced by the drying linseed oil. Reactions were followed as before and the results are shown in Figs. 4A and 4B.

The properties of different alkyds obtained from various RGO and RGO/linseed oil combinations are summarised in Table 2. The results confirm previous conclusions about increasing iodine value of the end product for increasing linseed oil content in the oil portion of the alkyd. Increasing the oil length whilst increasing the linseed oil content should, therefore, give resins with improved drying characteristics.

Table 2
Characteristics of rice germ oil (RGO) and rice germ/linseed oil alkyds

Ratio of oils		Acid value of final resin (mg KOH/g)			Iodine value of final resin (mg KOH/g)		
Linseed	RGO	Short	Medium	Long	Short	Medium	Long
0	100	35.2	12.4	10.8	30.7	55.4	75.3
10	90	33.3	12.0	12.7	29.3	58.8	75.3
20	80	36.4	11.2	12.6	48.8	55.4	80.7
30	70	33.4	11.2	10.8	40.9	62.4	81.0
40	60	41.3	10.4	12.2	43.8	59.1	82.1
50	50	42.0	10.4	17.9	46.7	59.9	85.1
100	00	45.1	9.4	10.7	48.7	76.1	93.7

Alkyd constants

Ratio of total -OH groups to total -COOH groups (R)	1.268	1.181	1.118
Alkyd constant (K)	0.9496	0.9395	0.9328
Yield (Y)	94.8%	96.0%	96.8%
Initial acid value (mg KOH/g)	390.7	345.8	317.9
Phthalic anhydride (%)	45.6	34.0	27.0

Film properties

A varnish of the composition given in Table 3 was prepared to investigate the film performance of all the resins.

Table 3
Formulation of an alkyd varnish

	Per cent by weight
Alkyd resin	50
Petroleum fraction (boiling range 147-203°C)*	50
Cobalt naphthenate	0.04
Lead naphthenate	0.1

*In case of short oil alkyds, aromatic solvents (such as toluene) were used instead of the petroleum fraction above.

Tables 4 to 6 illustrate the properties of the films, in turn, of the short, medium and long oil length modified and unmodified alkyds. In these Tables, the following abbreviations are used:

+ means drying or resistant to different reagents, and

— means non-drying, or not resistant towards different reagents.

It is worth while mentioning that the hardness measurements were made on dry films between 70 and 100µm thick.

Table 4
Film properties of the short oil-length alkyd resin

Oil composition (ratio of linseed oil to RGO in the alkyd)	Hardness (seconds)	Gloss (%)	Drying		Resistance against:		
			Room temperature	Stoving at 90°C	Water	Acid	Alkali
100% RGO	14	100	+	+	+	+	—
90% RGO	18	90	+	+	—	+	—
80% RGO	20	72	+	+	+	+	—
70% RGO	20	82	+	+	+	+	+
60% RGO	21	99	+	+	+	+	—
50% RGO	40	92	+	+	—	+	—
100% Linseed oil	62	85	+	+	+	+	+

Table 5
Film properties of the medium oil-length alkyd resin

Oil composition (ratio of linseed oil to RGO in the alkyd)	Hardness (seconds)	Gloss (%)	Drying		Resistance against:		
			Room temperature	Stoving at 90°C	Water	Acid	Alkali
100% RGO	17	85	—	+	—	+	+
90% RGO	17	81	—	+	—	+	+
80% RGO	18	86	—	+	+	+	—
70% RGO	23	34	—	+	—	+	+
60% RGO	27	93	—	+	—	+	+
50% RGO	32	98	—	+	+	+	+
100% Linseed oil	71	84	+	+	—	+	+

Table 6
Film properties of the long oil-length alkyd resin

Oil composition (ratio of linseed oil to RGO in the alkyd)	Hardness (seconds)	Gloss (%)	Drying		Resistance against:		
			Room temperature	Stoving at 90°C	Water	Acid	Alkali
100% RGO	12	99	—	+	—	+	+
90% RGO	13	79	—	+	+	+	+
90% RGO	13	98	—	+	+	+	+
70% RGO	15	81	—	+	+	+	+
60% RGO	18	27	—	+	+	+	+
50% RGO	25	94	—	+	+	+	—
100% Linseed oil	72	100	+	+	+	+	+

Comparison of film properties

The effects of oil length and oil composition on film properties were examined. From the collected results, the following main features can be observed:

- (i) Only the short RGO alkyds are air drying, whilst the medium and long oil RGO alkyds dry only upon stoving at 90°C for three hours. This behaviour is true also for RGO/linseed oil alkyds.
- (ii) Using the drying linseed oil alone, the drying characteristics of the finished alkyds improved as the oil length was increased. In the same way, the film hardness was increased. On the other hand, when using RGO alone or as an admixture with linseed oil, an increase in oil length leads to a decrease in film hardness. This behaviour is undoubtedly due to the low degree of unsaturation of RGO, whose iodine value is in the range 99 to 108cg I₂/g. Alkyds of oils with iodine value between 125 and 135cg I₂/g or less are known to be either non-drying or to take an extremely long time to form a dry film.
On the basis of the above results, RGO alkyds can be considered as semi-drying resins. Under the above drying conditions, the increase in oil length should lead to excessive amount of uncured oil-modified alkyd, and this in turn lowers the film hardness.
- (iii) Film hardness was improved by increasing the linseed oil content from 10 to 50 per cent, particularly for films prepared from short oil length alkyds.

- (iv) The gloss, and water and acid resistances of the films investigated were satisfactory. However, the alkali resistance of the films prepared from short oil length alkyds was not satisfactory.

Conclusions

Three different oil-length alkyds (35, 52 and 62 per cent), totally or partially based on rice germ oil, were prepared using the monoglyceride process.

The polyesterification reaction in the case of the short oil length alkyds occurred rapidly compared to the times for the medium and long oil alkyds. The long oil alkyd was the slowest. The viscosity of the resultant resin decreased with increasing the oil length.

The three types of RGO alkyds were separately modified by the incorporation of a high proportion of linseed oil, which replaced part of the RGO by up to 50 per cent by weight. This, of course, gave rise to resins of higher iodine value and hence better drying characteristics.

When the proportion of linseed oil in the oil mixture is increased, the short oil length alkyds can be processed to an acid value which is only slightly higher than the formulations containing low proportions of linseed oil, but the viscosity of the final resin is then higher and further heating would lead to premature gelation. In general, increasing the oil length leads to resins with lower viscosities and higher iodine values.

Evaluation of the film properties of the different varnishes shows that only short RGO alkyds are air drying whilst the others dry only upon stoving. This behaviour is true also for rice germ oil/linseed oil alkyds.

Replacing part of the rice germ oil by the drying oil leads to an improvement in drying characteristics and also to better film performance of the finished alkyds relative to those made from rice germ oil alone.

In general in the work described here, increasing the oil length of the alkyds caused a decrease in film hardness. Increasing the content of linseed oil from 10 to 50 per cent led to an improvement in hardness, particularly for coatings employing short alkyds. Furthermore, the gloss and water and acid resistances of the films investigated were satisfactory for all samples; the alkali resistance was satisfactory, except those corresponding to short alkyds.

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Next month's issue

The Honorary Editor has accepted the following papers for publication, and they are expected to appear in the May issue of the *Journal*.

The effect of the substrate on the resistance of polymer films by *J. E. O. Mayne and D. J. Mills*

Organotin-based antifouling systems by *C. J. Evans and P. J. Smith*

The role played by water soluble polymers in paint performance by *J. E. Glass*

Analysis of polyurethane resins by *L. A. O'Neill and G. Christensen*

London

High performance pigments for automotive finishes

The Section held its first technical meeting of the session on 16 October, under the Chairmanship of Mr K. Bargrove. Dr P. Lutz of Du Pont de Nemours, USA, presented a paper entitled "High performance violet, red, orange and yellow pigments for automotive and industrial finishes". A summary of the paper appears in a report of the Manchester Section (see page 142).

A selection of the questions raised by the paper are as follows:

- (Q) What restrictions are placed on the use of lead containing pigments?
- (A) None. An attempt was made in some States to eliminate lead and chromium containing pigments, but the finishes produced with alternative pigments were so poor, inferior gloss, opacity, durability, and so forth, that the users of the paints refused to accept them, and molybdate orange and yellow lead chromates are back in use.
- (Q) Are soluble lead tests carried out on pigments?
- (A) No.
- (Q) Are there any lead restrictions in the refinishing field?
- (A) There is no legislation, but there is some concern about the use of aerosols by the general public. There is the possibility of a vehicle refinishing aerosol being used to spray cots or other children's furniture.
- (Q) Is Florida exposure still the yardstick for durability of car finishes?
- (A) Yes, perhaps surprisingly, since there are fewer cars in Florida than in any other state. Even more surprising is the continued dependence of European manufacturers on Florida exposure tests.

A vote of thanks to the speaker was proposed by Mr D. Wigglesworth.

B.A.C.

Coatings for immersed conditions

A one-day symposium, jointly organised by the Association and the Institute of Corrosion Technology, was held at the Thames Polytechnic on 20 November 1974.

After an address of welcome on behalf of the Polytechnic by Dr R. C. Denny, Mr J. Day, a consultant, gave the first of the lectures "Abrasion resistance of coatings immersed in water". In this lecture, he described experiments designed to select, from 16 available systems, the best abrasion and impact resistant coating for steel immersed in rushing water containing debris, ice, etc.

Initially the 16 systems were applied by brush to steel discs. The coated discs were rotated in a slurry of sand and water for a total of 200 hours and were weighed at 0 hours, 100 hours and 200 hours. A proportion of sharp sand was added to the slurry after 100 hours.

The effect of water absorption was assessed by immersing a duplicate set of coated discs in water for 200 hours for adjustments of calculations to give true weight loss. Using percentage weight loss as a criterion for comparison, Mr Day had been able to divide the systems into groups, each showing twice the loss of the group preceding it. Group 1, having the lesser weight loss of two to four per cent, consisted of a grit/polymeric resin, a neoprene multicoat and a proprietary straight epoxy "ice-breaker paint". Mr Day suggested a less abrasion resistant, but more biocidal coal tar epoxy as an alternative to straight epoxy.

The speaker was questioned on several aspects of the project, such as the significance of variation in coating thickness from system to system; the difference between experimental and practical application methods; the apparent lack of replication; and the method of measuring impact resistance. With due regard to the contractual restrictions imposed upon Mr Day, some of the audience nevertheless had reservations about the conclusions drawn from the results of his project.

Dr Eileen Pankhurst of the British Gas Corporation, who was due to give the second paper, "The effects of soil micro-organisms on pipe wrappings and coatings", was unable to attend because of illness. At short notice her place was taken by Dr B. Currell, Head of the School of Chemistry, who talked about inorganic polymers as surface coatings. Whilst deviating somewhat from the theme of the symposium, the lecture was most enlightening. Dr Currell advocated the increased use of polymers made from cheap and plentiful elemental sulfur and mineral silicates.

Mr R. H. Banfield and Mr C. G. Sieling of Laporte Industries Limited gave the third lecture entitled "Chemical plant protection". Cheap coatings for substrates were acceptable in chemical plant only if there were (a) no pinholes in the coating, (b) the coating was anodic to the substrate and (c) the process chemicals were not too aggressive. Mr Banfield followed this statement with a short casebook of organic coating failures. The point was made that it was often necessary to protect the process chemical from pick up of contaminants rather than the substrate from corrosion. Mr Banfield extended his talk to include lining materials such as glass.

Mr Sieling concentrated on spillages and splashes on external surfaces. He expressed the opinion that if a substrate needed to be coated, then the wrong materials had been used to make it in the first place. Whilst a coating could be successful on properly cleaned surfaces, it was very difficult completely to rid a surface of sulfates, although members of the audience pointed out the use of high pressure water jets for this purpose. Mr Sieling gave examples, such as bitumen based materials, which had been used after application in adverse conditions.

Both lecturers were critical of the performance of organic coatings and the "expert sell". The latter criticism may have been justified, but in the ensuing discussion, it was pointed out that to give coatings a fair chance, conditions of use and application must be thoroughly investigated. It was also suggested that the simple expedients of "in-use" inspection and hosing down might save much coating damage.

In the fourth lecture "Coating immersed concrete for swimming pools and sewage installations", Mr P. J. Gay, formerly of the Paint Research Association, talked with authority on the problems of protecting and decorating immersed concrete with surface coatings. Mr Gay began by explaining the need for protection. The chemically active constituent of concrete, Portland cement, was a complex mixture of silicates and aluminates containing free lime. Calcium aluminate in the concrete could be attacked by sulfates derived from sea water, soil and the oxidation of hydrogen sulfide present in sewer pipes. Free lime could be leached out by pure water or water containing carbon dioxide. These effects were responsible not only for breakdown and pitting of concrete, but also for the release of sand and aggregate into the water contained by the concrete. Mr Gay went on to describe the precautions which must be taken in preparing a concrete surface for painting. He listed the required properties for coating of concrete, that is, good adhesion, minimum permeability, resistance to decomposition by water, resistance to acids and alkalis. The most suitable coating materials for concrete were hot asphalt or bitumen and epoxides.

During the combined discussion which followed the fifth lecture, Mr Gay said that he had no experience of coatings for concrete tanks containing demineralised water. He commented that there was no need to prime a well prepared concrete surface.

The final lecture "The protection of static inshore structures" was given by Dr J. A. Banfield of Berger Jenson & Nicholson Limited.

Dr Banfield defined static inshore structures as piers, jetties, dock gates etc, which were subjected to considerable abrasion as well as being in a highly corrosive environment. The traditional materials, bitumen and pitch, were still widely used for protection. The steel surface was often prepared manually. A thin solution or emulsion coating (30µm) of bitumen was then applied by brush to the prepared surface. This was followed by a much thicker coating (2mm) of bitumen containing fillers (mica, sand, asbestos, etc.) brushed on hot.

More recent systems for jetties and so forth, used in conjunction with cathodic protection, had given better results. An example of such a system was a zinc epoxy primer (75/100µm) followed by 2 to 4 coats of coal tar epoxy of total thickness 300/400µm.

Manchester

Audio-visual systems

A meeting was held at the Woodcourt Hotel, Brooklands Road, Sale, Cheshire, on Friday 10 January 1975. The lecture was given by Mr J. V. Ashworth, Manager, Telecommunications, IPC Services Limited, entitled "Is audio-visual sound sense?". Members of the Institute of Printing were specially invited on this occasion.

Mr Ashworth gave a survey of the audio-visual field as it applied to the home, then expanded this to show how these systems could be used in industry, firstly as a help in the administration of the company and secondly as a possible aid in production processes.

He continued with an explanation of the uses being made in the field of data broadcasting and included in this area a description of the BBC CEEFAX system and roughly how it worked. Other derivatives of this system were mentioned, together with likely future developments.

In tidal and splash zones, high build epoxy polyamides were applied by airless spray over a zinc silicate primer. Vinyl chloride or chlorinated rubber were possible alternatives.

Dr Banfield stressed the importance of surface preparations, that is, blast cleaning before or after fabrication with the immediate application of a protective or priming coat to the surface. He went on to describe the methods of maintenance in tidal zones and the use of hand applied solventless epoxy polyamide mastics. He ended by predicting that coatings would become thicker, tougher and capable of underwater application and curing.

In the subsequent discussion, comments were made on the dangers of using zinc rich primers and the method of applying thick coats. The view was also expressed that primers were not necessary if the surface preparation were sufficiently good.

Mr R. H. E. Munn, Chairman of the Section, made a short closing address.

J.R.A./B.A.C.

After an interesting question time, the vote of thanks was proposed by Mr I. Moll. The meeting was continued in an informal manner, with light refreshments.

A.McW.

High performance pigments

A lecture entitled "High performance violet, red, orange and yellow pigments in automotive and industrial paints" was given by Dr P. B. Lutz of El Du Pont de Nemours & Company (Inc) Pigments Dept., Wilmington, Delaware. The meeting was held at the Manchester Literary & Philosophical Society, 36 George Street, Manchester 1, on Friday 11 October.

Dr Lutz discussed in detail the composition and use, particularly in automobile finishes, of the available pigments considered in the title of his lecture. This was well illustrated by numerous slides and exhibits and is best summarised by two of the tables quoted by him:

Table 4
Pigments for solid finishes

	Violets	Reds	Oranges	Yellows
Primary pigments		Iron oxide Cadmium red	Molybdate orange Iron oxide Cadmium orange	Iron oxide Chrome yellow
Major blending pigments	Quinacridone violet	Quinacridone reds		
Toning pigments	Carbazole dioxazine violet	Quinacridone magenta Maroon B	Orange GR Orange RK	Nickel azo yellow Anthrapyrimidine Flavanthrone Tetrachloro-isoindolinone

Table 5
Pigments for metallic finishes

	Violets	Reds	Oranges	Yellows
Primary pigments		Transparent iron oxide	Transparent iron oxide	Transparent iron oxide
Major blending pigments	Quinacridone violet Thio-indigo Bordeaux	Quinacridone maroon Magenta red B Perylene maroon		Quinacridone deep gold Gold Flavanthrone Tetrachloro-isoindolinone
Toning pigments	Carbazole Dioxazine violet	Quinacridone maroon B	Quinacridone orange Orange GR Orange RK	Nickel azo yellow Anthrapyrimidine

A lively discussion followed which, in general, followed similar lines to that at the London Section (see page 141).

A. McW.

Public analysts

The meeting was held at the Manchester Literary & Philosophical Society, 36 George Street, Manchester 1, on Friday 6 December 1974. The lecture was given by Mr A. C. Bushnell, M. Chem.A, FRIC, of Lancashire County Council (County Analysts' Dept), entitled "Let her paint an inch thick—to this favour must she come".

Mr Bushnell spoke of the work of the public analysts and gave numerous examples of instances where paint came into their work, typically the investigation which showed that rhubarb juice was responsible for red staining of an acrylic lacquer, and that a paint flake found in a loaf of bread had in fact come from the complainant's house.

After an interesting discussion, Mr N. Piper proposed the vote of thanks.

A. McW.

Water or what?

A meeting was held at the Manchester Literary and Philosophical Society, 36 George Street, Manchester 1, on Friday 8 November 1974.

The lecture, given by Mr R. H. E. Munn of Cray Valley Products Limited, was entitled "Water or what?"

Anti-pollution controls introduced in the USA had had a traumatic effect on both the paint user and manufacturer. Although official legislation had not yet been enacted in the UK, there was little doubt that pollution controls would be forthcoming. Already there was greater interest within the industry in coatings offering reduced pollution potential. In 1974 and perhaps beyond, energy and raw material shortages aggravated the situation and would dictate to some degree paint usage and direction of new developments. Water based paints and high solids coatings typified by powders, NADs and radiation curing systems were likely to become strong competitors under such conditions and the pros and cons of these systems were reviewed.

A. McW.

Student Group

Metal pretreatment

At a meeting at the Manchester Literary & Philosophical Society on 20 November 1974, an interesting lecture was given by Mr C. Pearson of Pyrene Chemical Services, on metal pretreatment.

Mr Pearson began by outlining the history of the pretreatment of metals, which started with the Egyptians, but only really became commercially viable in 1906, with a succession of techniques which have constantly been improved.

Before discussing the advantages of a pretreated surface, Mr Pearson gave the basic chemistry of the systems based on the iron, zinc, and manganese phosphate. By pretreatment, the surface area might be increased by up to four times, and because the system was uniform and electrically non-conducting the electrochemical corrosion was appreciably reduced.

Reference was made to the methods of applying the treatment to metals. Two films then showed the various methods of coating metal and the improved performance of treated metals.

Newer techniques, including various treatments for aluminium, were mentioned. Mr Pearson then emphasised that the pretreatment of metals was becoming more sophisticated as surface coatings became more specialised; for example, in order to obtain from the optimum properties, the treatment for powder coatings would be different that for electrocoating.

A. McW.

Instrumental colour control

A student lecture was given on Wednesday 15 January 1975 by Mr G. H. Eastwood of Crown Decorative Products Limited. The speaker introduced the subject by appraising visual methods of control and by highlighting the need to quantify colour measurement. The talk described a number of colour measuring instruments, including colorimeters, spectrophotometers and the fibre optics colorimeter in particular. Mr Eastwood was careful to emphasise the uses to the paintmaker of techniques and instruments, and wisely refrained from a treatise on the theoretical background to the subject.

A lively discussion period followed the lecture, and Dr J. Scott summed up the appreciation of members and visitors in a vote of thanks.

A. McW.

Information Received

Batchelor Robinson restructuring

Batchelor Robinson & Company Limited has announced a restructuring of its industrial operations. The Group will now operate three divisions, Batchelor Robinson Metals and Chemicals, Batchelor Robinson Polymers and Batchelor Robinson Coatings as decentralised units.

Berger completes reorganisation

The Berger Group—Berger Jensen and Nicholson Ltd—has completed the reorganisation of its UK paint interests by bringing the Marine and Protection Divisions of Berger Chemicals within the Berger Paints organisation. Berger Paints is now the second largest paint company in the UK, covering virtually all aspects of paint development, manufacturing and supply.

French agency for English China Clays

English China Clays Sales Company Limited has appointed ICI (France) SA as agents for the sale and distribution in France of all ECC's products for the paint, rubber, plastics and chemical industries.

The agency agreement was negotiated for ECC by H. D. Pochin et Cie who operate from Paris as the company's branch office in France.

Mastermix acquires Welmway

The Mastermix Engineering Company Limited of Redditch, Worcestershire, has

recently acquired a new fabricating company, Welmway Limited, Leamore Industrial Estate, Bloxwich, Staffordshire. This acquisition enables the Mastermix Group to offer a comprehensive range of tank mixers and supporting steelwork in addition to its existing range of mixing dispersion and milling equipment.

Goodlass Wall/Celanese agreement

Goodlass Wall & Co. has announced a long term agreement with Celanese Coatings and Specialities Company through their subsidiary Devoe and Raynolds Company Incorporated, covering the licensing of Celanese technology in high corrosion control coatings for the marine and civil engineering fields. Celanese Coatings and Specialities Company has 17 plants in the United States and nine in other countries. It is a subsidiary of the Celanese Corporation and successor to Devoe and Raynolds Company Incorporated, America's first paint manufacturer. Goodlass Wall & Co. expects this exchange of technology further to strengthen its already firm position in the marine and civil engineering fields. Provision has been made to include under this agreement the companies: Alexander Ferguson & Co. Ltd., Glasgow, and Fergussons Paints (Pty) Ltd., Durban, SA.

New products

Degussa flattening agent

The Pigments Division of Degussa, Frankfurt am Main, has published a 12-page brochure concerning the flattening agent "OK 412." Apart from a summary of the specific properties of the product, its main physico-chemical data and general processing instructions, the brochure contains basic formulations for 6 different lacquer systems. A table shows the decreasing degree of gloss of the lacquer films in question which can be obtained with increasing OK 412 additives. The brochure is in three languages: English, French and German.

Literature

Chemical industry directory

"The 1975 Chemical Industry Directory" listing the names, addresses, telex and telephone numbers of companies internationally in the chemical and allied industries is available at £12.50 per copy from Benn Brothers Limited of London.

Conferences etc

FSCT Convention—call for papers

The Federation of Societies for Coatings Technology in America requests manuscripts for its Annual Meeting to be held in Los Angeles, California in October 1975. The deadline for submission of papers is 1 June.

Notes and News

Scarborough Conference 1975

The Association is pleased to announce that applications for its Conference to be held at the Grand Hotel, Scarborough, Yorkshire, England from 17 to 21 June 1975 have included many from overseas, and these delegates will be welcomed at the customary Overseas Visitors' Reception on the opening evening. Although the stated closing date for registration was 1 April, it is still possible to accept most applications. A programme of 17 papers has been arranged and these will be given in five sessions; there will also be three workshop sessions. Further details of the papers and biographies of the lecturers were published in the January 1975 issue of the *Journal*.

Registration fees

Council has fixed the registration fees for the Conference at £30.00 for Members, £10.00 for wives and £50.00 for non-Members. Registered students of the Association and retired Members are allowed to register at fifty per cent of the Members' rate. All the above fees are subject to Value Added Tax at the standard rate (8 per cent at the time of going to press). Members attached to the Hull, Newcastle and West Riding Sections may, if they so wish, register a daily attendance at £12.00 per day (plus VAT).

Preprints

Preprints of the papers are now being prepared and it is expected that these, together with details of accommodation, badges, programmes etc. will be sent to those who have registered in May. It is a feature of the Association's Conferences that preprints are sent well in advance of the

function, in order to enable delegates to read them before the Conference, at which the lecturers illustrate their topics but do not read the papers in their entirety. This allows for a much longer discussion period than at many other Conferences, and has proved of immense value to those attending previous Association Conferences.

Dates and times of sessions

The Conference assembles on the evening of 17 June when a reception for all those attending from overseas will be followed by a meeting of the lecturers and the chairmen of sessions. The Conference sessions will be held on Wednesday 18 and Thursday 19 June morning (9.30 to 12.30) and afternoon (2.30 to 4.30) and the morning of Friday 20 June (9.30 to 12.30). The Association's Annual General Meeting will take place at 2.15 pm on the afternoon of Friday 20 June and this will be followed by three Workshop Sessions. The subjects this year are: "How can we control over-specification?", "What is the reality of toxic hazards for the surface coatings manufacturer?" and "The impact of non-impression processes on the printing ink industry". The number attending each Workshop Session is strictly limited and places will be allocated in order of receipt of applications. When the total places for a session have been filled, later applicants will be informed and, if possible, offered an alternative session.

Receptions and Dinner

There will be an informal reception for all delegates at lunchtime on Wednesday and a Civic Reception will be held, at which delegates will be welcomed by the Mayor

and Mayoress of Scarborough, on the evening of the same day. The Association's Dinner and Dance will be the closing function of the Conference on the Friday evening. For the benefit of ladies other activities, such as coach tours, are being arranged, and further details of these are given in the Conference programme leaflet available from the Association's offices.



W. Funke

The paper by Dr H. Haagen (see this *Journal*, 1975, page 37) will now be presented jointly with Dr W. Funke, Professor of Polymer Chemistry at the University of Stuttgart. Dr Funke's research interests are the structure of crosslinked polymers, reactive microgels and the relations between structure and the properties of coatings.

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Stand 10

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IPD, TMD, Curing agents
V 214/V 215
IPDI, TMDI
IPDI-adduct T 1890*
(+ Oxyester Z 1439*)
IPDI-U 900/U 556
PUR-system UB 1256

Castings

Epoxy systems

Polyurethane systems

IPD, THPA, HHPA, MHHPA,
Curing agent V 214
IPDI-adducts H 2921/H 3150
(+ Oxyester V 2922*/T 1136*)

Laminates

Epoxy systems

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*development product

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OCCA—XXVII Exhibition

Olympia, London. 22-25 April 1975

A preview of the International Forum for Technical Display and Discussion in the Surface Coatings Industries

★ Australia ★ Belgium ★ Finland ★ France ★
 ★ Germany ★ Holland ★ Hungary ★ Italy ★
 ★ Norway ★ Poland ★ Rumania ★ Sweden ★
 ★ Switzerland ★ UK ★ USA ★

General

At the Exhibition this year, over 150 organisations from the United Kingdom and 14 overseas countries will be represented.

Manufacturers of resins, pigments, extenders, additives, solvents, oils, machinery, laboratory equipment, instruments and other miscellaneous items will be presented, as shown in graphical form later in this preview.

In addition to the "Analysis of Exhibits" table and the information below, the following will also be found in this preview: a full list of Exhibitors; organisations other than Exhibitors, which are mentioned in the "Official Guide"; floor plans of the Exhibition and a street map of the area around Olympia showing the Empire Hall; latest Stand telephone numbers (not allocated at the time when the "Official Guide" went to press); latest news of Exhibitors, including a late applicant (i.e. information issued since the printing of the "Official Guide").

A full review of the Exhibition, including many Stand photographs and a full technical review of the exhibits, will be appearing in the June issue of this *Journal*.

Special parties of overseas visitors

Following the success of the delegation of Japanese Paint Manufacturers to the Exhibition last year, the Association is pleased to be welcoming this year further delegations from several overseas countries.

Aims of the Exhibition

The Exhibition Committee wishes the aims of the Exhibition as stated in the Invitation to Exhibit to be as well known as possible, and accordingly these are reproduced below.

The aim of the Exhibition is the presentation of technical advances in those industries supplying the paint, varnish, printing ink, colour, linoleum and other allied industries. The technical advances may relate to: new products, new knowledge relating to existing products and their uses, or in suitable cases, existing knowledge which is not generally available in the consuming industries.

The Committee stipulates that exhibitors present a technical theme—i.e. to display in a technical manner the technical developments in raw materials, plant or apparatus

illustrated by experimental evidence. It is essential that a technically or scientifically trained person who has full knowledge of the products displayed be available on the stand throughout the official hours of opening.

Whilst the Committee naturally encourages the showing of new products, it does not stipulate that a new product has to be shown each year, since it fully appreciates that there are occasions when this is not possible. Accordingly, the Committee draws attention to the fact that new technical data on existing products are regarded as acceptable subject matter.

International character

The Exhibition, which has long been known as the forum for technical display and discussion for the surface coatings industries, in 1974 attracted visitors from more than 50 overseas countries. The motif chosen for this year's Exhibition continues the theme of OCCA-26 (when attention was drawn to the European Economic Community) by extending it to show the worldwide interest aroused by the Association's Exhibitions in London. To further the truly international character, the Exhibition is widely advertised in technical journals both at home and overseas. Interpreters are available at the Exhibition without charge to help both exhibitors and visitors alike.

Official Guide and Season Admission Tickets

Copies of the "Official Guide" have been dispatched to all members of the Association in the UK and abroad, to chemists and technologists in Europe, to technical colleges, to embassies and chambers of commerce and, through the courtesy of the trade associations, to companies in the paint, printing ink and pigment industries in the UK.

It has been decided on this occasion to make a small charge to non-members of £1.00 to cover both the Season Admission Tickets and a copy of the "Official Guide". Non-members wishing to receive tickets and copies of the "Official Guide" in advance should send to the Association's offices the necessary remittance as soon as possible.

Copies of the "Official Guide" and Season Admission Tickets will also be available at the entrance to the Exhibition.

At the beginning of March, each Member of the Association was automatically sent

an individual copy of the "Official Guide" and Season Admission Ticket. Members and non-members alike can purchase additional copies of the "Official Guide" at the Information Centre (Stand 17), price 50p each.

Hours of opening

The Exhibition will take place at the Empire Hall, Olympia, London W14, and will open on the following dates and times:

Tuesday, 22 April	09.30—17.30 hrs
Wednesday, 23 April	09.30—17.30 hrs
Thursday, 24 April	09.30—17.30 hrs
Friday, 25 April	09.30—16.00 hrs

Travel and accommodation

The Underground train service will operate at 10- to 15-minute intervals to Olympia from Earls Court (District and Piccadilly lines), the first train leaving Earls Court at 09.00 hrs and the last leaving Olympia at 19.00 hrs.

The Wayfarers Travel Agency Limited, Cranfield House, 97-107 Southampton Row, London WC1B 4BQ, has been allocated a Stand facing the OCCA Information Centre at the Exhibition and will be prepared to advise on, and arrange, hotel accommodation and travel facilities to the Exhibition. They will also be able to make theatre ticket reservations for the evenings of the Exhibition.

British Transport Hotels, centrally situated at main railway termini in London, have available both single and double rooms and further details are given on page 50 of the "Official Guide".

Banking and postal services

National Westminster Bank Limited has been allocated Stand 19, where full facilities will be available, including the cashing of cheques and receipts of credit, and the encashment of foreign drafts and notes, travellers' cheques and letters of credit. Credits for the cashing of cheques should be established at the West Kensington Branch of National Westminster Bank, 85 Hammersmith Road, London W14, through visitors' and exhibitors' own bankers.

A Post Office Self-Service Suite will be available in the Empire Hall for the sale of postage stamps and letter cards. A post-box will also be provided and collections will be made at intervals during the hours of opening. Public telephones are situated by the escalators.

Technical education

As in previous years a Stand will be devoted to technical education and this will be staffed by representatives from the Paint-makers' Association and from technical colleges. Details will be available not only on courses in the technology of the industries but also the optional Professional Grade recently introduced by the Association for its Ordinary Members.

The theme of the Stand this year will be "Radiation curing". A leaflet with this title has been specially prepared and copies will be freely available on the stand.

Information centre and overseas visitors

The Information Centre (Stand 17) is

placed opposite the main entrance with the Interpreters (Stand 18) on one side and the Technical Education Stand (Stand 16) on the other. In front of the Information Centre is one of the three seating areas which are a special feature of this Exhibition, allowing visitors an opportunity to read literature from the Stands and write notes at ease. Many overseas visitors find it convenient to meet their friends at the Information Centre and the Association's staff and the interpreters will be only too pleased to assist them in this way. The use of the public address system to find visitors is restricted to one announcement each hour (on the hour) and those wishing to use this service should give in the name of the visitor(s) concerned

to the Association's staff and make a point of being at the Information Centre when the announcement is broadcast. Overseas visitors are particularly requested to sign the special Visitors' Book at the Information Centre.

Telephone messages

During the build-up period before the Exhibition messages can be recorded at Olympia on 01-603 0921 through the courtesy of Recordacall Limited. During the Exhibition hours the Association's staff may be contacted on the Information Centre, Stand No. 17 (Tel. 01-931 1411).

Numerical list of Exhibitors—OCCA XXVII

For position of stand, please refer to plan views of the Exhibition Hall on page 150

Stand

- 1 Baker Perkins Chemical Machinery Ltd.
- 2 Henkel & Cie GmbH
- 3 Cabot Carbon Ltd.
- 4 Willy A. Bachofen
- 5 Dynamit Nobel AG
- 6 Esso Chemical Limited
- 7 Kinhurst Engineering Ltd.
- 8 Tenneco Chemicals Europe Ltd.
- 8A Neumo Ltd.
- 9 Chemische Werke Huls AG
- 10 Veba-Chemie AG
- 11 Microscal Ltd.
- 12 Rudolph Meijer Inc.
- 13 Rohm & Haas (UK) Ltd.
- 14 Marchant Bros Ltd.
- 15 British Steel Corp. (Chemicals) Ltd.
- 16 Technical Education
- 17 Information Centre
- 18 Interpreters' Stand
- 19 National Westminster Bank
- 19A Produits Chimique Ugine Kuhlmann
- 20 Jenag Equipment Ltd.
- 21 Toxide International Ltd.
- 21 Titanium Intermediates Ltd.
- 22 Bayer AG
- 23 Sheen Instruments (Sales) Ltd.
- 23A BOC Special Gases Division
- 24 GAF (Great Britain) Ltd.
- 25 Jacobson van den Berg & Co. (UK) Ltd.
- 26 Eastman Chemical International AG
- 27 William Boulton Ltd.
- 28 Diffusion Systems Ltd.
- 29 Durham Raw Materials Ltd.
- 30 Anchor Chemical Co. Ltd.
- 31 Shell Chemicals UK Ltd.
- 32 Joseph Crosfield & Sons Ltd.
- 33 RK Chemical Co. Ltd.
- 34 Torrance & Sons Ltd.
- 35 Hercules Powder Co. Ltd.
- 36 Wayfarers Travel Agency Ltd.
- 37 Laporte Industries Ltd.
- 38 Porter Lancastrian Ltd.
- 39,40 Hoechst Aktiengesellschaft
- 40A G. J. Erlich Ltd.
- 40B A. Strazdins Pty. Ltd.

Stand

- 41 BASF Farben + Fasern AG
- 42 Chemolimpex
- 43 Wacker-Chemie
- 44 NL Industries Inc.
- 45 Rhone-Poulenc
- 46 British Industrial Plastics Ltd.
- 47 Croda Resins Ltd.
- 48 SCC Colours Ltd.
- 49 Imperial Chemical Industries Ltd.
- 50 Manchem Ltd.
- 51 Byk-Mallinckrodt Chemische Produkte GmbH
- 52 Phillips Petroleum Co.
- 53 Sandoz Products Ltd.
- 54 Union Carbide Europe SA
- 55 Schering AG
- 56 Sun Chemical Corporation
- 57 CdF Chimie
- 58 Degussa
- 59 Corneliu Chemical Co. Ltd.
- 60 Kemira Oy
- 61 Hilton-Davies Chemical Co.
- 62 Arco
- 63 Roehm GmbH
- 64 Chemische Industrie Synres BV
- 65 Sachtleben Chemie GmbH
- 66 Polyvinyl Chemie Holland BV
- 67 CIBA-GEIGY UK Ltd.
- 68 BASF United Kingdom Ltd.
- 69 A/S Norwegian Talc
- 70 Winter Osakeyhto
- 71 Polymers Paint & Colour Journal
- 72 Joyce-Loebl Ltd.
- 73 Polychrome Ltd.
- 74 Tin Research Institute
- 75 Akzo
- 76 Dyno Industrier AS
- 77 Wheatland Journals Ltd.
- 77A John Godrich
- 78 Montedison
- 79 Amoco Chemicals Europe
- 80 Research Equipment (London) Ltd.
- 81 Worsdall Chemical Co. Ltd.
- 82 Ciech
- 83 Imeco (Arcode)
- 84 Berol Kemi AB
- 85 Norprint Limited

In addition to the exhibitors listed above, reference is also made in the *Official Guide* to the following:

Stand	Company	Official Guide page number	Stand	Company	Official Guide page number
78	ACNA	141	83	Arcode Ltd.	92
25	Air Products and Chemicals Inc.	94	25	Armoform Ltd.	95
75	Akzo Chemie BV	53	75	Armour Hess Chemicals Ltd.	53
75	Akzo Chemie UK Ltd.	53	7	Augusts Ltd.	98
75	Akzo Zout Chemie Nederland BV	54	71	Aviachem Ltd.	110
19A	Alliance Dye & Chemical Co.	113	1	Baker Perkins Incorporated	57

Stand	Company	Official Guide page number	Stand	Company	Official Guide page number
42	Budalakk	69	40A	M.P.I. Group of Companies	84
43	Bush Beach & Segner Bayley	134	14	Nagema	100
58	Bush Beach & Segner Bayley	78	40A	O'Toole	84
25	Cargas Blancas Inorganicas	95	59	Oulu	75
39 & 40	Cassella Farbwerke Mainkur AG	89	47	Plastanol Limited	75
77A	Chemecol	139	25	Podell Industries Inc.	94
25	Chem-Plast	94	27	Podmore	63
42	Chinon	69	25	Polychimie	94
25	Colorado Chemical Specialities Inc.	95	82	Polifarb	74
47	C.P.C. (United Kingdom)	75	71	Portcullis Press Ltd.	111
82	Daltrade Ltd.	74	42	Pevdi	69
26	Eastman Kodak Co.	83	40A	Previero	85
40A	GE-Halin	85	25	P.V.O. International Inc.	94
4	Glen Creston	56	39 & 40	Resinoux Chemicals Ltd.	89
8	Graco	128	45	Rhodia (UK)	142
27	Hardy, M. W. & Co. Ltd.	58	56	Shear Colour Ltd.	126
39 & 40	Harlow Chemical Co. Ltd.	89	41	Seigle	58
47	Harold Heydon & Co. Ltd.	75	2	Sipon Products Ltd.	87
39 & 40	Hoechst UK Ltd.	89	1	Steele and Cowlshaw Ltd.	57
10	Industria (Chemical Services Ltd.)	132	23	Stormer Krebs	124
71	Industrial Newspapers Ltd.	111	25	Supercolori S.p.A.	94
40A	Karcher	85	76	Tennant, Charles, & Co. (London) Ltd.	80
25	Lombard-Gerin	95	6	Tennant, Charles, & Co. (London) Ltd.	111
45	May & Baker Ltd.	142	8	Tenneco Colortrend BV	128
78	McNab, Wm. J. and Sales Ltd.	140	8	Tenneco Malros Limited	128
59	Mearl Corporation	75	42	TVK	69
40A	Microsfera	85	19A	Ugine Kuhlmann Chemicals Ltd.	113
1	Midland Speciality Powders	57	25	Van Lerberghe, Ests A.	95
56	Mitchell, W. A. & Smith Ltd.	138	11	Vianova	103
40A	Molteni	85	39 & 40	Vianova Kunstharaz AG	89
29	Monsanto	80	56	Warwick Chemical (Yorkshire) Ltd.	138
78	Montedison	140			

News of Exhibitors

Late applicant

Stand 28

Diffusion Systems Limited

43 Rosebank Road, London W7

The range of surface measuring instrumentation manufactured by Diffusion Systems can be seen to best advantage on the stand.

This range comprises, among the more popular instruments, the following:

Fixed angle Glossheads to BS3900 and ASTM D523 20, 60 and 85° methods, with special modification for plastic film and metal finishes (Plaspec B and Metspec). Variable angle glosshead for independent and concerted polar measurements between 10 and 85°.

A simple spectrophotometer (0° 45°) for colour and brightness measurements. When used with a selection of filters, the instrument will provide simple spectrum analysis with a nine narrow band filter set, tristimulus values with XYZ filter wheel, and reflection densities using tricolour absorption and reflection filters. Visual brightness can be achieved with the Y function of the tristimulus filter.

The PRS reflectometer will provide simple comparison of visual brightness when used in conjunction with its eye correction filter. A portable version of this reflectometer is available for in-plant use with its own self-contained read-out and power supply. All the above instruments are available with analogue or digital options.

The Model 57 spherical hazemeter is now available with its own integral numerical display for the measurement of total and diffuse luminous transmittance, as well as its main function, the measurement of "haze" in plastic film to ASTM D1003.

Transmission and reflection densities required in the printing and photolithographic industries are readily measured with the Model 6 and 7 densitometers. A full range of complementary photometric instrumentation will also be on view.

Late applicant

Stand 85

(Opposite Stand 59)

Norprint Limited

Horncastle Road, Boston, Lincolnshire

Norprint Ltd. will be demonstrating its new fully automatic paint can labeller. The equipment, incorporating a conveyor and photosensing unit, applies high quality self-adhesive labels in exactly the same position on each can. Damaged cans are automatically detected and rejected, instead of passing on to the filling station. Five different can sizes will be accepted; only ten seconds is needed to adjust the equipment. Depending on their size, 40 to 85 cans can be labelled per minute.

The labelling equipment may also be used as an overprinter to add variable information in one or two colours. Colour reference labels are printed with paint, ensuring an exact colour match.

Stand 30

Anchor Chemical Co. Limited

In addition to the Anchor Chemical Company's exhibits mentioned in the "Official Guide", Ancomer Limited, a company formed jointly by Anchor and the Sartomer Company, Philadelphia, will be exhibiting the Sartomer range of polyfunctional acrylic monomers for radiation curing.

Stand 67

CIBA-GEIGY (UK) Limited

CIBA-GEIGY (UK) Limited has recently published a book "Safety in Laboratories" and the company hopes that the booklet will form the basis of a general code of practice for the safe operation of chemical and other processes carried out in the laboratory.

The 42-page booklet is available from the Corporate Public Relations Department, CIBA-GEIGY (UK) Ltd., Simonsway, Manchester M22 5LB.

Stand 58

Degussa

A principal feature of the stand will be the carbon blacks described in the "Official Guide". The Chemicals Division of Degussa, however, has recently announced the availability of an auto-crosslinking acrylate resin "VP 3949" for the production of powder lacquers.

VP 3949 consists of a methacrylate resin with hydroxyl groups and a blocked polyisocyanate; under the influence of heat, it is converted to a crosslinked polyacrylic urethane.

Stand 49**ICI Limited**

ICI Organics Division is to build a £6m plant at its Grangemouth Works as a further expansion to its capacity for the manufacture of "Monastral" Green pigments.

The original plant was completed in 1971 and production has expanded since then. The new plant will more than double the present manufacturing capacity to a total of 3 000 tonnes.

Stand 20**Jenag Equipment Limited**

Jenag Equipment Limited, manufacturer of paint straining equipment, has announced marked achievements in overseas markets. Four of the company's model 1800 units have recently been ordered for installation in Bulgaria—the first sales achievement by Jenag in this part of Europe. In the United States, where Jenag already has a number of installations, a further model 3000 strainer has just been ordered by PPG.

Stand 77A**John Godrich**

The Bemrose laboratory heat transfer press is already widely used where it is necessary to control with great accuracy conditions during transfer printing on a wide variety of materials.

Using the most sophisticated control equipment, the laboratory press enables samples to be produced quickly, conveniently and accurately.

Platen pressure is maintained pneumatically and an automatic timer releases the pressure after a predetermined dwell time. Sensitive temperature controllers ensure that the sample temperature remains constant.

John Godrich of Ludford Mill, Ludlow, Shropshire, is now world-wide distributor of this machine and will be pleased to arrange for demonstrations of the unit and supply literature.

The first of the Werner Mathis laboratory jet dryers to be delivered to the UK has just been commissioned. This machine will take a sample of maximum weight 150g and has a liquor content of 2 to 3 litres. John Godrich will be pleased to supply further details of the machine.

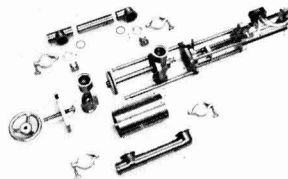
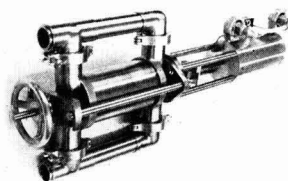
Stand 60**Kemira Oy**

Kemira lays special emphasis on the inadequacy of chalking and gloss reduction alone as the main indicators of the durability properties of coatings. Other characteristics, such as cracking, rusting and fading of tints, have been subjected to critical inspection in order to illustrate the total effect of titanium dioxide pigments on the durability and the protective value of coating films.

Stand 31**Shell Chemicals UK Limited**

As mentioned in the "Official Guide", the Shell Chemicals stand will show products and developments in the field of resins and solvents.

The solvents exhibits are based on the principle that "a fundamental understanding of solvent behaviour can help to solve practical coatings problems!". Information on solubility parameters is linked with a new technical bulletin which approaches the subject from a practical rather than the more usual theoretical standpoint, demonstrating in a manner easy to follow the application of solubility parameters to predicting solubility and selecting and replacing solvent blends in coatings.

Stand 8A**Neumo Limited**

An air-operated transfer pump (pictured above), with an output of up to 320 litres per minute and capable of being stripped quickly without tools, has been introduced by Neumo Limited, Newhaven, Sussex.

The unit comprises a reciprocating air motor driving a five-litre capacity positive displacement, double-acting pump connected by a quick-release coupling. Constructed in stainless steel throughout, it is available in two versions—with PTFE seals and additional clamps on the manifolds for paints, chemicals and similar liquids, including abrasive products, and with synthetic seals for sanitary applications in the food industry.

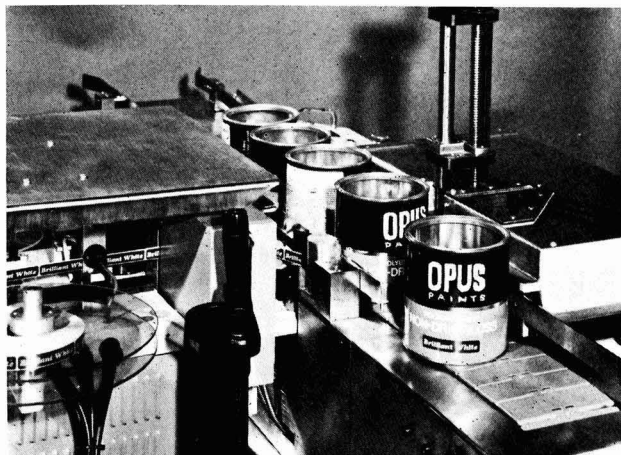
Powered by a normal factory compressed air supply, an air-pressure regulator controls speed of pumping; water separation and mist lubrication are provided. The pump is designed for continuous or intermittent operation and can be stalled without damage to the motor. It is completely safe in flameproof areas, can be washed down freely and is quickly stripped for cleaning or simply flushed out.

Stand 11**Microscal Limited**

In addition to the latest versions of the flow microcalorimeter, photo and X-ray sedimentometers, spinning rifflers and light fastness testers, Microscal will be showing a new apparatus to produce accurate samples of powders in liquid suspensions. This apparatus has been invented by the United Kingdom Atomic Energy Authority and developed by Microscal.

Stand 40B**A. Strazdins Pty. Ltd.**

Strazdins will show a full range of its improved design of *Blendorama* colourant dispensers. The company will demonstrate its single-pump 50ml capacity dispensing machines for small and medium retail stores, together with the double-pump 150ml capacity units for larger stores, and the large 600ml capacity double-pump for bulk blending at the factory or depot.



Fully automatic paint can labeller from Norprint



ALLAN-DOUGLAS LIMITED,
15 Blackfriars Lane,
London EC4V 6ER.

Tel: 01-248 5987 Telex: 887444

We also supply:

Acetone
 Adipic Acid
 N-Butanol
 Iso-Butanol
 PHTHALIC ANHYDRIDE
 Phosphoric Acid
 Solvent Naphthas
 Styrene
 Toluene
 Xylene
also
 Acrylates, Phthalates
 and many other Chemicals

ALLAN-DOUGLAS LIMITED are U.K. Agents for the range of Alkyd Resins of Messrs. Ernst. Jäger of Düsseldorf, West Germany.

As we shall not be exhibiting at OCCA this year, we should like to bring to your attention the fine Jäger Products we are able to supply.

Amongst the newest Resins we can offer are:

JÄGAPLAST 1749

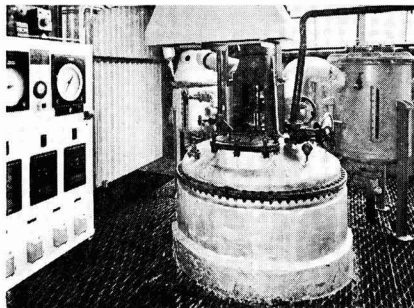
JÄGAPLAST 1770

These are Hydroxypolyester Resins for use in the manufacture of high gloss low solvent stoving finishes. With many applicators they can be sprayed cold (with a solid content of approx. 80%), or hot if the solid content is 90%.

Why not send for further details?

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 San Diego, California

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WE PRIDE OURSELVES AS SPECIALISTS IN THE MANUFACTURE OF VARNISHES. PRODUCTION BY SOPHISTICATED MODERN PLANT OPERATING UNDER EXPERIENCED TECHNICAL CONTROL ENABLES US TO SUPPLY OLEO-RESINOUS VARNISHES TO CUSTOMER SPECIFICATION OR OUR FORMULATIONS AT COMPETITIVE PRICES.

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 'Varnish Makers to the Paint Industry'

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with
Irgazin[®]
Yellow 5GT

Suitable for a wide
range of applications
especially
automotive finishes,
solid colours or metallics

High performance

Marked flip tone

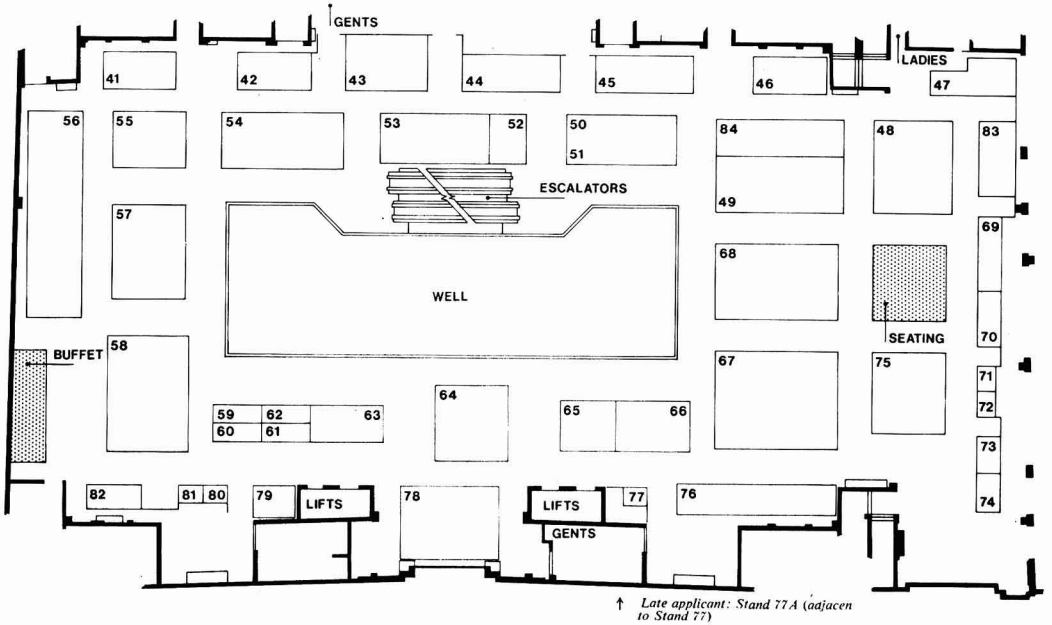
Very green hue

For further information ask for Product Bulletin Paint No 3

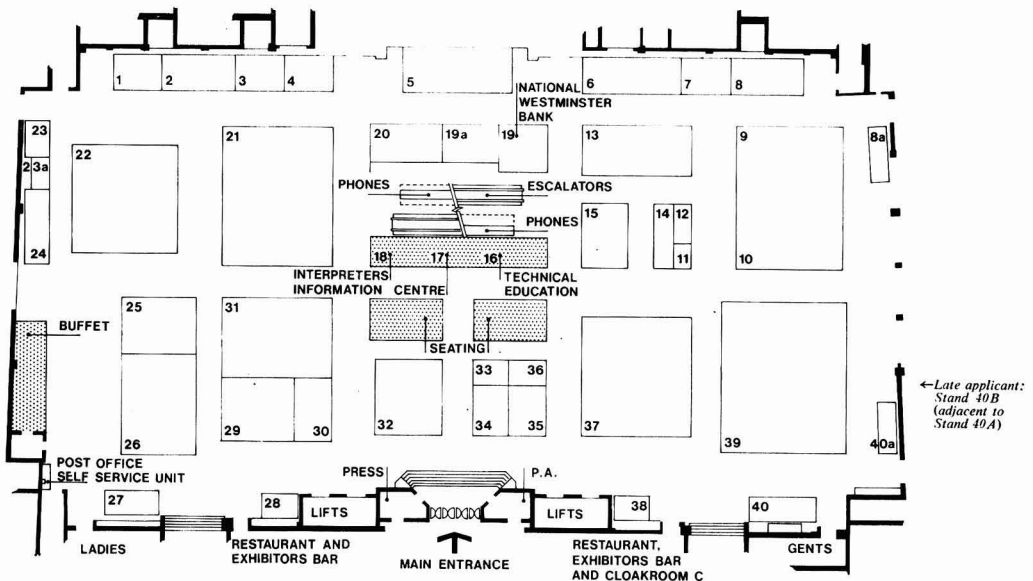
Pigments Division
CIBA-GEIGY (UK) Limited, Roundthorn Estate, Wythenshawe, Manchester M23 9ND
Tel: 061 998 7121 (Head Office)



Floor plans of the Exhibition Hall at Olympia



FIRST FLOOR



GROUND FLOOR

Analysis of Exhibits

Stand No.	Exhibitor	Resins	Extenders, fillers, matting agents	Pigments	Additives, driers, surfactants etc.	Chemical intermediates	Manufacturing equipment, drums etc.	Laboratory apparatus and testing equipment	Miscellaneous
75	Akzo	•			•	•			
79	Amoco Chemicals Europe	•				•			
30	Anchor Chemicals Co. Ltd.	•	•		•	•			Polyfunctional monomers
62	Arco	•			•				
4	Bachofen, Willy A.						•	•	
1	Baker Perkins Chemical Machinery Ltd.						•		
41	BASF Farben + Fasern AG			•					
68	BASF United Kingdom Ltd.	•		•					
22	Bayer AG	•		•	•				
84	Berol Kemi AB	•							
27	Boulton, William, Ltd.						•	•	
46	British Industrial Plastics Ltd.	•							
23A	British Oxygen Co. Special Gases					•		•	
15	British Steel Corp. (Chemicals) Ltd.	•	•						
51	Byk-Mallinckrodt Chemische Produkte GmbH				•			•	
3	Cabot Carbon Ltd.	•			•	•			
9	Chemische Werke Huls AG	•				•			Solvents
57	CdF Chimie	•			•	•			
42	Chemolimpex	•			•				
67	Ciba-Geigy (UK) Ltd.	•		•					
82	Ciech								Technical literature and shade-cards (colour-cards) for various paints, lacquers and enamels
59	Cornelius Chemical Co. Ltd.	•	•	•	•				
47	Croda Resins Ltd.	•							
32	Joseph Crosfield & Sons Ltd.		•						
58	Degussa		•	•					
28	Diffusion Systems Ltd.							•	
29	Durham Raw Materials Ltd.			•	•				Anti-corrosive pigments
5	Dynamit Nobel AG	•				•			
76	Dyno Industrier AS	•							
26	Eastman Chemical International AG	•			•				
40A	Erich, G. J., Ltd.						•		
6	Esso Chemical Ltd.	•				•			
24	GAF (Great Britain) Ltd						•	•	

Stand No.	Exhibitor	Resins	Extenders, fillers, matting agents	Pigments	Additives, driers, surfactants etc.	Chemical intermediates	Manufacturing equipment, drums etc.	Laboratory apparatus and testing equipment	Miscellaneous
40B	Strazdins, A., Pty. Ltd.								Colourant dispensers
56	Sun Chemical Corporation			•					
64	Synres, Chemische Industrie B.V.	•							
8	Tenneco Chemicals Europe Ltd.		•		•	•			Colourants
74	Tin Research Institute								
21	Tioxide International Ltd.			•					
21	Titanium Intermediates Ltd.					•			
34	Torrance & Sons Ltd.						•		
19A	Ugine Kuhlmann, Produits Chimique			•					Transfer printing dyes
54	Union Carbide Europe S.A.	•			•	•			
10	Veba-Chemie A.G.	•			•				
43	Wacker-Chemie	•			•				Fungicides
77	Wheatland Journals Ltd								Technical journals and services
70	Winter Osakeyhto								Wintermix tinting system
81	Wordsdall Chemical Co. Ltd.	•							

Obituary

J. S. Jordan

With deep regret, it is announced that Mr J. S. Jordan passed away suddenly in the early morning of 9 February at his home in Healing, near Grimsby, aged 56.

Jim Jordan worked with Goodlass Wall before the War, and re-joined them for a short period after the War. He then held various appointments with Keystone Paint, Leyland Paint and J. E. Williams. He joined Laporte Titanium Limited in 1963 as

a Technical Representative. Subsequently he served in a number of technical roles supporting the company's activities within the surface coatings industry both in the UK and overseas. In January 1972 he was appointed Senior Technical Associate within the newly created Surface Coatings Market Group.

He leaves a widow and two sons who are both currently at university. The condolences of the Association are passed to them.

News of Members

Mr K. Hodgson, an Ordinary Member currently vice-chairman of the Newcastle Section and a Fellow in the Professional Grade, has formed a company A.C.D. Coatings Limited, to produce high quality paints and surface coatings. In particular, the new company is interested in heavy industry, sophisticated coatings and decol with relation to customers' special requirements. Mr Hodgson is a Fellow of the Institution of Works Managers with a diploma in industrial management.

London Section

Ladies' Night

The Annual Ladies' Night was held recently at the Cafe Royal, London. The chairman, Mr R. H. E. Munn, and his lady, were pleased to welcome as guests Mr Gilbert, immediate past president of the Birmingham Paint, Varnish and Lacquer Club, and Mrs Gilbert, and a number of Section Chairmen and their ladies. Following dinner the chairman made a short speech of welcome and Mr Gilbert replied on behalf of the guests. Dancing then commenced and continued until midnight.

B.A.C.

Midlands Section

Trent Valley Branch

Visit to Denby pottery factory

Thirty-one members, wives and friends spent an interesting and enjoyable afternoon touring the Denby Pottery factory on Wednesday 12 February. The visitors were shown the processes used from the throwing to the final glazed product, and were then entertained to tea. Among visiting members were Mr D. E. Hopper, Chairman of the Midlands Section, and Mr A. S. Gay, Immediate Past Chairman of the Section, and their wives.

C.V.W.



Mr A. C. Jolly

Mr A. C. Jolly, an Ordinary Member attached to the Manchester Section and a Fellow in the Professional Grade, has been appointed Market Development Manager of Synthetic Resins Limited.

Forthcoming Events

Details are given of meetings in the United Kingdom up to the end of the month following publication, and South Africa and the Commonwealth up to the end of the second month.

April

Thursday 3 April

Newcastle Section: Annual General Meeting to be held at the Royal Turks Head Hotel, Grey Street, Newcastle upon Tyne at 6.30 p.m.

Tuesday 8 April

West Riding Section: Annual General Meeting to be held at the Griffin Hotel, Leeds at 7.30 p.m.

Thursday 10 April

Thames Valley Section: Annual General Meeting to be held at the Beech Tree Hotel, Maxwell Road, Beaconsfield, Bucks, at 7.00 p.m. The meeting will be followed by a supper, to which Members' wives and guests are cordially invited.

Friday 11 April

Bristol Section: Annual Dinner Dance, Mayfair Suite, Civic Entertainments Centre, Bristol.

Manchester Section: Annual General Meeting to be held at the New Albion Restaurant, 34 High Street, Manchester 4, at 6.30 pm.

Midlands Section—Trent Valley Branch: Combined AGM and social evening, to be held at the Cross Keys Inn, Turnditch, Derbyshire.

Wednesday 16 April

Irish Section: Annual General Meeting to be held at the Clarence Hotel, Dublin at 7.45 p.m.

Scottish Section—Eastern Branch: "A topic on the testing of organic pigments." Speaker from Ciba-Geigy Ltd. in the Carlton Hotel, North Bridge, Edinburgh at 7.30 p.m.

Friday 18 April

London Section: Annual General Meeting to be held at the Great Northern Hotel, Kings Cross, London, at 7.00 p.m.

Midlands Section: Annual General Meeting, to be held at the Crown Hotel, Broad Street, Birmingham, at 6.30 p.m.

Tuesday 22 April—Friday 25 April

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Friday 25 April

Bristol Section: Annual General Meeting to be held at the Royal Hotel, Bristol at 7.15 p.m.

May

Thursday 8 May

Thames Valley Section—Student Group: "Colour matching and measurement" by Mr. B. Jeffs, ICI Ltd., Paints Division to be held at 4.00 pm at Slough College in the main Lecture Hall.

Register of Members

The following elections to Membership have been approved by Council. The Section to which new Members are attached is given in *italics*.

Ordinary Members

- ADAMS, JOHN ANTHONY, BSc, British Imperial Paints Ltd., PO Box 9295, Newmarket, Auckland, New Zealand. (*Auckland*)
- ATEN, WILLIAM C, Gatehouse, Links Green Way, Cobham, Surrey. (*London*)
- BARKER, ALAN WILLIAM, 21 Raven Lane, Billericay, Essex. (*Thames Valley*)
- BARTON, DEREK, BSc, ARIC, Hickson & Welch Ltd., Ings Lane, Castleford, West Yorks WF10 2JT (*West Riding*)
- CARLTON, DOUGLAS, BSc, Tioxide International Ltd., Central Laboratories, Portrack Lane, Stockton on Tees, Cleveland TS18 2NQ. (*Newcastle*)
- COLLING, JOHN HARVEY, BSc, 66 Littlecoates Road, Grimsby, South Humberside DN34 4LT. (*Hull*)
- DE GUZMAN, AQUILINO B, BSc, 81 Xavierville Loyola Heights, Quazon City, Philippines, Postal Code 3005. (*General Overseas*)
- DELAFIELD, JOSEPH RICHARD, LRIC, 35 Central Drive, Westhoughton, Bolton BL5 3DS. (*Manchester*)
- GRISENTHWAITE, RONALD JAMES, BA, BSc, 281 The Dashes, Harlow, Essex CM20 3SA. (*London*)
- HALL, LEE, BSc, Flat 7, 23 Waratah Street, Birkenhead, Auckland 10, New Zealand. (*Auckland*)
- HIRD, MICHAEL JOHN, BSc, PhD, MSc, Tioxide International Ltd., Portrack Lane, Stockton on Tees, Cleveland TS18 2NQ. (*Newcastle*)
- HUGHES, RAYMOND, BSc, 46 Shielmartin Drive, Sutton, Co. Dublin. (*Irish*)
- IRVINE, ALEXANDER McHUGH, ARIC, 68 Rockmount Avenue, Thornliebank, Glasgow G46 7DW. (*Scottish*)
- JOYCE, EDWIN, BSc, 1 Dell Meadow, Abbots Langley, Herts. (*London*)
- KING, DENNIS, FTC, 26 Glenshiels Avenue, Hoddlesden, Nr. Darwen, Lancs. (*Manchester*)
- McCLURE, MATTHEW, BSc, 25 Kelvinside Terrace South, Glasgow. (*Scottish*)
- McDONALD, JAMES GRAHAM, 141 Newtyle Road, Paisley, Renfrewshire. (*Scottish*)
- McEWAN, RONALD, GRIC II, 19 Rosedale Avenue, Gleniffer Estate, Paisley PA2 0RR. (*Scottish*)
- McMILLAN, ERIC, BSc, 5 Boyndie Street, Glasgow G34 9JF. (*Scottish*)

- NAG, ANIL KUMAR, BSc, Khamarpara, Bakultola Lane, PO Bansberia, Dist. Hooghly, West Bengal, India. (*General Overseas*)
- READER, CHARLES E. L., BSc, Shell International Chemical Co. Ltd., Shell Centre, London SE1. (*London*)
- RENNO, IBRAHIM, BSc, Sipes International Paint Mfg. Co., PO Box 3300, Beirut, Lebanon. (*General Overseas*)
- RYMAN, KEITH ADRIAN, BSc, Consolidated Chemicals Ltd., PO Box 15-104, New Lynn, Auckland, New Zealand. (*Auckland*)
- SADHU, ISHWAR, BSc, Consolidated Chemicals Ltd., PO Box 15-104, New Lynn, Auckland, New Zealand. (*Auckland*)
- SHERLOCK, JOHN CHRISTOPHER, BSc, PhD, AIMF, 4 Grapevine Close, Wycombe Marsh, High Wycombe, Bucks. (*London*)

Associate Members

- BATES, TREVOR JOHN, PO Box 9130, Wellington, New Zealand. (*Wellington*)
- ELLIOTT, ROSS EDWARD, 31 Tahī Street, Miramar, Wellington, New Zealand. (*Wellington*)
- ELLIS, JOHN GRAHAM WILLIAMS, British Chemical Products & Colours Ltd., 22 Buckingham Street, London WC2. (*London*)
- HANDLEY, ANTHONY ROBERT, AC Hatrick (NZ) Ltd., PO Box 51-005, Tawa, New Zealand. (*Wellington*)
- KELL, GARRY MOUNTIER, AC Hatrick (NZ) Ltd., PO Box 51-005, Tawa, New Zealand. (*Wellington*)
- PETERS, IAIN JAMES, 3 Challoner Close, Finchampstead, Berks. (*Thames Valley*)
- SEWELL, ANTHONY ROBERTS, FT Wimble & Co. (NZ) Ltd., Box 14-441, Panmure, New Zealand. (*Auckland*)
- STOOKE, JOHN SIDNEY, SCC Colours Ltd., Maryland Road, London E15 1JH. (*London*)

Registered Students

- CAIRNS, STEWART, 136 Dundonald Avenue, Johnstone, Renfrewshire PA5 0LP. (*Scottish*)
- KIRKHAM, ELIZABETH MARY, 29 Burns Drive, Johnstone, Renfrewshire. (*Scottish*)
- McDONALD, JAMES, 14 Tantallon Drive, Brediland, Paisley PA2 9JS. (*Scottish*)

...and one more makes three



Modaflow Liquid, recognized by paint chemists as the 'standard' in flow modifiers, has been recently joined by Multiflow, a new flow modifier with excellent cost/performance properties.

Now Monsanto teams up new Modaflow Powder with Modaflow Liquid and Multiflow.

Together they represent the most comprehensive range of flow modifiers, designed to improve flow properties and to reduce surface imperfections.

Modaflow Powder, developed specially for the powder-coating industry, gives all the advantages of Modaflow Liquid, plus easy incorporation into paint formulations because of its powder form.

Mail the coupon and we'll send you enough Modaflow Powder to test, together with full supporting information.

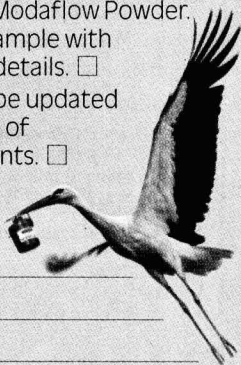
I would like to test Modaflow Powder. Please send me a sample with relevant technical details.

I would now like to be updated on the whole range of Monsanto flow agents.

Name _____

Company _____

Address _____



J01

Modaflow is a Registered Trade Mark.

Monsanto Europe, S.A. Plasticizers Department,
1 Place Madou, B-1030 Brussels, Belgium.

Monsanto

Raw Materials—The Prospects for the Paints and Inks Industry

A two day conference at the Mount Royal Hotel, London

on 29 and 30 April 1975

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PIGMENT AND RESIN TECHNOLOGY

Chairman: Keith Flory, formerly Director Paintmakers' Association

DAY I April 29

Keynote speech. The influence of energy and other cost inflations on raw materials. *Stanford Research Institute* has recently concluded detailed research on the varying effect of the elements of cost inflation of raw materials in the European paints industry (energy costs, labour costs and capital-related costs) and arrived at some startling forecasts. *E. S. Wilson, Stanford Research Institute (Europe)*.

Pigments

- Titanium dioxide. *G. R. Siddle, Laporte Industries Ltd.*
- Chrome pigments. *L. J. Williamson, SCC Colours Ltd.*
- Anti-corrosive pigments. *Drs Benzing and Pantzer, Siegle.*
- Extenders. *R. Simpson, English China Clays.*

Reclamation of Wastes. *R. A. Scaddan, The Dorr-Oliver Company.*

Emulsions

The future, trends, cost patterns. *J. M. Cruden, Harlow Chemical Co. Ltd. J. Hortensius, Synres International, Holland. W. A. S. Hill, Manders Paints Ltd.*

DAY II April 30

Solvents

Can new formulation technology reduce costs? *P. Sorensen, Koge Chemical Works, Denmark.*

Computers are here to stay. *J. J. Marron, Tioxide International Ltd.*

Powder coatings. *R. Lever, Volstatic Ltd.*

Vegetable oils. Speaker to be announced.

Resins

- Anti-pollution aspects. *A. C. Jolly, Synthetic Resins Ltd.*
- Hydrocarbon resins. *Dr E. D. M. Eades and J. C. Kerridge, ICI.*
- Vinyl resins. *J. Pelgrims, Union Carbide Europe SA, Switzerland.*
- Epoxy resins. *Dr J. C. Paladini, C d F Chimie, Paris.*

Materials conservation and the polymer industry. *Prof. G. Scott, Birmingham University.*

Open forum, led by a panel to include *P. Houchell, International Pinchin Johnson, A. Cumbers, Carless Capel & Leonard Ltd.*

Application form

To: Conference Office, Raw Materials—the Prospects for the Paints and Inks Industry Conference, 21, Lewes Road, Haywards Heath, Sussex, England.

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OCCA Conference 1975



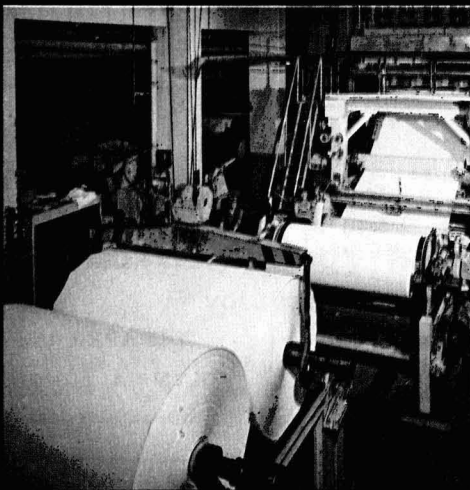
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OCCA XXVII
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OLYMPIA LONDON APRIL 1975

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