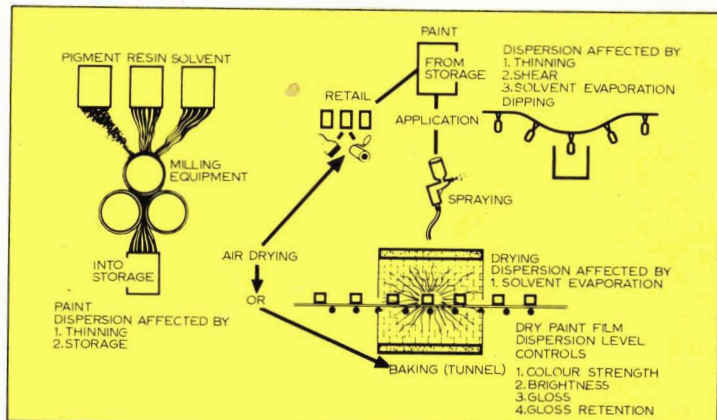


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JOURNAL OF THE I.C.C.A. & COLOUR CHEMISTS' ASSOCIATION

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Dispersion – the neglected parameter

W. Carr

Radiation polymerisation as a tool for the surface coatings industry

J. L. Garnett

Refinishing today – legislation, implied and statutory

K. P. Kozma

PMR spectra of vinyl monomers based on undecanoic acid

A. V. B. Sankaram, N. G. Kulkarni, N. Krishnamurti and P. C. Chatterjee



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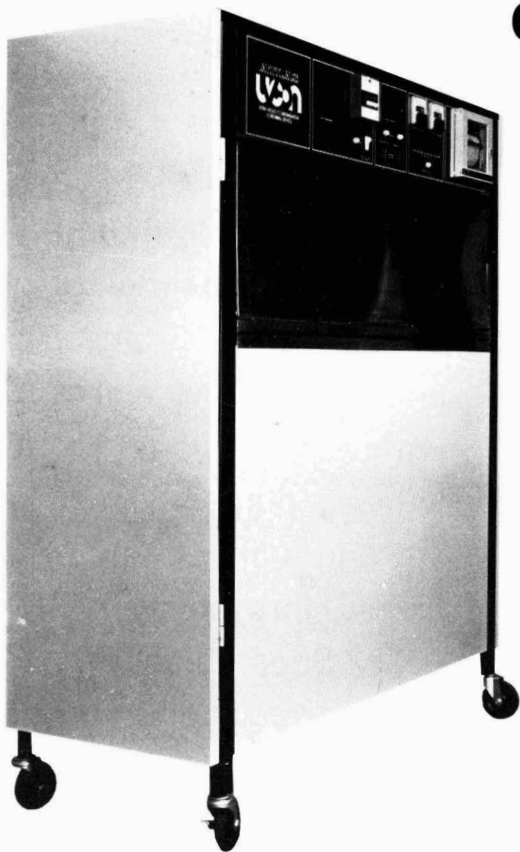
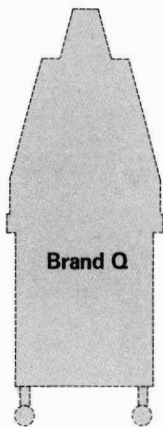


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Transactions and Communications

Dispersion – the neglected parameter

By W. Carr

31 Lindow Fold Drive, Wilmslow, Cheshire SK9 6DT, England

Summary

The author maintains that dispersion levels control the application properties of paints and inks and the optical properties of films. The levels achieved depend on the raw materials and the milling machinery used, but once the product has been made, these levels can vary with storage, application and drying.

It would therefore appear essential to measure and monitor dispersion levels, and industry is criticised for its failure to do this.

Keywords

Processes and methods primarily associated with

manufacturing or synthesis

flocculation
milling
pigment dispersion
pigment/solvent reaction
pigment/vehicle reaction
thinning

Properties, characteristics and conditions primarily associated with

materials in general

opacity

raw materials for coatings and allied products

color stability
particle shape
particle size

coatings during application

bronzing

dried or cured films

brightness
flooding
gloss
performance

La dispersité – le paramètre oublié

Résumé

L'auteur prétend que le degré de dispersion exerce une influence décisive sur les propriétés d'application des peintures et encres d'imprimerie et les caractéristiques optiques des films. Le degré de dispersion atteint se dépend des matières premières et du type de broyeur que l'on utilise, mais après la fabrication du produit, le degré de dispersion peut changer pendant le stockage, le procédé d'application et le séchage.

Donc il paraît indispensable que le degré de dispersion soit déterminé et surveillé, et l'on critique l'industrie parcequ'elle ne fait pas ces mesures de contrôle.

Dispersität – der versäumte Parameter

Zusammenfassung

Der Autor behauptet, dass der Dispersionsgrad die optischen Eigenschaften, die Anstreicheneigenschaften der Anstrichstoffe und Druckfarben beherrscht. Der erreichte Dispersionsgrad hängt von den Rohstoffen und der Mühle, die man benützt, ab. Doch nach der Herstellung des Produkts ändert sich der Dispersionsgrad während der Lagerung, des Anstreichensverfahrens und der Trocknung.

Es wurde daher erforderlich erscheinen der Dispersionsgrad zu messen und zu überwachen. Die Industrie wird kritisiert wegen ihres Versäumnis diese zu tun.

Introduction

The preparation and application of paints has been carried on since the times when mankind lived in caves.

Today, the manufacturers of paints and allied surface

coatings consider themselves to be technical men engaged in a sophisticated technology.

In many respects this is true. Surface coatings in general consist of a suitable pigment or blend of pigments

dispersed in a suitable film forming vehicle, with the dispersion having satisfactory application properties.

The chemistry of most pigments, both organic and inorganic, is well-known and can be varied in a controlled manner. Their physical properties are not quite as well understood but can be varied.

The chemistry of most film forming resins is well understood, and the resin industry claims, with justification, that it can tailor-make resins having any desired combination of properties by varying their chemistry.

The chemistry of the drying oils and solvents in which the resins are dissolved or dispersed is well-known, as are their physical properties.

Paints and inks tend to be judged by the properties of the dry films obtained from their applications to a substrate, and adequate technology is available to measure these film properties, such as colour strength, hue, brightness, gloss, haze, opacity, light fastness, hardness, resistance to chemicals etc.

Application properties, particularly flow, can be measured over a wide range of shear by sophisticated viscometers.

In one respect, however, the surface coatings industry does fall far short of what modern technology could reasonably expect. Moreover, this respect is in fact the basic process involved in coatings manufacture.

This basic process is the dispersing of the pigment, to an adequate degree, in the film forming vehicle.

The coatings industry does not know enough about this process to accord with its claim to be a modern, technology-based industry. It does not know which are the best mills for making any specific products; it does not know how to operate any particular mill to maximum efficiency; it does not know the level of dispersion achieved in its products; it does not know what percentage of intrinsic colour value it is getting from the pigments it uses; it does not know whether the level of dispersion achieved in its products is stable over the storage periods normally associated with them; it only has a sketchy idea of the effect of dispersion on the application properties of its products; it has no knowledge of the effect of the application conditions on the dispersion level; it has no knowledge of the effect of the substrate on dispersion. Finally, even though the vast bulk of paints and inks are applied wet which then dry to the solid films, the industry has no idea of the effect of drying mechanisms on the level of pigment dispersion.

It does know, from experience, that it is the dispersion level of the pigments in the dry films which is responsible for the initial colour strength and gloss of the films. It also knows that such optical properties of the dry films are major selling points, as they are the properties which the final user actually sees for himself.

It is this ignorance on practically all aspects of dispersion that justifies the title of this paper; dispersion *is* a neglected parameter because it is never measured. Because it is never measured, the paint and ink industries are largely in the dark about its significance.

This criticism of the lack of basic knowledge about

dispersion must be seen in the correct perspective. It does not mean that the paint and ink industries cannot or do not make satisfactory products at reasonable prices – of course they do. The quality and performance of both decorative and industrial paints and all types of printing inks have improved steadily over the years and are still improving, and the extent of these improvements are now noticeable even to the lay user.

Nevertheless, it is still true to say that most surface coatings are made to an agreed standard or specification regarding the finished dry film. They are not made to a specific level of dispersion which would give the optimum balance between optical properties and application properties, and their actual manufacture is not sufficiently well controlled to ensure the best use of the milling machinery used.

Thus, the criticisms voiced above apply only to the field of dispersion and not to the end-products as such.

Measurement of dispersion

To be fair, dispersion is seldom measured in industry because the measurement of dispersion is a particularly difficult problem.

In wet paints and inks the mean diameters of the pigments, whether organic or inorganic, are now known to be less than 1 micron. This means that they are well below the limits of optical microscopy.

The pigment particles are non-uniform in size, they are irregular in shape, and they are present in high concentrations and this means that the number of pigment particles in even a small volume sample is very large. This large number in conjunction with a variation in the sizes of individual particles introduces statistical problems that are difficult to cope with.

Moreover, the medium in which the pigment particles are dispersed is usually complex.

On top of all these conditions is the fear or suspicion that paints, inks and pigment dispersions are systems in some form of uneasy equilibrium and that any alterations to the system, such as dilution, for the purpose of measuring the dispersion level might of itself alter the original dispersion level.

Most of these difficulties apply equally well to the measurement of pigment dispersion in dry films.

So it has to be admitted that the measurement of pigment dispersion in paints and inks is a very difficult experimental problem – at the present state of knowledge. But these experimental difficulties do not disguise the importance of pigment dispersion and the need to measure it.

The measurement of pigment dispersion is a challenge. It is a challenge that could and should be taken up, now that computer, laser and other powerful technologies are at the disposal of industry.

Experimental methods

Ref. 1

The author has applied himself over many years to the

task of dispersion measurement, using research or semi-research methods, with limited success. It is now proposed to review the results obtained to date. These will show: (i) the need for dispersion, (ii) the importance of dispersion levels to the application properties of coatings and the optical properties of the final films, and (iii) how dispersion levels can be affected by the raw materials used, the method of dispersion, storage times, and the conditions of application and drying. It is believed that these results, although limited in character, will confirm the validity of the claims he has made regarding the importance of dispersion levels.

The methods used by the author for measuring dispersion have been described in detail elsewhere¹. Three experimental techniques have been used. These are: centrifugal sedimentation, measurement of colour strength under standardised conditions, and the measurement of optical densities.

The first method gives a complete size distribution curve, the other two will only give a mean particle size.

The mean size referred to above and throughout this paper is the 50 per cent diameter which is the diameter of the equivalent sphere above and below which there are 50 per cent, by weight, of the particles.

It is not claimed that any of these methods are free from criticism or are suitable as rapid, routine methods for use in paint and ink manufacture and quality control, but their use in research has, it is believed, demonstrated clearly the importance of dispersion and the factors which can influence it.

Need for dispersion

Ref. 2

Pigment powders are heavily aggregated. This is due to a combination of factors. If a powder particle is reduced below 20 microns in size it can no longer exist as a powder but becomes a dust or smoke. The basic particle size of pigments, whether organic or inorganic, is usually well below 1 micron. Particles as small as this can approach one another so closely that inter-particle forces of attraction, known as van der Waals or London forces, come into play and cause aggregation until the pigment can exist as a powder. On the other hand, pigments do not give any appreciable colouring strength until, on dispersion in the vehicle, these aggregates are broken down to less than 1 micron in size. This is known from both practical experience and theoretical considerations.

Consequently in the dispersion process, these aggregates of 20 microns and more have to be broken down to 1 micron or less in the vehicle and the resultant dispersion has to be stabilised. This is necessary because the short-range forces of attraction apply in both liquid and air media. Much has been written about stabilising mechanisms and the reader is referred particularly to a recent paper by Parfitt². For the purpose in hand, it is assumed that in most non-aqueous paints and inks the pigment particles are stabilised and prevented from rapid re-aggregation by a steric hindrance mechanism arising from the adsorption of long chain molecules from the medium on to the surface of the particles. The long chain molecules are often the molecules of the surface coating resin.

Effects of dispersion

Refs. 3, 4

(a) Effect on flow

Vehicles usually exhibit Newtonian flow and it is widely known that as a vehicle is pigmented its flow becomes non-Newtonian in character. It is also known that as the pigmentation is increased, the deviation from Newtonian flow becomes greater and is accompanied by the development of thixotropy. There is little published information however on how, at any given pigmentation level, the flow properties or thixotropy are affected by an increase in dispersion level.

(b) Effect on optical properties of films

colour strength

With air drying decorative paints based on alkyds or similar resins, the effect of the dispersion levels of organic pigments on the optical properties of the resulting dry films has been determined^{3,4}.

The most significant effect is that on colour strength. As the mean size is reduced below 0.5 micron the rate of increase in colour strength becomes very marked, and if the mean diameter becomes lower than 0.2 micron the rate of increase is very rapid. Curves of k/s , i.e. *absorption*, which is directly proportional to colour strength, plotted against mean diameter, are shown in figures 1 and 2 for a number of organic pigments. They all follow the same general shape and it can be seen that if the mean particle size is reduced from say 0.5 to 0.15 micron, increases in colour strength are obtained of the order of 2, 3 and even 4 fold.

Bearing in mind that any paint or ink with a pigment particle mean diameter of 0.5 micron would probably give a fineness reading completely off the scale of any grind gauge, the importance of dispersion levels to colour strength is vividly illustrated by these graphs.

Brightness

Increasing dispersion has also been shown to increase the brightness of coloured films.

Gloss

Increasing dispersion has been shown to give marked increase in gloss, i.e. specular reflection, and marked decrease in haze, i.e. diffuse reflection⁴.

Gloss retention

Our work has also shown that once the particle size of a pigment is reduced below a certain level, the initial improvements in gloss and haze mentioned above are maintained over considerable periods of time⁴.

Transparency

It was found qualitatively that transparency increases with dispersion.

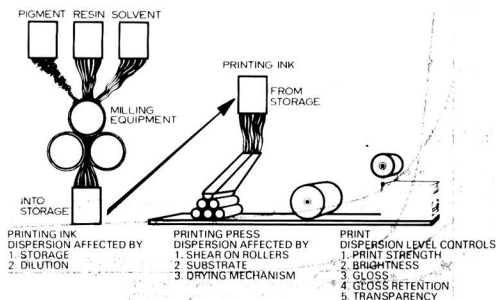


Figure 3(b). Flow diagram of pigment to ink

Curves for three pigments dispersed in a typical air drying alkyd resin by ball milling are shown in Figure 4.

In each case it is seen that during the first four hours of milling, the rate of reduction in particle size is very rapid, although this does vary from pigment to pigment. After 12 hours of milling, the rate of reduction in mean diameter is very slow and the 50 per cent diameter becomes almost but not quite constant. The diameters at which the curves almost level off also vary from pigment to pigment.

The shape of these curves is what would be expected from theory. The mechanical energy breaks the aggregates down rapidly at the start and the particles begin to adsorb resin molecules from the solution. This adsorption helps to stabilise the smaller aggregates and to prevent them from re-aggregating. The smaller aggregates are less easily broken down further by mechanical means and they also have a greater tendency to re-aggregate because, as they are reduced in size, they can approach each other more closely and the forces of attraction increase. To achieve stabilisation more resin must be adsorbed.

Although the three curves illustrated follow the same pattern, they differ from each other in detail because the affinity of the resin molecules for the pigment surface varies from pigment to pigment.

Pigment modifications

If the surface characteristics of any particular pigment are

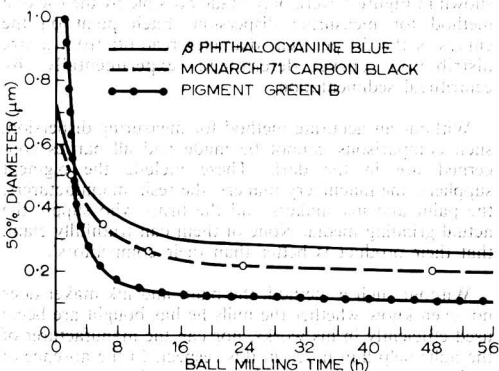


Figure 4. Particle size versus ball milling times for three organic pigments (Beckosol P470 stainers)

modified during manufacture or by an after-treatment, then more or less resin may be adsorbed and this will alter the size level at which the system becomes stabilised.

We can therefore summarise the effect of the pigment in making a good dispersion as follows: in non-aqueous systems the stabilising mechanism preventing re-aggregation is usually the adsorption of the resin on to the surface of the pigment and this explains why breakdown of pigments is rapid at first and then approaches a limiting value. All organic pigments follow this general pattern but differ in detail because they differ in surface properties. If the surface characteristics of the pigment particles are altered, this will affect both the speed and extent of the resin adsorption and consequently the rate of dispersion and the final level of dispersion.

Influence of the resin

Ref. 3

From the above it may be expected that different resins will have different affinities for the same pigment surface and hence different stabilising actions. These expectations have been confirmed experimentally³ on a limited scale.

Comparing ink and paint resins, a calcium-4B metal salt behaves quite differently in publication gravure resins than in alkyd resins, both in the initial rate of breakdown of aggregates and the final limiting level of dispersion, Figure 5. In the ink, the 50 per cent diameter is reduced to 0.17 micron after only six hours ball milling, but prolonged grinding does not reduce the mean diameter further.

In the paint stainer, the breakdown of the aggregate proceeds more slowly and a 50 per cent diameter of 0.17 micron is only reached after 30 hours milling. On further milling however, this 50 per cent diameter keeps on decreasing, albeit slowly.

A tentative explanation of these results is based on two assumptions. Firstly, that any particular resin molecule will exert its maximum stabilising action when adsorbed on to a particle of a certain size, and secondly, that a major difference between the ink and the paint resin, apart from their affinities for the pigment surface, lies in their homogeneity with respect to the chain lengths of their respective molecules.

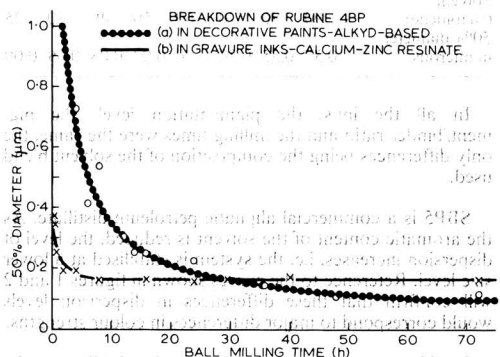


Figure 5. Particle size versus ball milling times for a calcium 4B metal salt in alkyd and calcium-zinc resinates

Alkyd resins usually consist of a wide spectrum of molecular weight fractions, which means that their molecules have a wide range of chain lengths, they can thus stabilise a wide range of particle sizes.

In a typical commercial calcium-zinc resinate resin, however, the range of molecular weight fractions is very narrow. This means that only a narrow range of molecular chain lengths is present and therefore only a narrow range of particle sizes is efficiently stabilised.

This explanation would account for the differences between the two curves shown in Figure 5. The resinate molecules, although they have a greater affinity for the pigment than those of the alkyd resin molecules, are only capable of fully stabilising molecules in the region of 0.17 micron.

The dispersing and stabilising action of a resin is dependent on the speed and extent to which it is adsorbed on to pigment surfaces. Resins differ from each other in these properties. The actual size level at which particles are stabilised will be determined by the homogeneity of chain lengths of the resin molecules.

Influence of the solvent

It will be clear from the above that in paints, as in inks, the resin has two functions. Besides being the film forming component, it also has to stabilise the pigment dispersion. For the first it has to remain in solution; for the second it has to be adsorbed on to the pigment surface from the resin solution.

One could expect, therefore, that the solubility of the resin in the solvent would have some effect on the extent to which it is adsorbed by the pigment surface and this has been confirmed experimentally.

The most striking examples have been found in liquid inks, and a typical set of results is given in Table 1.

Table 1
Calcium 4B publication gravure inks
calcium-zinc resinate in toluene/SBP5 blends

Solvent (% toluene) 50% diameter in microns	24 hour ball millings							
	90	80	70	60	50	40	30	25
	0.37	0.35	0.30	0.10	0.07	0.08	0.09	0.09

In all the inks, the pigmentation level, the pigment/binder ratio and the milling times were the same, the only differences being the composition of the solvent blend used.

SBP5 is a commercial aliphatic petroleum distillate. As the aromatic content of the solvent is reduced, the level of dispersion increases, i.e. the system is stabilised at a lower size level. Reference to the curves shown in figures 1 and 2 will confirm that these differences in dispersion levels would correspond to major differences in colour strengths.

In this system, the resin has good solubility in the aromatic component of the solvent blend but is virtually

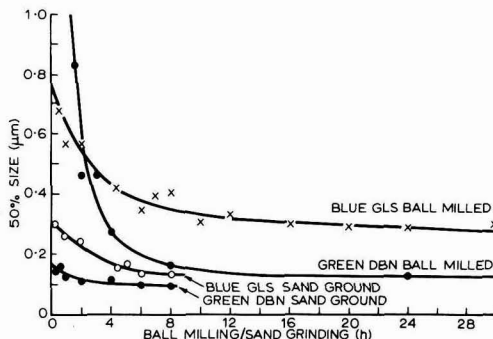


Figure 6. Sand grinding versus ball milling

insoluble in the aliphatic component. Consequently, in the blends rich in toluene, the solvent tends to reduce the extent to which the resin is adsorbed onto the pigment. The stabilising effect is therefore reduced, and the level of dispersion reached is coarser. As the toluene content is reduced, the solubility of the resin is reduced. More resin is then adsorbed giving a better level of dispersion.

It must be assumed from evidence such as this that the solvent *can* have a very significant effect on the level of dispersion achieved in a paint or ink depending on the affinity of the resin for the pigment surface and its solubility in the medium.

Influence of milling machinery

Paints and inks can be made on a wide variety of dispersing machinery.

There is little published data on how the various types of mills compare with each other in their dispersing efficiency, but it would be naïve to assume that they are all equal. Work carried out with paint stainers in laboratory ball mills and sand grinders shows that these two types of mills differ markedly from each other both in their initial rates of dispersion and in their final levels of dispersion achieved, Figure 6. Despite these differences in detail, the same general pattern is found with both milling techniques.

The comparisons of ball milling and sand grinding shown in Figure 6 were only made possible by the use of a method for measuring dispersion. Each point on the curves is the 50 per cent diameter read-off from a size distribution curve determined experimentally by centrifugal sedimentation.

Without an accurate method for measuring dispersion, such comparisons cannot be made and all parties concerned are in the dark. These include the pigment suppliers, the machinery makers, the resin manufacturers, the paint and ink makers and the firms who supply the actual grinding media. None of them can truthfully claim that their product is better than their competitors'.

Without such a method, the paint and ink maker does not even know whether the mills he has bought are being used efficiently in his works, nor can the manufacturer of the mills help him much in this respect. In the absence of such a method, all the parties have to rely on experience, guesswork, intuition and sometimes imagination.

Experience is not a factor to be ignored, but neither will it always supply the correct answer.

Grind gauges

Ref. 5

The criticism of the paint and ink industries implicit throughout this paper is that they do not control the level of pigment dispersion in their products, and that this lack of control of dispersion results in a wide area of ignorance. The industries may defend themselves by pointing to the widespread use of grind gauges for measuring dispersion. It has been appreciated for a long time, however, that such gauges only reveal the presence of individual giant over-size particles in paints. They do not give any information on the mean level of dispersion in the paint. The limitations of grind gauges for measuring dispersion were critically exposed by Valentine⁵ in 1963 when he was then Director of the Paint Research Station in England.

Effect of storage on dispersion

After a paint or ink has been made and passed as being up to specification, even though the dispersion level of the pigment is unknown, there must inevitably be a time interval before it is used. What will happen to the level of dispersion during this time? Are changes likely to occur, and if so, can they be prevented?

In the author's view, the determining factor is whether the pigment particles or aggregates are in the true colloidal state or not. If they are in the true colloidal state there will be a perfect balance between the forces of attraction and repulsion, and the particles will be so small that they will be prevented from settling by Brownian motion. If the particles are outside the true colloidal state, even by only a small degree, the balance between the forces of attraction and repulsion will not be perfect and there will be a gradual coarsening of the particles leading to a loss of colour strength and gradual sedimentation.

Unfortunately, even academic literature is uncertain about the upper size limit for the true colloidal state, but we believe that for organic pigments, this upper limit is between 0.2 and 0.3 micron. Pigment particles smaller than this will be inherently stable and will therefore not coarsen on standing. Particles larger than this will not be completely stable and will coarsen slowly on standing. This effect is illustrated in Figure 7 for a phthalocyanine blue paint stainer, which shows particle size distribution curves initially and after standing for seven months. The curves are identical to the left of 0.2 micron but differ to the right of it, becoming coarser on standing.

If this view of storage is accepted, then for the dispersion level of a pigment in a paint or ink to be stable indefinitely during storage, all the particles should be smaller than say 0.3 micron, as this will ensure that all the particles will be in the true colloidal state. This has been verified for several pigments in paints and also for pigments in liquid inks, where the position is not complicated by the presence of thixotropy.

Application of paints and inks

Effect of thinning

Before any paint or ink is used, the operator may feel it incumbent on him to thin the paint. Thinning or dilution of

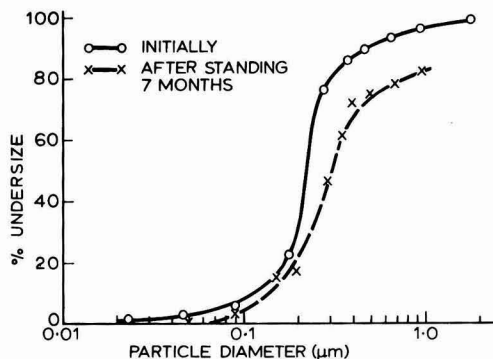


Figure 7. Size distribution curves for a phthalocyanine blue stainer — initially and after storage (48 hours milling)

any nature involves the risk of coarsening the pigment dispersion by means of a phenomenon usually referred to as "dilution shock". As had been previously stressed, pigment dispersions in the sub-micron range represent equilibrium systems, and the equilibrium can be disturbed by dilution. Even if the disturbance is only temporary, by the time equilibrium is restored some of the adsorbed layer may have been removed allowing some flocculation of the pigment to occur.

Practical ways of avoiding dilution shock are to carry out the dilution slowly, in stages if necessary, with agitation and to add some resin or surfactant to the diluting liquid. By this means the risk of stripping some of the adsorbed layer from the pigment surface is minimised.

In the author's experience, the risk of dilution shock varies in extent from pigment to pigment in any particular system. The finer the original dispersion is, the better it is able to withstand dilution and vice versa. This is not surprising as the better the dispersion, the greater affinity of the resin for the pigment and the less likely it is to be stripped off by dilution.

Application

In discussing the possible effects on dispersion level of the methods of application, there is only time here to discuss application by hand, and application by spraying and dipping.

It is known that with some decorative paints heavy brush-outs will give a deeper shade than light brush-outs. Blue shades used to be noted for this defect even when other shades based on the same systems did not give the trouble. It was commonly assumed that the defect was caused by the flocculation of the blue pigment. Nowadays it is believed that heavy brushing applies considerable shear and can improve the level of dispersion of the blue pigment, if it is only moderately dispersed, and thereby increase the colour strength significantly. If the dispersion level of the blue pigment in the original paint is improved, then heavy brushing will no longer be able to improve the level of dispersion and the defect disappears.

Similarly, when industrial paints are applied by spraying and dipping, the sprayed film is often found to be stronger tinctorially than the dipped film. This extra strength may well be due to the extra shear experienced by

the pigment in the spray gun giving better dispersion and hence a stronger colour. As in the case of brushing, if the original pigment is well dispersed, the extra shear in the spray gun will not produce better dispersion. With stoving or baking paints, however, the problem is complicated by the effects of rapid solvent evaporation, a factor which will be discussed later.

Flooding

Many air drying, decorative paints are based on titanium dioxide in conjunction with an organic pigment. On application, especially in thick films, either the white or the organic pigment may "flood" or "float" to the surface, giving a surface layer which is paler or stronger than the interior of the film. Various explanations have been put forward from time to time to explain this phenomenon but without convincing supporting evidence.

A simpler explanation is that the levels of dispersion of the two pigments are markedly different and their mean diameters differ considerably. Consequently, whilst the film is still wet there is a slight separation of the two pigments due to their differing rates of sedimentation. The finer pigment would be richer at the surface and would alter the colour strength accordingly. Certainly the phenomenon can be reversed by reversing the relative levels of dispersion of the two pigments as is shown in Table 2.

Table 2
*Air drying, decorative alkyd-based white paint
tinted with a phthalocyanine blue stainer*

Dispersion level of white base	poor	good	good
Dispersion level of blue stainer	good	poor	good
Flooding	blue flooding	white flooding	none

These dispersions were obtained by varying the grinding times, the actual levels of dispersion were not measured. Dispersion measurements carried out on both the blue and white pigments would enable this explanation to be checked.

Effect of substrate

It is possible that the nature of the substrate, particularly its porosity, may affect the level of dispersion of the pigment in the final paint or ink film on the surface of the substrate. Such an effect could be brought about by the substrate acting as a filter for the fine particles. In practice, porous substrates can be treated with a sealing coat, but even here it is probable that the sealing efficiency is related both to the mean diameter and the particle size distribution of the solid particles in the sealer coating. This relationship cannot be determined without a method for measuring sizes and size distributions.

Effect of drying mechanisms

Refs. 4, 6

Once a paint or ink film has been laid down on a substrate it starts to dry, and the end result is dispersion of pigment particles in a solid resin film. For any given pigment and film thickness and pigmentation level, the colour strength

and other optical properties of the film are very dependent on the dispersion level of the pigment particles in the film (see the curves in figures 1 and 2). It is commonly assumed that this final dispersion level is the same as that in the original bulk paint or ink, but it is pertinent to ask whether this assumption is justified, especially in rapid drying systems.

It is believed that with industrial baking enamels some flocculation of the pigment takes place on drying, and there is experimental evidence supporting this.

This belief that flocculation takes place on drying arises from the differences between the curves of colour strength versus particle size obtained for a given pigment in different systems.

In Figure 8 a curve of colour strength in the film versus particle size in the wet paint is shown for a dioxazine violet in an air drying alkyd-based decorative paint. This curve is identical, within experimental error, to the theoretically predicted Mie curve for this pigment. The Mie curve is a plot of colour strength in the film versus particle size in the film. This agreement between the theoretical and experimental curves supports the view that particle sizes in the wet paint remain the same on drying. This type of agreement has also been found for at least six other pigments in this type of system.

Figure 9, on the other hand, shows the experimental curves of colour strength versus particle size obtained for the same violet pigment in a melamine-formaldehyde (M/F) baking enamel applied by both spraying and dipping. The curves for the spraying and dipping applications are different from each other and are both different in shape from the corresponding curve for the same pigment in the air drying paint. These differences can be explained if it is assumed that, with the baking enamel, some flocculation of the pigment takes place on drying⁶.

The suspicions aroused by these results need more direct experimental evidence before they can be confirmed. For this purpose, dispersion measurements have to be carried out on wet paints and the dry films obtained from them by a method that is applicable to both wet and dry systems. One such method is the measurement of optical densities and the calculation of extinction coefficients; this technique has been applied to a small number of baking enamels.

In essence it involves plotting curves for extinction coefficients versus particle sizes for the wet paints and the dry films derived from them. If there is no flocculation of the pigment on drying the two curves should be identical, within the limits of experimental error.

The results for the industrial M/F baking enamel based on a dioxazine violet are shown in Figure 10.

It will be seen that the curves for the wet paint differ considerably from the curves for the corresponding dry films in the level of the values of the extinction coefficients, the curves for the dry films being the lower ones. It is believed that the lower values for the dry films demonstrate that the level of pigment dispersion in them is appreciably less than that in the wet system.

The same type of experiment has been carried out on pigments in air drying alkyd-based decorative paint stainers. Films of these stainers or tinters dry slowly,

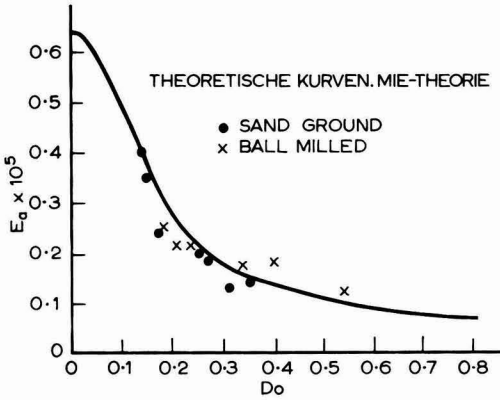


Figure 8. Extinction coefficient (colour strength) (k/s) versus particle size for a dioxazine violet alkyd stainer (a) according to Mie theory, (b) experimentally determined

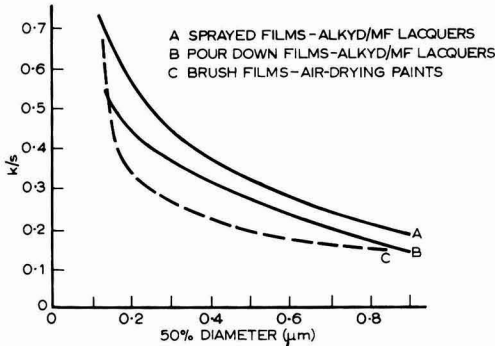


Figure 9. Colour strength (k/s) versus particle size for dioxazine violet in a baking enamel (1:75 reduction)

mainly by oxidation. The results for a calcium 4B metal salt and a β -phthalocyanine blue are shown in figures 11 and 12 and it will be seen that, in each case, the curves for the wet paints and dry films are identical.

These results confirm the soundness of the experimental approach and indicate that with slow drying systems, where the mechanism is one of oxidation, there is no flocculation of the pigment on drying. They also confirm the belief that where a system dries rapidly, mainly by evaporation of solvent, there is some flocculation of the pigment on drying.

This belief has also been strengthened by similar results obtained with printing inks⁴.

That flocculation of the pigment can take place during rapid drying by solvent evaporation should cause no real surprise. The equilibrium nature of dispersions in the wet state has been stressed as well as the vulnerability of this equilibrium to external influences. Dilution shock is a familiar example. Very rapid drying by solvent evapora-

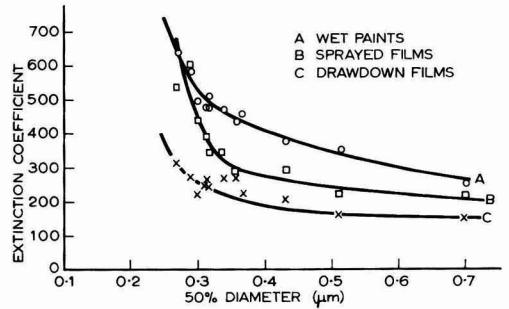


Figure 10. Extinction coefficient versus particle size for a dioxazine violet in a baking enamel - wet paints and dry films

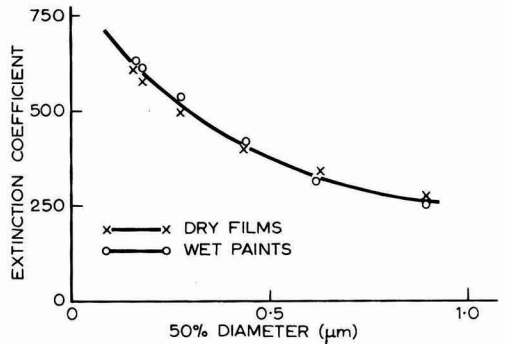


Figure 11. Extinction coefficient versus particle size for a calcium 4B metal salt in an air drying alkyd - wet paints and dry films

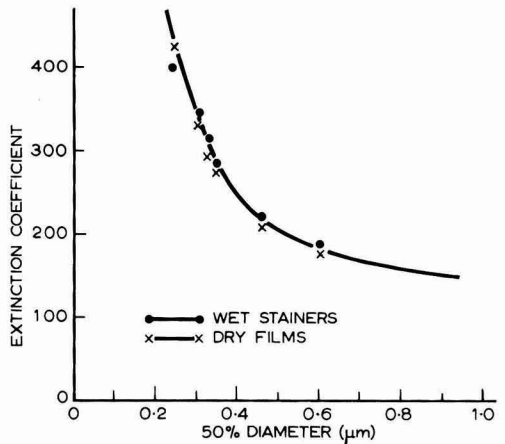


Figure 12. Extinction coefficient versus particle size for a beta-phthalocyanine blue in an air drying alkyd - wet paints and dry films

tion must set up considerable physical forces in the wet films as they dry and these could well upset the dispersion equilibrium. Such rapid evaporation could be expected to give rise to some flocculation in the pigment by "evaporation shock", analogous to dilution shock.

If water is considered as a solvent, then drying by solvent evaporation is a vital mechanism with many paints and inks. If such a mechanism does give rise to pigment flocculation, then the extent and control of such flocculation would appear to be an important field of study, bearing in mind that it is the dispersion level of the pigment in the final dry film which controls the optical properties of the film. Such a field of study must rely heavily on the experimental measurement of dispersion.

Discussion

The above review of the paint and ink making application processes, although it has dealt only with organic pigments, has demonstrated the triple importance of dispersion levels.

1. Dispersion levels, of themselves, control the application properties of paints and inks such as stability on storage and flow properties, as well as the optical properties of the final films. Once the mean diameter of the pigment particles is reduced to 0.5 micron, further reductions in size give major improvements in storage properties and in optical properties, such as strength, brightness, gloss and gloss retention. Improved dispersion may also give major increases in apparent viscosity but these increases may be deleterious to the flow properties of the product.

2. The actual level of dispersion achieved in a paint or ink during manufacture is dependent on the physical properties of the pigment and the affinity of the resin molecules for the pigment surface. The dispersing efficiency of any given resin is dependent on its molecular weight spread and on its solubility in the liquid phase. Again the extent of the effects can be considerable.

The dispersion level achieved in the freshly made product is dependent also on the type of dispersing equipment used, the time for which it is run and the method of operating it.

3. Once a paint or ink has been made, the dispersion level achieved is not necessarily stable on storage, application or drying. The dispersion can coarsen on standing or by dilution; it can be increased by heavy shear during application; and it can be severely reduced if the drying mechanism is one of rapid solvent evaporation.

With organic pigments, therefore, it should be clear that the dispersion level of the pigment is a parameter which is important in every aspect of paint and ink manufacture and application. It is likely that the same will hold true for inorganic pigments and particularly for titanium dioxide.

Acknowledgement

Most of the experimental results quoted in this paper were obtained whilst the author was employed by the Pigments Division of Ciba Ceigy (UK) Ltd in Manchester, England. The interpretations of the results and the views put forward in the paper represent the author's own opinions; he is now retired.

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Radiation polymerisation as a tool for the surface coatings industry*

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Summary

The use of radiation polymerisation as a processing tool for the surface coatings and related industries is discussed in terms of both grafting reactions and rapid cure technology. In grafting systems, relatively lengthy reaction times are usually required whereas with rapid cure treatments the process is completed in a fraction of a second. These radiation processes can be initiated

by electron beam (EB), gamma rays from cobalt 60 sources and sensitised UV. The relative merits of each of these initiators for typical industrial applications is considered. The future commercial potential of the radiation polymerisation technique is discussed with particular emphasis on EB rapid cure technology.

Keywords

Processes and methods primarily associated with manufacturing of synthesis

graft polymerisation

drying or curing of coatings

electron curing
polymerisation
ultraviolet curing

Polymérisation par radiation – un outil de valeur pour l'industrie de peintures

Résumé

On discute, en termes à la fois des réactions de greffage et de la technologie de durcissement rapide, l'emploi de polymérisation par radiation en tant qu'outil de confection pour l'industrie de peintures et des produits assimilés. Dans le cas des systèmes de greffage, les durées de réaction assez longues sont à être attendues en générale, tandis qu'en ce qui concerne les techniques de durcissement rapide le processus est achevé dans une fraction de seconde. Ces processus de radiation peuvent être

assurés par faisceaux d'électrons, rayons gamma à partir des sources de cobalt-60, et par les rayons ultra violets. On considère la valeur relative de chacun de ces initiateurs par rapport aux applications industrielles typiques. On discute, à l'égard particulier de la technologie de durcissement rapide par faisceaux d'électrons, le potentiel commercial à l'avenir de la technique de polymérisation par radiation.

Strahlungspolymerisation als ein Werkzeug für die Lackindustrie

Zusammenfassung

Vom Standpunkt der Propfpolymerisationsreaktionen und der Schnellhärtungstechnologie wird die Anwendung der Strahlungspolymerisation als ein Verarbeitungswerkzeug für die Lack- und verwandten Industrien diskutiert. Die Propfsysteme erfordern gewöhnlich eher lange Reaktionszeiten, während in Falle Schnellhärtungsvorgänge der Verfahren im Bruchteil einer Sekunde vollendet wird. Diese Strahlungsverfahren können von

Elektronenstrahlen, oder aus Kobalt-60 quellen vorkommende Gammastrahlen, oder sensibilisierte Ultravioletstrahlen begonnen werden. Die relativen Werte jeder dieser. Initiatoren werden für typische Industrieanwendungen überlegt. Die zukünftige Leistungsfähigkeit der Strahlungspolymerisationstechnik wird mit besonderer Betonung auf die Elektronenstrahlen vorkommende Schnellhärtungstechnik diskutiert.

Introduction

The current world energy crisis has prompted research workers in the surface coatings and related fields to examine the use of alternative paint and varnish systems which do not contain solvents. Radiation is a convenient initiator for the synthesis and curing of novel resins which are essentially 100 per cent solids and can be used as the basis of new formulations for the coatings industry. Both ionising radiation and UV have been used extensively in this work, the two initiating techniques tending to complement each other rather than to be in competition.

Two types of radiation processing systems involving polymerisation reactions are of commercial significance. These are grafting and the so-called rapid cure reactions. The time scale associated with the polymerisation essentially serves to separate the two systems. In grafting work, minutes and even hours of irradiation time can be involved in the reaction, whereas in rapid cure processes the polymerisation is complete within a fraction of a second. Most rapid cure systems essentially involve homopolymerisation, however during these reactions some grafting to a substrate, if present, may occur, such copolymerisation tending to enhance the physical

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properties of the resulting product. By contrast, in grafting processes, the predominant purpose is to form a true carbon-carbon bond between monomer and/or polymer being grafted and backbone polymer. Frequently, solvents are used in grafting systems to wet and swell the backbone polymer and thus improve grafting efficiency, whereas rapid cure processes are essentially solvent-free.

Grafting reactions

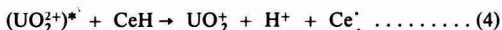
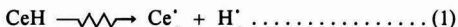
Refs. 1-15

Types of systems

The types of grafting systems available for use have been reviewed¹⁻⁶. These include: (i) The simultaneous or mutual irradiation method, where the trunk polymer is irradiated whilst in direct contact with the monomer which may be present as vapour, liquid or as a solvent solution. (ii) The pre-irradiation procedure, where polymer is irradiated with O₂ excluded or in the presence of an inert gas then removed from the radiation facility and reacted with monomer, usually at elevated temperature, to achieve grafting. (iii) The peroxidation method, where the polymer is irradiated in air or oxygen to yield stable di-peroxides or hydro-peroxides which can subsequently be decomposed with monomer to form graft copolymer. (iv) The direct crosslinking of two polymers in intimate mixture by irradiation. (v) The prepolymer technique where preformed oligomers of low molecular weight (≈1000 - 3000) are reacted with a second monomer/oligomer. Of these methods, the first two processes are the most widely used, with the predominant work being performed with the simultaneous technique.

Types of initiators

Grafting reactions can be initiated by ionising radiation¹⁻⁶ or UV⁷⁻¹². In the former method, both cobalt 60 (preferred) and EB techniques are utilised, whilst sensitised UV is the most useful procedure in the latter case since the presence of sensitizer significantly enhances rates of polymerisation. Grafting curves for a typical system, namely styrene in alcohols to cellulose, are shown in Figure 1. Data for both cobalt 60 and uranyl nitrate sensitised UV copolymerisation reactions are similar in many respects. Thus, each exhibits a Trommsdorff of gel peak at a particular monomer concentration; grafting is most efficient in the lower molecular weight alcohols, i.e. those which wet and swell the trunk polymer. The gel peak is of practical significance since the absolute grafting yield is highest at this point. The position of the gel peak changes from the cobalt 60 system (30 per cent monomer) to the UV system (90 per cent), reflecting the additional diffusional problems associated with activation of the trunk polymer in the latter case. The mechanisms of grafting are similar in both systems (equations (1)-(4)), involving free radical activation of the trunk polymer (CeH), followed by reaction with monomer. Equation (1) depicts gamma ray activation whilst the remaining equations show the uranyl nitrate sensitised pathway with UV.



UNBROKEN LINE:
 GAMMA RAY GRAFTING OF STYRENE
 IN ALCOHOLS TO CELLULOSE.
 DOSE: 0.2 x 10²⁰ rad AT 0.008 x 10⁶ rad/h
 —■— METHANOL, —●— OCTANOL, —▼— n-PROPANOL,
 —▲— ISOPROPANOL, —◆— n-BUTANOL

BROKEN LINE:
 UV GRAFTING OF STYRENE IN
 ALCOHOLS TO CELLULOSE WITH
 URANYL NITRATE AS SENSITISER.
 (CONDITIONS AS IN REFERENCE 11)
 —○— METHANOL, —▽— ETHANOL,
 —□— n-PROPANOL, —△— ISOPROPANOL,
 —◇— n-BUTANOL

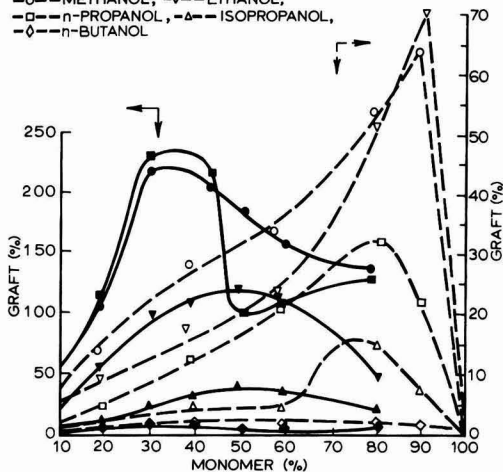


Figure 1.

Enhancement in grafting efficiency

Methods for enhancing grafting yields or reducing competing homopolymer formation are important. With ionising radiation systems, many trunk polymers are radiation sensitive and thus any procedure for reducing the total dose absorbed by the polymer to give a particular percentage graft is of value. Inclusion of additives for this purpose have been proposed. Thus, addition of mineral acid¹³ in small amounts to a monomer solution can enhance grafting considerably as the data in Figure 2 show, where the presence of low concentrations of mineral acids enhance the grafting yields of styrene in methanol to polyethylene. The mechanism of acid enhancement is thought to be due to an increase in G(H) yields, due to interaction of H⁺ with the secondary electrons in the system. It is also known that inclusion of ions such as Cu²⁺ or Zn²⁺ can reduce homopolymer formation in these reactions¹⁴. Co-monomer methods for achieving the same result have also been developed¹⁵.

All of these techniques for improving grafting efficiency are applicable to a large range of monomers with or without solvent and also a wide variety of trunk polymers.

Application of grafts

A major area where radiation grafting is of commercial

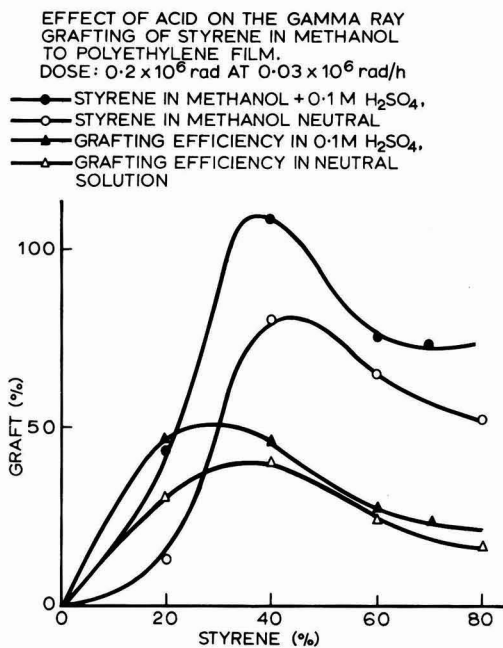


Figure 2.

value is in the use of the technique to change the surface properties of polymers, especially for applications in the paint and varnish industry. Other important uses are in composites, medical uses, especially for bio-compatibility, and flame proofing of substrates. Thus, surfaces can be rendered hydrophobic, hydrophilic, solvent resistant, alkali and acid resistant by one-step radiation grafting methods.

In addition to the surface coatings uses, there are applications in related areas. Thus, specific functional groups can be incorporated into a surface by grafting a monomer with the appropriate functionality, yielding methods for the synthesis of new ion exchange resins^{2,6}, and also a procedure for immobilising enzymes and anchoring catalytically active complexes⁶.

Rapid cure processing

Refs. 6, 16

In contrast to the grafting systems which may involve relatively lengthy irradiation times and the inclusion of solvents or other additives to optimise the copolymerisation, the rapid cure techniques are fast and essentially

solvent-free. The predominant radiation sources used for these systems are EB and sensitised UV since cure times of up to 0.01 second may be required. To achieve these cure times, partially polymerised monomers or prepolymers have been developed using novel techniques including radiation itself⁶. Commercial prepolymers prepared by chemical methods are also available. The inclusion of an acrylate group is frequently a useful chemical method for inducing radiation cure in prepolymers. Thus, epoxy acrylates, polyester acrylates and urethane acrylates all with molecular weights of 1000-3000 are commercially available for this purpose. These materials are usually combined with poly-functional acrylate monomers to adjust the viscosity of the rapid cure mixture for application purposes. Such formulations are thus solvent-free with no environmental pollution problems or the necessity to install solvent recovery plant.

For many rapid cure applications in the surface coatings field, the effect of radiation is essentially to homopolymerise a thin film of prepolymer onto the backbone substrate. The properties of many such finished materials can be significantly improved if some grafting occurs at the polymerising interface. Such copolymerisation can enhance properties of flexibility, adhesion and thermal stability. The author has carried out the rapid curing of mixtures of monomer/prepolymer onto cellulose and polypropylene using both EB and sensitised UV. A novel tritium labelling technique was used to show that some grafting, although low (1.2 per cent), did occur in both systems⁶. Other rapid cure processes using both EB and sensitised UV have been found where the grafting yields are high⁶. Such results are important since one of the major problems with this rapid cure technology is whether to use EB or UV. The fact that for certain reactions grafting may occur in only one or two of the two techniques can determine which of the two processes is to be used. Where grafting can occur simultaneously with cure, EB generally gives higher grafting yields and is to be preferred. This result may reflect the degree to which ionic mechanisms can influence the grafting since only with ionising radiation are such processes possible.

Applications of rapid cure

Table 1 lists a range of common applications of the rapid cure technology in the surface coatings and related industries. Most of the applications listed use UV facilities at the present. However, a number of EB lines are on stream in these areas with predominantly low energy (200-400kV) beams of electrons, which are ideal for coatings applications.

In the cellulose field, UV has been an established technique for a number of years especially with timber, paper and cardboard products. Recently in the US a very successful commercial EB line was installed for record cover production, an area previously served by UV. With

Table 1
Typical applications in surface coatings and related industries of UV and EB rapid cure processes

Cellulosics	Metals	Printing	Miscellaneous	Research
Overproof varnish - paper	Decorating Protection	Packaging Flexo	Floor tiles PSA	Coil coating Polyolefins, PVC
Record covers	Circuit boards	Screen	Fibre optics	Leather
Timber			Magnetic tapes	

metals, established radiation processing lines are on stream in the fields of decorating, circuit boards and protection, particularly corrosion. Printing is also a traditional UV field for processing, especially screen printing. However, the first industrial EB line for printing has recently been installed. Other established UV processing fields are floor tiles, pressure sensitive adhesives and fibre optics, whereas magnetic tapes are becoming an EB application.

Finally, in the research areas, coil coating still remains a very large field with great potential for EB. Shrinkage of film during fast cure still raises problems to be solved in this application. Adhesion of radiation cured coatings to polyolefins and PVC could be improved to a lesser extent, and with this development this area will expand. On leather, UV cured coatings have been developed and are currently being evaluated against the traditional finishes. Many other research areas, particularly using EB, are currently being explored. For the surface coatings and related fields, low energy EB is favoured since for most of this type of work, deep penetration of the substrate is not required and electron energies up to 400 kV are eminently suitable.

Conclusions

Radiation processing of polymers with both UV and EB is continuing to make inroads into the traditional surface coatings areas previously covered by chemical methods. With grafting – where relatively lengthy irradiation times (as with cobalt 60 type work) are needed – in the present world economic climate, new industrial applications appear to be confined essentially to speciality products designed for specific purposes. With rapid cure UV and EB, however, there are the additional advantages associated, not only with environmental and energy considerations, but also in yielding products with novel and improved properties, e.g. improved gloss and toughness. This type of radiation processing will thus continue to make steady penetration into the traditional market pre-

viously supplied by products of the conventional chemical processes. In particular, EB type processes will become more economically attractive to industry, not only because the resins are potentially cheaper than those for UV, since no sensitiser is needed, but also because line speeds can be much faster. EB will be even more viable as the need to process under inert atmosphere gradually disappears.

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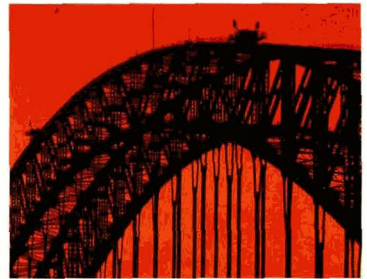
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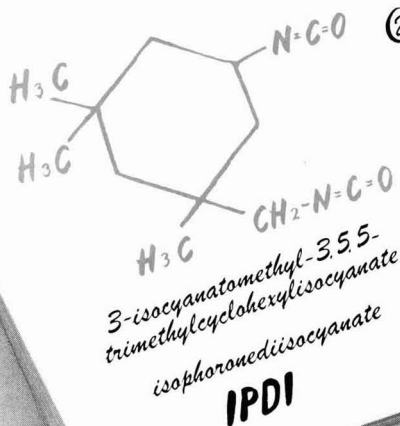
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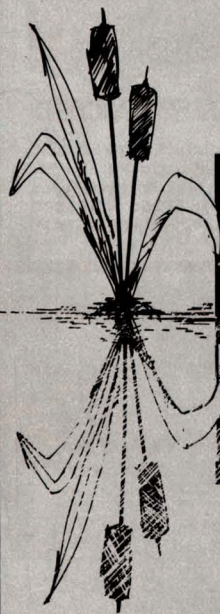
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CHEMICALS

Refinishing today – legislation, implied and statutory*

By K. P. Kozma

Burntwood Engineering Co Ltd, Mount Road, Burntwood, Walsall WS7 0AU, England

Summary

The Codes of Practice relating to the Health and Safety at Work Act 1974 are discussed as they apply to the car refinishing industry.

The main hazards are toxicity and flammability towards both the operatives in the factory and towards the general public in the environment.

High rates of airflow and freedom from objects which might impede the airflow in spray booths are essential.

Dry spray booths must be avoided because they are a potential source of fire; efficient water-washing is strongly advocated.

Keywords

Properties, characteristics and conditions primarily associated with

materials in general

toxicity

Miscellaneous items

*fire hazard
fire prevention*

Equipment primarily associated with

application of coatings and allied products

spray booth

drying or curing of coatings

ovens

Le repeinturage d'automobiles à l'heure actuelle. La législation implicite et réglementaire

Résumé

On discute, à l'égard de l'industrie de repeinturage de voitures, les Codes de la Pratique afférents au Health and Safety at Work Act, 1974.

En ce qui concerne les ouvriers dans l'atelier et le grand public aux alentours, les principaux risques sont la toxicité et l'inflammabilité des produits utilisés.

Il est absolument nécessaire d'assurer un taux élevé de débit

d'air aux cabines de pistolage et d'y éliminer tout objet qui risque d'entraver la libre circulation de l'air.

On ne doit pas se servir des cabines de pistolage sèches, parce qu'elles présentent une source éventuelle de feu et par conséquent, la provision d'un système efficace d'arrosage des parois est fortement conseillée.

Das Autolackieren der Gegenwart. Andeutens und gegebene Gesetze

Zusammenfassung

Die Praxiscodex hinsichtlich des Health and Safety at Work Act, 1974 wird im Falle der Autolackierenindustrie besprochen.

Gegenüber den Arbeitern im Betrieb und dem allgemeinen Publikum in der Umgebung, sind die Giftigkeit und der Entflammbarkeit der angewandten Produkte die Hauptgefahren.

Es ist durchaus nötig in Spritzkabinen einen hoch

Luftdurchfluss zu beschaffen, und jeden Gegenstand beizuseitigen, der dort den Luftdurchfluss hindern könnte.

Weil sie eine potentielle Feuerquelle bilden, müssen Spritzkabinen ohne Spülwassermöglichkeiten vermieden werden und deshalb wird gut funktionierendes Wasserspülen strengst beraten.

The title of this paper may be rather misleading. It is not intended to give precise legal definitions or citations of endless passages, but rather to look at factors that the engineer considers when designing equipment used for application in the refinishing industry.

Hazards arise in connection with refinishing which is defined as the operation where paint or paint-like substances are applied to protect or enhance a product following accident damage, for a change of colour or other reasons. The very heart of the operation is the safe

*Paper presented at the Thames Valley Section's "Vehicle refinishing" seminar held on 22 October 1981.

working zone e.g. spray booth, room or other suitable enclosure with its ventilation; health and flammability hazards will usually be present.

Generally speaking the refinisher will come into contact with:

- (i) The factory inspectorate – which is concerned with what goes on in a place of work and its safety.
- (ii) The environmental health officer who is responsible for emissions from the workplace and to what extent they may effect the public.
- (iii) The fire officer in fire prevention – who is responsible for issuing safe access certificates and often for granting petroleum licences.

Most of us by now have recovered from the shock waves caused by the Health and Safety at Work Act which received Royal Assent two years after the Robens Committee published its recommendations in connection with safety and health.

The Act in question makes provision for Codes of Practice approved by the H & S (Health & Safety) Commission. These Codes of Practice will require the consent of H.M. Secretary of State to safeguard the interest of Parliamentary control. These codes on the one hand may not have the same effect as regulations but they may be cited in a court of law as evidence.

Stopping short of Codes of Practice the H & S Executive is issuing Guidance Notes to illustrate good practice. For instance, E/H9, published in 1977, has caused and is still causing more problems than it was designed to solve. The lack of clarity could undoubtedly be attributed to the absence of consultation with designers and manufacturers.

For example, it laid down minimum exhaust velocities as 140 feet per minute which should be increased to 290 feet per minute if what is termed particularly toxic materials are used. Now, this could mean that whereas an average booth used in refinishing needs some 0.33 million Btu/h heat in winter, this would have to be increased to nearly 3.5 million Btu/h in the case of particularly toxic materials – a ten fold increase. It was known that some Factory Inspectors actually walked around with instruments to check velocities and implied that statutory powers were in force.

In August 1981 the H & S Executive issued Guidance Note PM25 following consultations with designers, manufacturers, importers and suppliers. The author was present at this consultation which took place on 15 January 1981 at Caxton House. Regrettably, only a handful of manufacturers were present, the remainder were either the same manufacturers' representatives under different names, or agents with more interest in conversion rates from lira and other foreign currencies to pounds sterling than knowing the meaning and importance of flammable limits. Anyway, the note has been published and the industry must comply.

One small consolation is that paragraph 52 relating to spontaneous ignition has been included at the insistence of the author.

Paint spraying is usually carried out in one of the following environments:

- (a) Open air
- (b) Workshop

- (c) Specially constructed spray rooms
- (d) Proprietary spray booths with or without a drying/curing facility.

Modern paints require modern application techniques, and with the increasing use of two-pack paints there is present an irritant likely to create physiological hazards. In this system one component, the catalyst, contains free monomeric isocyanate and an isocyanate pre-polymer. It is now proven that even in grossly over-ventilated spray enclosures, such as mentioned in connection with EH9, there are areas where the air movement is shielded by the component being painted, other equipment present or the operator himself, thus the subsequent inhalation of active isocyanate is probable. For this reason, breathing apparatus must be worn in all circumstances.

Paint application in the open air cannot be acceptable due to the unreliability of atmospheric conditions and the presence of dust, insects etc, and most certainly should be discouraged in workshops, as overspray drift cannot be controlled and whilst the sprayer will adhere strictly to the Paintmakers Association's health warning, unsuspecting operators carrying out other tasks can be exposed to the hazard.

Specially constructed spray rooms can serve a very useful purpose because there is a physical barrier between the paint spraying zone and adjoining areas. They should be constructed of fire resistant or other approved materials, and adequate exhaust ventilation should be provided using systems that do not necessitate the placing of electric motors in the path of vapours. Taking the optimistic view that all these requirements are met, one very important factor remains, that is the air distribution.

It should be recognised that air flow in any ventilated compartment is determined by the position and the design of air inlets and vents by which air is exhausted. However, conventional building techniques do not readily lend themselves to the inclusion of air input plant or filters, and unfortunately the word "adequate" is open to interpretation. When designing a ventilation system the following three basic points are claimed to be good practice:

1. Exclusion of flammability hazards
2. Removal of toxic hazards
3. Ensuring that the operators breathing zone, and not only the vehicle, is ventilated. At the same time attempting to avoid "short circuiting" and maintaining uniform speed of air. Neglecting attention to the latter could lead to the circulation of fibres, lint and dust, thus creating damage to the paint finish.

Taking each one in turn the following recommendations can be made:

Flammability: It is perfectly straightforward to calculate and/or assess the flammable ranges of common materials and the quantities of them that may be present at any one time.

Difficulties can arise when more than one flammable constituent is present. In calculating the actual air volume to be moved, the quantity of air must be sufficient to ensure that the solvent concentration does not exceed 25 per cent of the lower flammable limit.

Toxic hazard: It must be recognised that human beings do

not always behave rationally. They may remove breathing apparatus for instance. Therefore it is necessary to obtain the threshold limit values (see references) for the toxic constituents and to dilute them so as not to exceed the maximum concentration level expressed in ppm.

Where health and life are concerned any effort is worthwhile.

Design of air flow: It is absolutely impossible to arrive at hard and fast rules in determining this particular design parameter. Much experimental data produced by reputable manufacturers are still confidential.

Suffice it to say that down draught airflow is always more successful. The best answer is to use downward air movement, well distributed filters in ceilings for input air and underfloor excavations covered by a grill floor for the exhaust path.

NB: For many years now an arbitrary rate of air movement of some 30-60 air changes per hour has been mentioned in connection with ventilation requirements in areas where paint spraying takes place. Such practice must be discontinued as it does not take into account the solvent emission/evaporation rates, or the possible toxic constituents of the composite materials being applied.

Proprietary spray booths, of course, are preferred with well tried and proven airflow patterns. Unheated spray booths offer very few advantages, nowadays all successful units draw air from the atmosphere and offer consistency of throughput irrespective of summer or winter conditions. Basic design parameters remain the same as those for spray rooms, with added refinements. A totally unnecessary feature, i.e. monitoring of the airflow, may also be necessary according to PM25.

Drying/curing is carried out in ovens designed to operate at 60-80°C. To date the author has not yet seen a successful unit other than of proprietary manufacture. Most of these, apart from some of foreign origin, already incorporate safety features, i.e. explosion relief vents and the monitoring of "strip-off rate" to avoid build up of an explosive mixture. A relatively new concept, and a very sensible one, is to attempt to minimise the risk of pressure build up in fuel tanks by fitting an automatic timer. Whilst discussing ovens it should be noted that at least one plant is offered for sale in this country incorporating a once-through air movement during the curing stage of the single compartment unit. In this, unlike conventional ovens where the air is constantly re-circulated thus offering maximum fuel economy, the airflow is reduced to obtain a higher rate of temperature increase from the heat exchanger. Economies are also made due to the absence of a changeover mechanism and pressure relief vents.

Buyers should be aware of this shortcoming before making a decision as long term fuel savings can be substantial with re-circulating type ovens.

Spontaneous ignition has been mentioned in the Guidance Note. It is not considered that the H & S Executive has gone far enough in the interest of safety in the light of three occurrences reported recently. One took place in Staffordshire and two in Bedfordshire. All three had one thing in common, namely, dry spray booths or dry air paths were in use. Oxidisation can take place with certain two-pack materials and nitrocellulose lacquers. Attention is drawn to the Paintmakers Association booklet, paragraph 2.3 which states "... it is not advisable to spray both cellulose and oil-based synthetic paints in a work room with dry extraction because of the highly flammable nature of the solid residues from the cellulose paint and the possible spontaneous heating of the solid residues from the oil-based paint; a water washed extraction system should be used under these circumstances."

Full water washing at source – on the floor of the booth and not at some point in the system – is the answer.

Part I of the Health and Safety at Work etc. Act 1 – 1(c) refers to controlling the emission into the atmosphere of noxious or offensive substances. Ultimately this means overspray could be termed noxious whilst solvent could be termed offensive. One could argue that anyone venting paint overspray into the atmosphere could be served with an improvement notice or a prohibition notice and be faced with prosecution.

In conclusion, the days when paint shops were fitted only with a flameproof propeller fan have gone. There is writing on the wall, it is an Act of Parliament. To the author's knowledge the part of the Act making reference to noxious and offensive substances has not yet been enforced too rigidly. For the future, there will probably be fewer small refinishers but more, better-equipped professionals who can accept modern technology and still make money.

[Received 19 November 1981]

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The following documents are the most important on the author's shelf. References are made to them directly and indirectly in the text.

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2. "Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972", HMSO.
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PMR spectra of vinyl monomers based on undecanoic acid

By A. V. B. Sankaram, N. G. Kulkarni, N. Krishnamurti* and P. C. Chatterjee

Regional Research Laboratory, Hyderabad-500009, India

Summary

PMR spectra of six vinyl monomers representing the groups: vinyl ether, vinyl ester, allyl ether, allyl ester, methacrylic ester and acrylic ester respectively are discussed. The influence of the

chemical environment on the proton magnetic absorption of the olefinic protons is analysed in detail.

Keywords

Raw materials used in the manufacture or synthesis of ingredients for coatings

monomer

Processes and methods primarily associated with analysis, measurement or testing

spectroscopy

Les spectres de résonance magnétique protonique de monomères vinyliques basés sur l'acide undecanoïque

Résumé

Les spectres de résonance magnétique protonique de six monomères vinyliques renfermant respectivement les groupements suivants, éther vinylique, ester vinylique, éther allylique, ester allylique, ester méthacrylique et ester acrylique ont été

discutés. L'influence qu'exerce l'environnement chimique sur l'absorption du magnétisme protonique des protons oléfiniques a été analysée en détail.

Die protonmagnetischen Resonanzspektre der auf Undekansäure gegründeten Vinylmonomere

Zusammenfassung

Die protonmagnetischen Resonanzspektre der sechs Vinylmonomere, die die folgenden Gruppen, Vinyläther, Vinyl ester, Allyläther, Allyl ester, Methacryl ester, Acryl ester

beziehungsweise enthielten, wurden diskutiert. Der Einfluss der chemischen Umgebung auf die protonmagnetische Absorption der olefinischen Protonen wurden umständlich analysiert.

Introduction

Refs. 1-3

A wide variety of vinyl monomers derived from products based on castor oil were synthesised in this laboratory^{1,2}.

We have also reported³ separation by thin-layer chromatography of six such monomers, each representative of one of the following groups: vinyl ether ($\text{ROCH}=\text{CH}_2$), vinyl ester ($\text{R}-\text{CO}-\text{OCH}=\text{CH}_2$), allyl ether ($\text{R}'\text{OCH}_2-\text{CH}=\text{CH}_2$), allyl ester ($\text{R}-\text{CO}-\text{OCH}_2-\text{CH}=\text{CH}_2$), methacrylic ester ($\text{RCH}_2-\text{O}-\text{CO}-\text{C}(\text{CH}_3)=\text{CH}_2$) and acrylic ester ($\text{RCH}_2-\text{O}-\text{CO}-\text{CH}=\text{CH}_2$).

The present communication deals with the PMR spectra of the simplest representative compounds of this series, viz., the monomers derived from undecanoic acid.

Experimental methods

Ref. 1

Preparation of monomers, viz., undecyl vinyl ether, vinyl undecanoate, allyl undecyl ether, allyl undecanoate, undecyl methacrylate and undecyl acrylate, has been described earlier¹.

PMR spectra of the pure monomers in carbon tetrachloride solution were recorded using a Varian 60MC NMR spectrophotometer. The chemical shifts are reported in δ -values (ppm) with tetramethylsilane as internal standard.

Results and discussion

For all monomers the spectra are consistent with the structures, only the essential features are discussed below:

*To whom all correspondence should be addressed.

C₁₁—(undecanoic and undecyl) residue (figures 1-6)

This is common to all monomers. The methyl protons "a" form a part of an A₃B₂ system and are seen as a distorted triplet, being coupled with the adjacent methylene group, between 0.76 – 0.79. The protons corresponding to "e" constitute an A₂X₂ system due to coupling with protons of the adjacent methylene group, "d" thereby giving rise to triplets. The position of the triplet varies depending on whether the protons "e" are adjacent to an oxygen atom or a carbonyl group; in the former case it is distinctly downfield, in the latter case the system approaches an A₂B₂ system and the triplets, as would be expected of an A₂B₂ system, are distorted (figures 2 and 4). The multiplets expected for the protons represented by "b" (B₂ of an A₃B₂ system) and "d" (A₂ of an A₂X₂ system) are merged in the methylene envelope in the region 1.17 – 1.22, owing to protons "c" (figures 1-6).

From the viewpoint of PMR spectra, the monomers differ mostly in the chemical environment of the olefinic protons and are therefore discussed individually.

Undecyl Vinyl Ether (Figure 1)

The protons "h", "g" and "f" constitute an AMX system; "g" is coupled with "h" ($J_{gem} = 1.5$ c/s) as well as with "f" ($J_{trans} = 15$ c/s) and is seen as a quartet at 3.93. Similarly, "h" is coupled with "g" ($J_{gem} = 1.5$ c/s) and with "f" ($J_{cis} = 7$ c/s) to give a quartet at 3.75. However, the outer pair of the quartet for "h" is seen to be merged with the inner pair of the quartet for "g". The downfield quartet is assigned to the proton *cis* to oxygen "g". Normally, terminal methylene groups in α -olefins will absorb at 4.65.

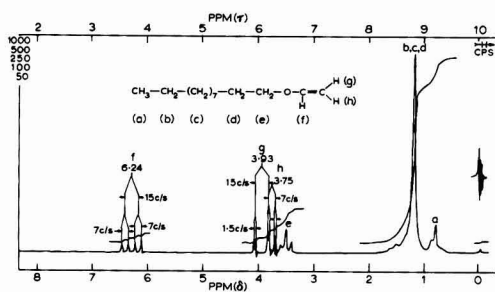


Figure 1. PMR spectrum of undecyl vinyl ether

Obviously, the shielding as well as the magnetic nonequivalence of these protons in this compound are brought about by the presence of an ether linkage to the α -carbon atom. The shielding is possible as the lone pair of electrons on the ethereal oxygen atom can create electron density at the terminal olefinic carbon atom:



The proton "f" in turn is split by "h" as well as by "g" ($J_{cis} = 7$ c/s, $J_{trans} = 15$ c/s) to form a quartet at 6.28.

Vinyl undecanoate (Figure 2)

Common features of the PMR spectrum of undecyl vinyl ether are preserved in the spectrum of vinyl undecanoate.

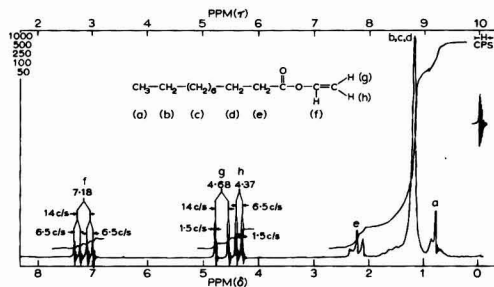
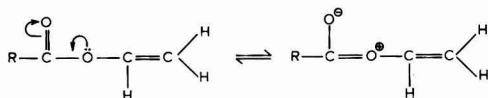


Figure 2. PMR spectrum of vinyl undecanoate

However, the three olefinic protons corresponding to "h", "g" and "f", constituting the AMX system, are deshielded by 0.62, 0.75 and 0.90 ppm respectively. This is due to the presence of a strongly electron withdrawing carbonyl group in conjugation with a lone pair of electrons on the ethereal oxygen atom:



Further, the difference in the chemical shifts of protons "g" and "h", i.e. $\delta_g - \delta_h$ (0.31), is more by 0.23 ppm compared to that in the undecyl vinyl ether (0.18). Consequently, protons corresponding to "g" and "h" are seen as two clear quartets at 4.68 and 4.37 respectively ($J_{gem} = 1.5$ c/s, $J_{trans} = 14$ c/s and $J_{cis} = 6.5$ c/s). Here again the proton *cis* to oxygen ("g") gives the downfield quartet. The proton "f" is most deshielded due to the presence of an adjacent carbonyl group and is observed as a quartet at 7.18 ($J_{cis} = 6.5$ c/s, $J_{trans} = 14$ c/s).

Allyl undecyl ether (Figure 3)

The protons corresponding to "f", "g", "h" and "i" are seen as multiplets of an A₂XYZ system. Protons "i", for instance, are split into doublets by the adjacent olefinic protons "f". Each member of this doublet is further split by two other olefinic protons "g" and "h" to give a multiplet in the region 3.69 – 3.82. Proton "f" is split by coupling with "g" ($J_{trans} = 17.5$ c/s) and "h" ($J_{cis} = 10$ c/s) as well as by the methylenic protons "i" ($J = 5$ c/s) to give a symmetric 12-line pattern in the region 5.45 – 6.06. Two of these lines are, in fact, merged. Similarly, the protons "g" and "h" are coupled with each other, with proton "f" and with the methylenic protons "i" to give multiplets in the region 4.80 – 5.27.

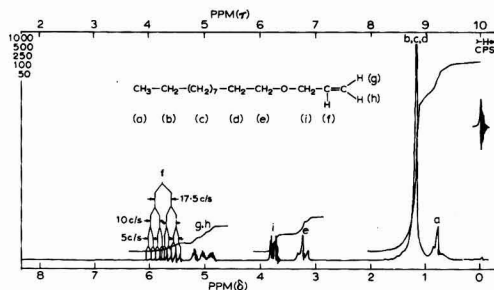


Figure 3. PMR spectrum of allyl undecyl ether

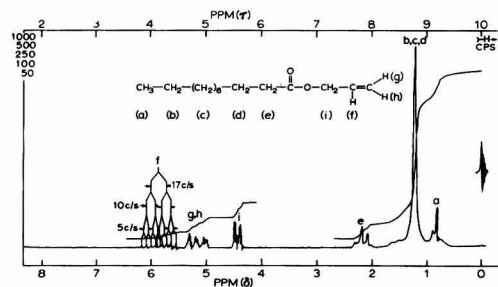


Figure 4. PMR spectrum of allyl undecanoate

Allyl undecanoate (Figure 4)

The PMR spectrum of allyl undecanoate is very similar to that of allyl undecyl ether. The same considerations therefore hold good for the olefinic protons. The individual assignments are shown in Figure 4 ($J_{gh} = 10$ c/s, $J_{gf} = 17$ c/s, $J_{fi} = 5$ c/s). In passing from the ether to the ester the allylic protons shifted by about 0.65 ppm downfield.

Undecyl methacrylate (Figure 5)

The protons corresponding to "g", "h" and "f" appear to constitute an A_2XY system. Proton "f" is split by both proton "h" (*cis*-allylic coupling) and "g" (*trans*-allylic coupling) and therefore appears as a quartet. In fact, careful scanning of this region at 250 second sweep

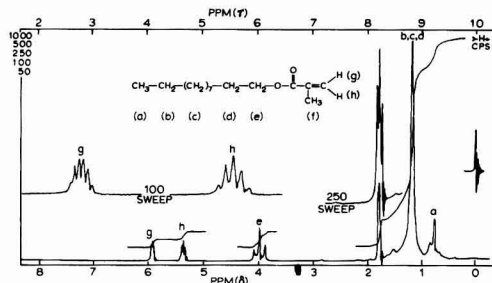


Figure 5. PMR spectrum of undecyl methacrylate

(Figure 5) showed a triplet and two distinctly different coupling constants ($J = 1$ and 1.5 c/s).

Protons corresponding to "g" and "h" are seen as non-identical multiplets in the regions 5.3 – 5.42 and 5.85 – 5.93. Since all the coupling constants involved are small, a clear-cut analysis could NOT be made. However, a close study of the 250 and 100 sweep patterns of these regions indicated that the geminal coupling constant is also of the same order as one of the allylic coupling constants (1.5 c/s). A larger allylic coupling constant ($J = 1.5$ c/s) appears to be incorporated into the band at 5.3 – 5.42 and the smaller allylic coupling constant (1 c/s) in the band at 5.85 – 5.93.

Undecyl acrylate (Figure 6)

The protons corresponding to "g", "h" and "f" appear to constitute an ABC system resulting in a multiplet. The bands due to the individual protons in the multiplet are shown in Figure 6. No coupling constants could be obtained from the spectrum.

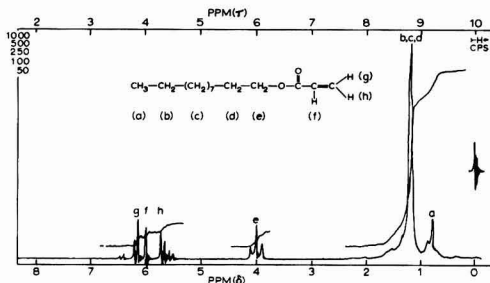


Figure 6. PMR spectrum of undecyl acrylate

[Received 24 December 1981]

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1. Kulkarni, N. G., Krishnamurti, N., Chatterjee, P. C. and Aggarwal, J. S., *JAOS*, 1968, 45, 465.
2. Kulkarni, N. G., Krishnamurti, N., Chatterjee, P. C. and Aggarwal, J. S., *ibid*, 1969, 46, 396.
3. Kulkarni, N. G., Krishnamurti, N., Chatterjee, P. C. and Aggarwal, J. S., *J. Chromatog.*, 1968, 34, 543.

Next month's issue

The Honorary Editor has accepted the following papers for publication. They are expected to appear in the November issue:

Colour measurement by *K. McLaren and R. P. Best*

The effect of part replacement of titanium dioxide by barytes on the properties of alkyd paints by *K. V. S. N. Raju and M. Yaseen*

Styrene copolymerisation of isomerised tobacco seed (*Nicotiana tobacum*) oil and its alkyd by *M. S. Saxena, P. K. Jain and A. K. Vasishta*

Organosilanes as adhesion promoters for organic coatings. Part I: silanes on the metal surface by *P. Walker*

Further information on any of the publications reviewed may be obtained by circling the appropriate *Reader Enquiry Service* number on the form at the back of the *Journal*. Enquiries will be forwarded to the publisher.

Outlines of Paint Technology

W. M. Morgans
Volume 1, Materials
Charles Griffin & Co. Ltd, London, 1982
pp. x + 298, price £24

This book is a revised and enlarged version of the author's earlier "Outlines of Paint Technology" published in 1969 and reviewed in *JOCCA*, 1969, 52, 638. It will now appear in two volumes, the first covering "Materials" and the second, which is in the course of preparation, will describe "Finished Products".

The first volume describes the raw materials used in paint manufacture, and is divided broadly into pigments, solvents and plasticisers, drying oils, natural and synthetic resins, cellulose derivatives etc. Their sources, methods of production, properties and uses are outlined without giving precise details of the processes involved. The normal paint technologist is not usually greatly concerned with the manufacture of these products, except possibly in the case of alkyd resins, oleoresinous and oil modified phenolic media. However, these strictly do not involve paint technology. Only passing reference is made to fossil resins, but this is justifiable on the grounds that their use is now nearly obsolete.

The reader is assumed to have some knowledge of elementary chemistry, as little description is given of basic reactions, such as esterification, polymerisation etc. However, some parallel study of chemistry is now practically essential for any student of paint technology.

Considerable thought must have been exercised in selecting the essential aspects of the subject. A useful feature of the book is the provision of references to suitable literature for further reading in greater detail. It is gratifying to members of *OCCA* that a high proportion of the more recent references are to our own journal. This should be a convenience to students at technical colleges or starting work at factories where *JOCCA* is usually readily available.

The author adopts a succinct style of writing which enables the maximum of information to be condensed into the minimum space. Such economy of words is essential in view of the costs. It is a sad reflection of present day economics that in 1969 the first edition of just over 400 pages cost £4: 4s: 0d compared with the present cost of £24 for just under 300 pages – an eight fold increase per page.

The volume is well produced in stiff covers and maintains the standard set by its earlier edition. There are very few typographical errors, and where these exist the intended reading should be obvious. Perhaps the most serious error is "nitrate" for "nitrite" on page 127 when discussing diazotisation. A great deal of thought and judgement has been used in the book's construction, which reflects the author's long experience in the teaching of the subject.

It is to be hoped that the second volume will not be too long delayed, as for many readers, it will cover what may well be considered the most important aspects of paint technology.

Reader Enquiry Service No. 21

S. R. Finn

reviews

Zinc Dust and Zinc Powder, Their Production, Properties and Application

B. C. Hafford, W. E. Pepper and T. B. Lloyd
International Lead Zinc Research Organization Inc,
292 Madison Avenue, New York NY 10017, USA

Compiled by members of the New Jersey Zinc Co, this book is the first comprehensive source of information on these zinc products. It describes the early history of the products, and dates the first use of zinc dust in priming paints (Mallett BAAS 1840). Chapters follow on the manufacture of dusts and powders and their composition and properties.

The chapters on the usage of these products are fairly well detailed, and of course cover far more than their application in surface coatings.

There is a comprehensive set of appendices including particle size measurements and distribution, primer formulations including those designed for potable water tanks and a list of US manufacturers of zinc rich paints classified under three headings – organic coatings, water-reducible inorganic coatings and solvent-reducible inorganic paints. Finally a chapter describes the protection of the Alaska pipeline by zinc rich paints.

This is an interesting book, containing much useful and interesting information, and will be an asset to all in the corrosion protection industry.

Reader Enquiry Service No. 22

D. S. Newton

Formulary of Paints and other Coatings. Volume 2

Michael and Irene Ash
George Godwin Ltd, London, 1982
pp. 399

This second volume of paint formulations follows the format of the first, published in 1978. It consists of a collection of several hundred formulations for conventional and special paints and coatings. Most are from American sources and in accordance with American practice, and all include several proprietary trade name ingredients. Even though the suppliers are named, it would be a long task to obtain all these materials in the UK. The earlier volume included a list of UK proprietary products and suppliers covering the same area, but this has, surprisingly, been omitted from the second volume.

On some matters of detail, the definition of a primer as a "gluelike" pigmented coat may cause puzzlement; and the flame-retardant paint described as polyvinyl chloride should be polyvinylidene chloride.

For this work to be of any great value in the UK, a version based on UK materials and practice would be necessary.

Reader Enquiry Service No. 23

L. A. O'Neill

OCCA meetings

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

Transvaal

Powder coatings

The Transvaal Section's meeting held on 21 July 1982 took the form of a mini-symposium on "Powder coatings" and was extremely well attended drawing 42 members and 20 guests. The attendance was all the more noteworthy considering that it was a non-sponsored meeting and was held at one of the most expensive "watering holes" in town.

The first speaker was Malcolm Powell of Spraying Systems and he dealt with equipment for powder application. Having touched on flocking and fluidised beds, most of his talk dealt with electrostatic spraying.

Faraday caging (or is it the Faraday cage effect?) was simply explained and the positive attributes of electrostatic spraying were enlarged upon, particularly the control of film thickness through like-charge repulsion.

Transfer efficiency and deposition efficiency were dealt with and the speaker then went on to discuss the problems involved with plant when changing colours. The Cartridge Booth and the later development of the Quick Colour Booth were explained.

Powders for heavy duty service

The second speaker was Simon Uphill-Brown of Plascon Evans who discussed "Powders for heavy duty service" and in the main dealt with fusion bonded pipeline coatings. His talk was illustrated with an excellent set of slides, originating from Saudi Arabia, showing in-field plant. These included shots of pipe bending, demonstrating the flexibility of fusion bonded coatings, and powder application on welds, being done over the ditch. Even more spectacular were shots of fusion bonded coated pipe being coiled up on a pipe barge prior to laying in the North Sea.

Duplex coating of powder over galvanised surfaces for mining use was also touched on.

Inspection of powder coatings

The third speaker was Eric Duligal of E. A. Duligal and Associates. His subject was the inspection of powder coatings and the consideration of powder coatings from a consultant's point of view.

He presented information, derived while on the staff of SABS, dealing with the water absorption properties of various powders together with their performance under impact and other tests.

He also drew attention to EVA thermoplastic powders for use on external anticorrosive work since these coatings

perform as well as epoxies with regard to anticorrosive properties and out-perform them in respect of weather resistance. Fluorocarbon powders for chemical and solvent resistance were also touched on.

Powders

The fourth speaker was John Molloy of Lutro Systems who stood in at very short notice to discuss "Powders".

The speakers then formed a panel to answer questions from the floor and discussion carried on until Chairman Gordon Munro had to close the meeting owing to the lateness of the hour.

A field test for soluble iron corrosion products on blast cleaned surfaces

The meeting held on 19 May 1982 by the Transvaal Section was a rare occasion indeed. Many meetings are thinly disguised advertising, particularly when presented by a supplier to the coatings industry. But here we had a lecture on a research topic, one in which, because it was non-commercial research, everything could be told.

The speaker was one of the leading figures in the coatings industry - Mr Fritz Weber, chief chemist and a director of Plascon Evans Paints. His subject was "A field test for soluble iron corrosion products on blast cleaned surfaces".

The work reported on arose out of South Africa's participation in the International Organization for Standardisation sub-committee ISO/TC 35/SC12 on preparation of steel surfaces before application of paint and related products.

The two methods currently in use to detect water-soluble iron salts, the Merckoquant test and the potassium ferrocyanide paper test, have considerable limitations particularly when operating on steel surfaces corresponding to C or D grades in the Swedish Code.

Two new methods have been developed and appear to be simple and easy to apply in the field and give good correlation when checked by atomic absorption examination of the water-soluble contaminants.

Both tests are conducted in a similar fashion. A pre-manufactured reagent is painted onto a small section of the prepared steel under study and within a few seconds a colour change is visible if contamination is present.

The first method - designated WR1 - makes use of a slurry containing a reagent similar to the Merckoquant reagent, iron-free titanium dioxide, butanol, ascorbic acid and alcohol containing not less than 15 per cent water. The ascorbic acid is added to render ferric and ferrous ions soluble. A positive test - the indicator is sensitive to 1 ppm of contaminant - causes the white slurry to turn pink.

The second method - designated WR2 - uses potassium ferrocyanide, iron free titanium dioxide and ascorbic acid carried in a water solution of Methocel. The reagent forms an adherent film due to the Methocel. The

colour change in the presence of the contaminant is from white to black.

Thus, a simple, sensitive test has been developed. What remains now is to accurately define what level of contamination is damaging under various types of coatings.

During this work an interesting sidelight emerged. The mass lost during abrasive blasting was determined for all four grades of steel recognised by the Swedish Code. To arrive at an Sa2½ finish the following mass losses occurred:

Grade A Steel	46 g/m ²
Grade B Steel	213 g/m ²

occa meetings

Grade C Steel	285 g/m ²
Grade D Steel	492 g/m ²

P. Marples

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

company visit

Glasurit Beck's open day

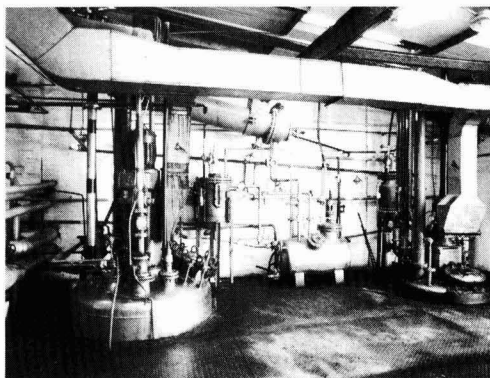
An open day was held on 3 September at Glasurit Beck's headquarters in Slinfold, Horsham, West Sussex to celebrate the 25th anniversary of the company.

Mr C. P. French, managing director, outlined the history of the company, which is a subsidiary of the BASF Group. The Dr Beck side of the company was formed in 1957 and moved to Slinfold in 1959. At that time, the chief products were wire enamels and resins for the electrical industry. Glasurit had for many years made paints in Germany, specialising in automotive finishes. Both these companies became members of the BASF Group and then merged to form the present company in the UK.

In this country, the main outlets for paints is for the refinishing and repair of vehicles, but the range of products is being extended to various materials for the building industry. Some outstanding examples of the results obtainable with the refinishing paints were exhibited. Paints are not manufactured at Slinfold but are distributed and serviced from the company's warehouse at Abingdon, Oxon. The number of employees at the two sites is about 180 and the annual turnover is around £12 million.

At Slinfold, the main products manufactured are wire and insulating enamels together with a wide range of sealants, impregnants and fillers. These are chiefly intended for the electrical industry but are suitable for many purposes where high insulation and/or protection against adverse exposure conditions are required. Many of the systems are designed to set rapidly at ambient temperatures and involve blending the main components with a reactive hardening agent. A number of ingenious packages were shown in which the necessary components are supplied in the correct proportions which can be mixed prior to use without the necessity for separate mixing in another container.

Most of the resins required for these products are manufactured at Slinfold. The resin production department is equipped with a number of reaction vessels of



Resin making plant at Glasurit Beck

various capacities in which condensation reactions can be performed under appropriate processing conditions. The course of the reactions is followed and controlled from an external control room.

A feature of the manufacturing plant is the solvent supply system which enables solvents to be delivered to various sites and reaction vessels via a separate control room. The pipe layout is so arranged that after supplying a given point the pipe lines drain back to the tanks and so prevents any contamination when a change to a different solvent is involved.

There are several laboratories in which all raw materials are tested before use, and finished products are tested against the relevant specifications before release. Additional ground has been purchased which, it is hoped, will make possible a new access road leading directly to the A29 and so avoid the passage of heavy vehicles through Slinfold village.

Reader Enquiry Service No. 25

*S. R. Finn
A past Hon. Editor of JOCCA*

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

Paint can awarded to man of the match

No wonder he's smiling! Shown on the right Kim Barnett, Derbyshire's No. 5 batsman, grins broadly as he receives a somewhat unusual cheque from Austin O'Malley, chairman of International Paint, Ladywood, Birmingham. The cheque, for £300, took the form of a paint can and was Kim's "man of the match" award for an outstanding performance during the International Paint sponsored Warwickshire versus Derbyshire cricket match. Kim scored his maiden first class century in his second innings.

International Paint Ladywood, Birmingham, home of the group's Vehicle Finishes Division, Automotive (original equipment) Division, Electropaint activities and Aviation Division, sponsored the three-day county match on 7, 8 and 10 August.

Austin O'Malley explained the reasons for the sponsorship: "Now that the whole of our automotive business - OE, refinish and electropaint - as well as our aviation activities are concentrated at Ladywood and a substantial programme of investment at this Birmingham site is in hand, we want to emphasise our Midlands base and our Midlands links in a number of ways. At the same time we wanted to give our employees and some of our customers the opportunity to enjoy a day's cricket. And of course, we wanted to support a Midlands activity. In view of the success of this event, we hope to provide further support for the Warwickshire County Cricket Club and for other Midlands activities."

Reader Enquiry Service No. 31

Lead Industries Group changes name

In September of this year the Lead Industries Group plc became known as Cookson Group plc. Among the notable subsidiaries of the Group are: Goodlass Wall; Alexander, Fergusson & Co. Ltd; H & O Wallcoverings; Harringtons & Goodlass Wall; and Fergusson's Paints.

Reader Enquiry Service No. 32

Confirmation through co-operation

The claim made by BASF that its 22 and 22U series chrome pigments are capable of stir-in dispersion was recently put to the test at Torrance & Sons Ltd when, by



Shown from left to right are Kevin Hayward, International Paint director and general manager of VFD, Ron Williamson, operations director, Kim Barnett, Derbyshire player, Jim Coombes, marketing manager of WCCC, Austin O'Malley, chairman of International Paint, Ladywood, and Dr Andrew Mawby, VDF's marketing director

customer request, a trial was made using Synolac 27X as well as Siccomin Yellow 1922U and Siccomin Red 3130U. Satisfactory results were obtained with surprisingly short dispersion times.

Reader Enquiry Service No. 33

UK chemical industry maintains its world position

The annual "UK chemical industry facts" leaflet published by the Chemical Industries Association shows that amid the deepening recession there was little change in the UK chemical industry in 1981 from 1980.

The British chemical industry remains the fourth largest UK manufacturing industry after food, drink and tobacco, and mechanical engineering and vehicles. Outside of the Eastern Bloc it is the fourth largest chemical industry in the world after the USA, Japan and West Germany. Turnover in 1981 is estimated to have been £17,500m compared with £16,529m in 1980.

Last year 40 per cent of chemical sales were exported (38 per cent in 1980) and the chemical industry maintained its position as the major manufacturing industry contributor to the UK balance of payments with a net export surplus (exports minus imports) of slightly over £2,000m compared with £2,142m in 1980. This surplus, however, brought little benefit to hard-pressed chemical manufacturers, who maintained export volume at the expense of reduced profit margins. The number of employees declined from 431,000 to 395,000.

Reader Enquiry Service No. 34

UK chemical industry improves its safety record

In 1981, the UK chemical industry once more improved upon its excellent safety record. Statistics published by the Chemical Industries Association show that the overall frequency rate fell from 1.14 in 1980 to 1.04 in 1981. Frequency rate relates all accidents, including fatalities, to the numbers at risk and their time at work i.e. to man hours worked.

To put the figures more simply, with 171,300 employees, one person in 50 had an accident which meant loss of work for more than three days, of the total there were four fatalities.

As a comparison - in the home, for every 200,000 people in the UK, one person in 50 also had an accident, but of the 200,000 there were over 20 fatalities (ROSPA 1982).

Under the CIA safety award scheme, out of 218 participants, 53 qualified for an award in spite of reducing the target frequency rate from 0.50 to 0.40 or less, and out of these 26 were accident free.

Reader Enquiry Service No. 35

Polymer Laboratories expansion

Polymer Laboratories Ltd, manufacturer of, amongst other things, GPC columns and polymer standards, continues to expand and the Instrument Division is now well established in new premises in Loughborough. The Division is sited on the north-western edge of the University campus, close to the departments of Physics and Polymer Technology, where laboratory, service and office facilities

have been set up. At the same time, production of polymer standards and specials, and SEC (GPC) columns has been increased at the Church Stretton head office to satisfy worldwide demand (exports account for 75 per cent of production), which continues to increase healthily despite the ever-growing number of competitors in this field.

Reader Enquiry Service No. 36

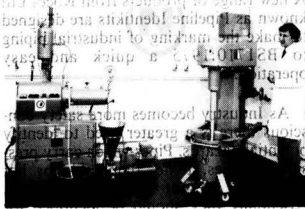
New test facilities

Netzsch (UK) Ltd has announced the opening of its customer test facility in Newcastle-under-Lyme. The new test facility contains mixing and milling equipment of the latest design with a totally flameproofed test area which is able to handle highly volatile products.

The unit was built to provide a local laboratory where Netzsch customers could bring their products for the testing and evaluation of Netzsch equipment.

Experienced engineers will be present during the testing of customer materials to offer technical guidance where necessary.

Reader Enquiry Service No. 37



Netzsch's new customer test facility at Newcastle-under-Lyme

new products

Antifouling compound

A tributyltin compound, bis(tri(n-butyltin)meso-dibromo succinate, which until now - according to its supplier - has only been used commercially in the Far East, is now available in Western Europe from Manchem Ltd. Manchem recently received a letter of intent from K-I Chemical Europe Ltd giving the company exclusive rights for the sale of this product in Western Europe.

The compound, which has the trade-name IT-104, is manufactured in Japan by the Ihara Chemical Company, one of two companies which have formed the London-based K-I Chemical Europe Ltd.

IT-104 is used as the active ingredient in marine antifouling paints and it is claimed to produce more stable paints and to have a relatively low mammalian toxicity. The use of IT-104 by the antifouling paint manufacturers in Japan is well established, IT-104 having been approved in 1978 by the Japan Shipbuilding Association.

Reader Enquiry Service No. 38

Testing opacity and chalking

Pearson Panke Equipment Ltd has announced three new instruments from Erichsen:

The Reflectometer is an instrument for the determination of contrast ratio and other opacity measurements.

The Chalkmaster is for the determination of chalking by the Helmen method. This method gives instrumental measurements of the degree of chalking as opposed to the usual method of comparing with a set of standards. This eliminates the errors due to different judgements being made by individual operators.

The Chalking Attachment for the Mini Glossmaster is also for the determination of chalking by the Helmen method. The combination of this adaptor and the portable Mini Glossmaster allows determination of both gloss and chalking at the weathering site as well as in the laboratory.

Reader Enquiry Service No. 39

The second cabinet is manufactured by Birt & Talbot. Called the Limping Glassware Drying Cabinet, it is fitted with a fine filter on the input and the fan heater system which ensures the glassware is dried in clean warm air.

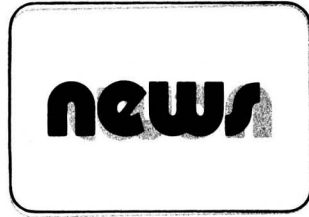
The capacity of the cabinet is 332 litres (119 cubic feet) with the opening door so that loaded racks can be slid straight into the cabinet. Three stainless steel mesh shelves (expandable to four) and six sets of eight runners allow the space within the cabinet to be used to full advantage. The cabinet is fitted with a safe revolving glass door and is finished in a white stove enamel.



Small tank-cleaning machine from Toft & Jorgensen

New small tank-cleaning machine

Toft & Jorgensen, a Danish company well established in the manufacture of cleaning machines for large tanks, has now developed a small machine with an overall diameter of only 75mm. It uses the same rotating jet system as the larger machines, and is suitable for tanks down to about 1 metre in diameter. The cleaning liquids can be recirculated, keeping the cost down and minimising problems of effluent disposal. The machine is made of stainless steel throughout, with teflon bearings, so, in addition to the usual aqueous detergent



solutions, solvents for most resins, paints and adhesives may be used.

It is expected that the new machine will find application in the resin and paint industries as well as other manufacturing industries, such as food, brewing, pharmaceuticals, adhesives, soap and chemicals.

Reader Enquiry Service No. 40

New mixers

Lightnin Mixers has introduced a new range of mixers called XL. Designed to give high flow with very low shear, the new range is suitable for open or closed tank operation.

Reader Enquiry Service No. 41

Compressed air/steam leak detection

Neotronics Ltd and Wessex Power Technology Ltd have teamed up with Froude Engineering Ltd for the sale of the new Froude compressed air and steam leak detector.

The detector is designed to locate precisely the position of even very small leaks in the most inaccessible places without the use of soap solutions, etc.

It works on the principle that turbulence is created from a leak, generating ultra-sound which is then detected by the instrument.

Powered by rechargeable batteries, the unit is said to be suitable for use within all types of compressed air and steam raising plant.

The DOE estimates that the waste incurred by the presence of a single 1/16th of an inch hole leaking compressed air or steam costs £202 per annum.

Reader Enquiry Service No. 42



New from Froude - a compressed air/steam leak detector.

news

Two new chrome pigments

ICI organics division has introduced two scarlet shades of chrome pigments to complete the F-Grade range designed for high performance industrial paints.

Scarlet Chrome F-HM and Scarlet Chrome F-HY join Lemon Chrome F-H4G, Middle Chrome F-HG and Middle Chrome F-HR. The F-Grade products are said to possess improved durability and dispersion properties, outstanding resistance to sulfur dioxide and good acid-spot resistance in addition to the high opacity, brightness of shade and fastness to heat and solvents typical of chrome pigments.

The major market for these products is in car paints, refinishes, coil coatings and transport finishes, where stability and colour retention are required under demanding conditions.

Reader Enquiry Service No. 43

Clean air drying cabinets

Two companies have recently announced, independently, production of new filtered-air drying cabinets.

The first is from Marrutt Ltd. It is described as an all purpose drying cabinet and circulates warm air first through a

purifying filter to remove any dust particles then evenly throughout the cabinet at a constant temperature ranging from ambient up to 60°C.

Two filters are available, the standard filter which has a 96 per cent filtration efficiency, and a special filter with a 99 per cent filtration efficiency, which almost provides a totally clean-air drying cabinet.

The cabinets are constructed from zinc-coated steel and epoxy finished to assist in resisting corrosion and scratching.

The internal fittings are of stainless steel and are designed to adapt to most layouts and hanging arrangements.

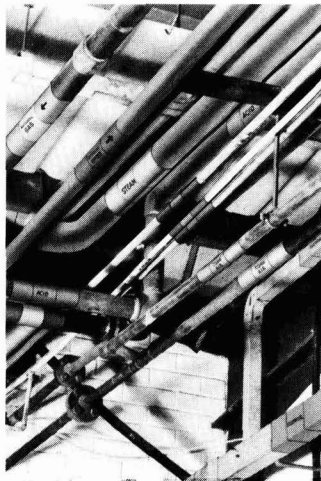
The white mesh polythene coated shelves can be spaced to individual needs using up to a maximum of five shelves.

"We produced this all-purpose cabinet when we found our cabinets, which are well known in photographic fields, were being used for a great number of other applications", said Roy Tubman, one of the directors of Marrutt Ltd.

The second cabinet is manufactured by Baird & Tatlock. Called the Unitemp Glassware Drying Cabinet it is fitted with a fine filter on the input of the fan heater system which ensures that glassware is dried in clean warm air.

The capacity of the cabinet is 535 litres (19 cubic feet) with a wide opening door so that loaded racks from most glassware washing machines can be slid straight into the cabinet. Three stainless steel mesh shelves (extra available if required) and six sets of shelf runners allow the space within the cabinet to be used to full advantage. The cabinet is fitted with a safe armour plate glass door and is finished in durable white stove enamel.

Reader Enquiry Service No. 44



Pipeline labels from Rocol Ltd

Pipeline labels

A new range of products from Rocol Ltd known as Pipeline Identikit are designed to make the marking of industrial piping to BS1710:1975 a quick and easy operation.

As Industry becomes more safety conscious there is a greater need to identify potential hazards. Pipes which carry pressurised gases, toxic, flammable or hot materials present an obvious risk. Essentially they should be identified for maintenance purposes and, perhaps more importantly, to help easy identification by emergency services.

Reader Enquiry Service No. 45

Deer rheometer

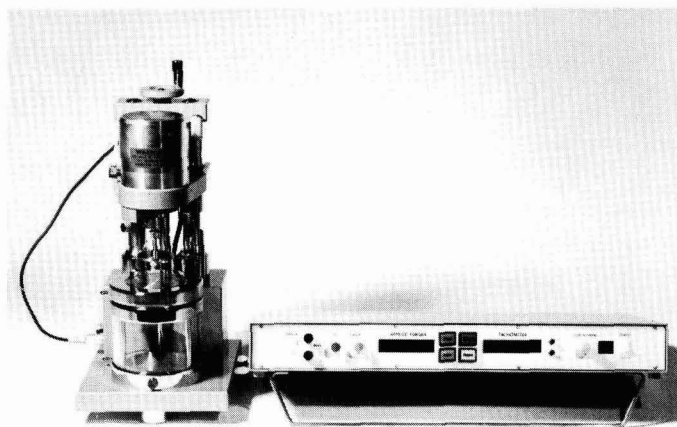
Developed from the PDR 81 Deer Rheometer, Rheometer Marketing Ltd has announced the redesigned and uprated Series 11 Rheometer.

The constant stress Rheometer is said to be especially useful for investigations in the region of elasticity prior to the yield point, giving accurate non-destructive test results.

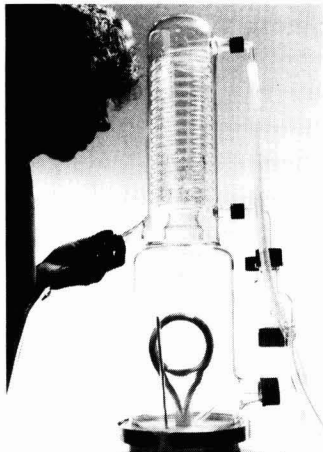
Having exceeded the sample yield point, the instrument will then proceed into very slow rotation, well in excess of six and a half hours per revolution, where the visco elastic properties of materials can be investigated. The shear rate can then be increased to use the instrument as a conventional viscometer.

The instrument is suitable for Newtonian and non-Newtonian investigations - from creep regions and yield values through low stress to conventional flow from the same small sample of liquid, suspension etc.

Reader Enquiry Service No. 46



New from Rheometer Marketing is this Series II Rheometer — it is suitable for Newtonian and non-Newtonian investigations



Schott-Geräte's new water still

Water still

Schotte-Geräte has introduced a still which produces water said to be free from metal ions.

The still is made from Duran borosilicate glass of the first hydrolytical class, the bottom plate is PVDF, and the heater is quartz sheathed thus the whole of the boiling chamber is metal free.

Reader Enquiry Service No. 47

New low level palletiser

Lo-Stak Mk II is a new low level palletising system for handling unit loads such as cartons, crates, shrink wraps and tray packs.

Manufactured by W & C Pantin Ltd it is aimed at the small producer with a limited budget. The machine is designed to accept moderate outputs from a single packaging line at speeds up to 30 units per minute. Standard equipment includes in-feed belt conveyor, synchronised empty pallet dispenser, discharge conveyor and personnel safety barriers.

Programmable logic control is available to suit individual applications.

Reader Enquiry Service No. 48



Lo-Stak Mk II palletising system for handling unit loads

literature

Lead chrome paints

A booklet which explains the latest legislation in the use of lead chrome pigments in paint manufacture has been produced by ICI Organics Division. The objective of the booklet is to provide some practical guidance on the implications of recent legislation as it affects the manufacture and use of lead chrome paints, and to provide factual information that will enable lead chrome pigments and paints to be handled in a safe manner.

Copies of "Lead Chrome Paints - The Facts" are available free by using the Reader Enquiry Service form at the back of the *Journal*.

Reader Enquiry Service No. 49

User's guide to adhesives

Ciba-Geigy has published a 16 page booklet entitled "The user's guide to adhesives" covering the design of bonded joints, the selection and use of adhesives and the pretreatments necessary before bonding.

The booklet is available free by using the Reader Enquiry Service form at the back of the *Journal*.

Reader Enquiry Service No. 50

Isocyanates incidents

An information leaflet on how to deal with isocyanates incidents has been published by the Isocyanates Product Group of the Chemical Industries Association (CIA).

The leaflet covers the nature of the hazards involved and gives details of the actions to be taken in the event of a major spillage, including medical treatment and first aid.

Reader Enquiry Service No. 51

Chemistry in a young country

The New Zealand Institute of Chemistry (NZIC) has published a book entitled "Chemistry in a young country" edited by P. P. Williams. The book, hardbound, is 243 pages in length and is divided into the following sections: Chemistry as a profession, Chemical disciplines, Chemistry and society, Chemistry and agriculture, Chemistry and food processing, Chemistry and natural resources, and Materials chemistry, all, of course, in the context of New Zealand.

Unfortunately only four pages are devoted to surface coatings, which is probably an indication of huge size of the subject tackled by this single volume. The book should appeal to anyone interested in the history and development of chemistry in New Zealand's industries and society.

Reader Enquiry Service No. 52

news

meetings, etc.

Analytical chemistry symposium

The Analytical Chemistry Division of the Royal Australian Chemical Institute will be holding its 7th Analytical Chemistry Symposium in Adelaide from 22-26 August 1983. The theme will be "Quality through chemistry". For further information contact: the Secretary, Mr D. Patterson, c/o AMDEL, PO Box 114, Eastwood, South Australia, 5063, Australia.

FATIPEC congress in 1984

The Swiss Colour and Paint Chemists' Association is calling for papers to be presented at the XVII FATIPEC Congress to be held at Lugano from 23-29 September 1984. The theme of the congress will be "Coatings, paints and printing inks - today and tomorrow". For further information contact: Erich V. Schmid, Höhenweg 13, CH-9000 St Gallen, Switzerland.

people

Professor Sir Hermann Bondi, who presented the Association's Annual General Meeting Lecture in 1980 on "Energy in the world", will become master of Churchill College, Cambridge in July 1983.

Eagle Industrial Paints Ltd has announced the appointment of Miss Melanie Pursglove as joint managing director with effect from 1 August 1982.

Miss Pursglove, who read French at London University and obtained a BA (Hons) degree, is currently director of marketing. She was recently awarded a masters degree in business administration from the Manchester Business School.

Colin Bladen has joined the Coatings Division of Burmah Speciality Chemicals Ltd as marketing director with effect from 2 August 1982.

The Division comprises Dussek Campbell (wax blends, cable compounds and related industrial products) and Solignum (wood preservative products). The marketing director - a newly created post - will have functional responsibility for all marketing activities worldwide.

OCCA news

Harry B. Smith

Harry B. Smith, a member of the London Section and an Associate in the Professional Grade, is, after 32 years service, retiring from his position as technical director of Odhams (Watford) Limited.

Harry Smith, who has been responsible for engineering and technical activities, has been involved in many of the innova-

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

tions in printing techniques and equipment. He has also been responsible for the development of specifications for raw materials such as ink and paper.

He plans to continue his long association with the industry on a consultancy basis and to play a part within professional associations which he admits he has neglected over the last few years.

Philip Jeffery

Philip Jeffery has been named area sales manager for Bee Chemical Company's UK facility in Lower Sydenham. According to Dave Mendez, general manager of the UK section, Mr Jeffery will be

responsible for the north of England and East Midlands. He brings a strong background in research and sales to this position.

Mr Jeffery has an honours degree in inorganic chemistry from the University of Manchester Institute of Science and Technology. The Jeffery family resides in Bradford.

Bee Chemical Company is a leading manufacturer of industrial coatings for plastics and metals, it also produces universal dispersions and additives for the coatings industry, hot stamp foil, it has a diversified line of business products, and manufactures the Bee Injecta Color System (liquid colourants plus precision metering pumps for colouring plastics).

new members

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

Ordinary Members

AMOS, LARRY MORRIS, BSc, MSc, 17 Mountain Road, RD1 Henderson Valley, Auckland, New Zealand (*Auckland*)

GALLOWAY, NEIL, BSc, 23 Clunie Avenue, Raumati South, Wellington, New Zealand (*Wellington*)

GOUGH, RONALD, BSc, CChem, MRSC, Berger Paints SA (Pty) Ltd, PO Box 664, Pinetown 3600, Republic of South Africa (*Natal*)

GUNE, SHARAD KUMAR, BSc, MSc, Lot 1667 Taman T K K, 3½ Mile Jalan Pantai, Port Dickson, West Malaysia (*General Overseas*)

JARRETT, MURRAY ROYDEN, Landrost Industries Ltd, PO Box 20-198, Glen Eden, New Zealand (*Auckland*)

MCLENNAN, BRUCE LINDSAY, BSc, 222 Riddell Road, Glendowie, Auckland, New Zealand (*Auckland*)

MILLER, KEITH CLARK, 76 Warner Park Avenue, Laingholm, Auckland 7, New Zealand (*Auckland*)

NOWELL, STEPHEN, 73 Oakland Avenue, Offerton, Stockport SK2 5RD (*Manchester*)

O'BRIEN, WILLIAM HALL, BSc, PO Box 2091, Wellington, New Zealand (*Wellington*)

ROBERTSON, NEIL ANTHONY, PO Box 29156, Christchurch, New Zealand (*Wellington*)

SCRIVENER, ANTHONY JOHN, BSc, Associated Lead, PO Box 12043, Jacobs 4026, Republic of South Africa (*Natal*)

SLATER, ROBERT MACK, BSc, MSc, 706 Remuera Road, Auckland 5, New Zealand (*Auckland*)

STEWART, ROBERT G. M., BSc, 4208 Great North Road, Henderson, Auckland, New Zealand (*Auckland*)

STONE, MARK JAMES, BSc, Chemicals Manufacturing Co Ltd, PO Box 38493, Petone, New Zealand (*Wellington*)

THOMSON, IAN GILES, BSc, Shell Chemicals NZ Ltd, PO Box 2091, Wellington, New Zealand (*Wellington*)

WALMSLEY, JOHN, River Road, Drummond, Natal, Republic of South Africa (*Natal*)

Associate Members

CHIBANDA, RAYMONDA, 10 Danbury Avenue, Marlbergeln, Harare, Zimbabwe (*General Overseas - Zimbabwe Branch*)

DE ROUFFIGNAC, PAULETTE ANNE, 3/625 High Street, Lower Hutt, New Zealand (*Wellington*)

HUNTER, WILLIAM PATERSON, 29 Church Road, Giffnock, G46 6LT (*Scottish*)

JONES, LEE MARTIN, 1259 High Street, Lower Hutt, New Zealand (*Wellington*)

LACEY, ANGELO MERT, F2 15 Dryden Avenue, Papatoetoe, New Zealand (*Auckland*)

MCMNAMARA, SHAYNE GREGORY, 14 Connolly Street, Lower Hutt, New Zealand (*Wellington*)

PRENTIS, JOHN, Dulux Ltd, Post Box ST 92, Southerton, Harare, Zimbabwe (*General Overseas - Zimbabwe Branch*)

THORPE, MARK JACKSON, 522 Redfern, New Germany, Natal, Republic of South Africa (*Natal*)

Registered Student

FRITH, WILLIAM JAMES, BSc, 70 Clarence Road, Teddington, Middlesex TW11 0BW (*London*)

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NL Chemicals Europe Inc., rue de l'Hôpital 31-Bte 6, B-1000 Brussels, Tel: (02) 512 00 48, Telex 24662

OIL & COLOUR CHEMISTS'



ASSOCIATION

Marine Finishes

Reprints are now available of the OCCA Monograph number 1 on Marine Finishes by Dr T. A. Banfield from the Association's offices. These bound copies reprinted from the February and March issues of the *Journal* cost £2 including post and packaging.

CLASSIFIED ADVERTISEMENTS

APPOINTMENTS



**asian
paints**
(INDIA) LIMITED

Asian Paints (India) Limited has established itself as India's premier surface coatings Company. They have been the leaders in the Paint Industry for the last fifteen years and 1980 gross sales were over Rs. 540 million. The Company has ambitious growth and diversification plans and the production capacity will, in the next three years, increase by over a 100% from the present level. To aid the Company achieve these plans, it requires Indian Technologists now abroad to participate in its Research & Development activities.

Specifically, the Company has opportunities for Doctorates in Paint Technology, Polymer Technology/Chemistry or Organic Physical Chemistry with about five year's industrial R&D experience in the surface coatings area. The Company would be particularly interested in individuals having exposure to recent developments in high technology areas such as high solids coatings, powder coatings, water-borne coatings, automotive finishes, electro deposition, etc.. It would be desirable that individuals have knowledge of both Paint and Resin systems.

With its ambitious growth plans combined with an excellent work atmosphere, the Company offers a satisfying career opportunity for Indian nationals presently settled abroad who would like to return to India. The Company offers an attractive compensation package consistent with individual qualifications and experience. The jobs will be based at Bombay and suitable accommodation will be provided.

Individuals who would like to be considered for these positions may apply giving full details of academic qualifications and work experience to:

The General Manager—Personnel,

Asian Paints (India) Limited,
LBS Marg, Bhandup, Bombay 400 078. (India)

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asian paints

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Paint technologist
Seeks Position at
Home or Abroad

A 37 year old Ghanaian with 15 years experience in paint manufacture (especially formulation and production) and an ATSC seeks employment as a Paint Technologist in a paint, varnish and/or lacquer making organisation.

The post is sought in any English speaking African or Asian country, or in Europe.

Please reply in strictest confidence to:

Box No. 514

SITUATIONS WANTED

Member Seeks
Position

Member with director experience age 57 seeks employment. Wide technical experience in speciality coatings for paper and film, vacuum metallising, management and sales.

Replies in confidence to
Box No. 518

AGENCY ON OFFER

Business Opportunities
Abroad in Dyes and
Preparations

An agency in Zimbabwe wishes to specialise in the importation of dyes and colour preparations from Britain.

Communications addressed to the box number below by companies interested in receiving further particulars will be forwarded by air mail.

Reply in strictest confidence to
Box No. 516

INDEX TO ADVERTISERS

Further information on any of the products advertised in this *Journal* may be obtained by circling the appropriate number on the *Reader Enquiry Service (RES)* form. The numbers are shown in brackets below. Enquiries will be forwarded to the organisations concerned.

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JOCCA

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Please also send information on the following items relating to the above:

Photocopy or cut out this form and send to:

Journal of the Oil and Colour Chemists' Association

Priory House, 967 Harrow Road, Wembley, Middx., HA0 2SF, England
 Telephone: 01-908 1086 Telex: 922670 (OCCA G)

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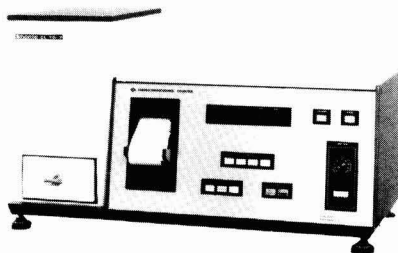
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Send completed form to: Martin Hill, Longman House, Burnt Mill, Harlow, Essex, CM20 2JE, England.

George Godwin 

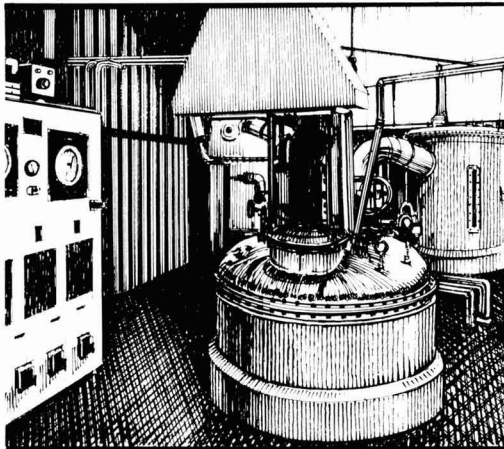
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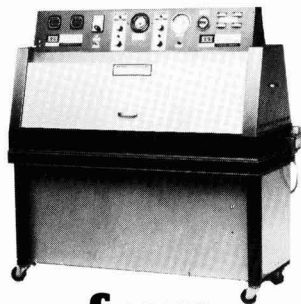
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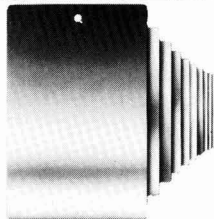


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