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JOCCA

HIGH DURABILITY

EXTERIOR VARNISH STAINS

Also in this issue:

- Accelerated drying techniques
- Computer assisted match prediction and quality control
- What can we do when things go wrong in the printing processes

Enclosed: Message from the President regarding retiring Director & Secretary's Gift Fund

Journal of Oil and Colour Chemists' Association,
Priory House, 967 Harrow Road, Wembley, Middlesex, HAO 2SF, England.

JOURNAL of the OIL AND COLOUR CHEMISTS' ASSOCIATION

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Transactions and Communications

OIL AND COLOUR CHEMISTS' ASSOCIATION
Priory House, 967 Harrow Road, Wembley, Middlesex, HA0 2SF England

Accelerated drying techniques*

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Summary

Accelerated drying using high efficiency techniques such as ultra violet and infra red energy is being utilised on more and more printing presses. This was first developed for sheet fed litho printing of cartons and metal decorating but is now used to produce a much wider range of packaging as well as for web fed applications such as direct mail and magazine covers. A further major growth area is in protective and decorative varnishing.

This paper examines four different high energy drying processes: infra red, ultra violet, hot air and electron beam, the present generation of press dryers and some possible areas of development.

Introduction

With the process of applying wet conventional inks onto various types of substrates the ink will take time to dry. The drying process is normally through the absorption into the substrate itself, the evaporation of the solvent to atmosphere and the oxidation of the ink itself.

These processes take time and therefore as the substrate leaves the last printing station the ink will still be comparatively wet and if the reverse side is brought into contact with a previously printed area, such as would be experienced in a sheetfed press the ink would set-off on this reverse side. For many years now this has been overcome by the application of spray powders onto the surface of the print which prevents the subsequent printed sheet coming into contact with it. This overcomes the problem of set-off but leaves the surface of the sheet with a rough feel due to the spray powder being trapped in the ink.

If the printed material has to be reprocessed for additional colours and is to be subjected to cutting and creasing (or similar processes) then time must be allowed for the natural drying process to take place before any further work can be started.

In the current industrial climate printers have found more and more pressure on them to process their work much faster but at the same time maintain and even improve on the quality of the final product.

Infra-Red

The first and most logical method is to find a method of drying the conventional ink more rapidly. The most common method for this is to raise the temperature of the ink and substrate causing both a faster evaporation of the solvents and an increase in the speed of oxidation.

On an offset litho printing press it is normal to use a form of infra-red mounted in the swan neck delivery of the press.

Infra-red radiators are normally classified in wavelength bands and are described as long wave, medium wave and short wave. Each vary in their effectiveness for use in the process.

Long wave is sometimes referred to as black heat. Its output has very low penetration effects and would rely on long exposure times to allow the ink and substrate temperatures to be raised sufficiently to evaporate and oxidise the inks.

Medium and short wave infra-red radiation systems are more suitable mediums for ink drying processes. Both have advantages and disadvantages in operation.

Short wave infra-red has the advantage that it can be switched on and off almost instantly which means that no time is wasted waiting for the full power output to be reached. Short wave has very good penetration both to the ink and to the substrate. However, because the lamps are made only in short lengths they have to be mounted longitudinally to the substrate direction. This of course means that if output power needs reducing then a thyristor control is required in order to reduce all the lamps at the same time. This control system can make installations expensive. Although penetration of the ink is very desirable, too much temperature rise of the substrate can be a disadvantage.

Medium wave infra-red systems, the type produced by Wallace Knight, do take a little longer to reach full operating output and unless the printing press is stopped in an emergency are normally left on throughout the day's operation.

The lamps made by Wallace Knight are manufactured in lengths to suit most widths of printing operations and can be mounted across the width of the substrate. This allows for a very simplified power selection which is normally performed by switching banks of lamps on and off as required.

Medium wave output has less penetration than short wave leaving the substrate generally of a lower temperature and the spectral output conforms closest to the response of the organic materials in the inks thus achieving a quicker drying operation.

Infra-red systems have been used for many years but in most cases reduced amounts of spray powder are still required to prevent set-off especially when heavy solids are being printed. This of course still gives the surface a rough feel. Additional time, although less, is still required before secondary operations can be performed.

Ultra-Violet

In the early 1970's new methods and ideas were developed to try to overcome these problems and with the technology already gained in the manufacture of printing plates, silk

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screens and electronic printed circuit boards by photopolymerisation it was a logical step to develop ink systems which would also polymerise when exposed to a high intensity light source, normally in the ultra-violet spectrum.

An ink system used for this technique is totally different from conventional systems. Instead of the ink being made up of solvents, resins and pigments, the ultra-violet curable inks are made up of monomers, pigments and photo initiators. When the ink films are exposed to UV light the system polymerises almost instantly giving a cured dry ink film keyed to the substrate surface. The system is 100% solids, containing no solvents, does not rely on absorbtion and because it is cured can be re-worked immediately.

As with infra-red accelerated drying a suitable ultra-violet light source has to be built into the printing machinery to initiate cure prior to the substrate being delivered to a stack or a reel.

Ultra-violet light is part of the electrogenetic spectrum and falls on the other side of visible light to infra-red.

There are several types of light sources available capable of generating the correct ultra-violet wavelengths required. The most commonly used light sources are:

1. High pressure mercury arc capillary lamps.

2. Electrodeless mercury arc lamps.

3. Medium pressure mercury arc lamps.

As with infra-red the wavelength generated by each light source has advantages and disadvantages.

1. High pressure mercury arc capillary lamps. Due to the construction, design and operating features of these lamps they must be water cooled. All mercury arc lamps run at relatively high temperatures in order to maintain the mercury as a vapour; temperatures up to 800°C can normally be expected. Start up is instant and output per linear centimetre is usually high. However, running life tends to be around 800 hours maximum and changing the lamps can be a lengthy process. Lamps are only made in a limited number of sizes and maximum lengths up to 100 cm only are made.

2. Electrodeless mercury arc lamps are as the name implies electrodeless. The arc is struck and maintained across the lamp by use of microwaves generated by magnatrons at each end of the lamp. These lamps have the facility to be instantly started therefore saving energy when in use. However, once again lamps can be produced and operated at relatively short lengths which means that many lamps would need to be arranged across wide sheets or web width. As each lamp has a magnatron at each end this means a very expensive and cumbersome installation.

3. Medium pressure mercury arc lamps, the type manufactured by Wallace Knight, have the advantage that they are relatively cheap, easy to install and maintain and can be produced in lengths up to and beyond two metres. MPMA lamps however require time on start up to reach full output power but this is overcome by the installation of a standby mode, i.e. once the lamps have reached full operating power, unless the printing equipment is working, the control is designed to drop the lamps to 50% power which, when the printing equipment is started, will allow the lamps to come up to full power instantly. These lamps are the most widely used in accelerated drying systems.

Having a suitable high output UV lamp on its own is insufficient to ensure that the maximum amount of UV energy generated is directed to the substrate surface. This of course can be achieved by the use of a reflecting medium. The material chosen is a high polished aluminium having been found to have the best reflective properties for UV light. In web and conveyorised installations elliptical shaped reflectors are used and can be positioned accurately to give the highest intensity of the focal point on the substrate surface. However, in a sheetfed press, the reflector assembly is normally mounted between the gripper chains with the grippers passing in front of the lamps.

This gives rise to two possible problems. One, the focal distance from one press to another will be different and two, the grippers themselves will cause a shadow and a lack of cure on the gripper edge. Wallace Knight overcomes these two problems by firstly designing each reflector shape to give the optimum focal distance in each press installation and secondly integrating into this design their patented angled reflectors which directs the UV light behind the grippers therefore minimising shadow caused by them.

As has been stated earlier, UV lamps generate heat. Firstly, because the lamp has to run at around 800°C in order to maintain the mercury as a vapour and secondly because 60% lamp output is infra-red emission.

The simplest way of dissipating this heat is by the use of high volume air passed both over the lamp and the reflector. This also serves to remove the ozone produced by the shorter UV wavelengths generated by the lamp.

However, when the substance is heat sensitive, excess infra-red output has to be removed. This can be done by placing a water filter in front of the lamp, the water flowing through quartz tubes removing the heat. This however also tends to filter out some of the UV making the system less efficient. It also makes maintenance of the system difficult as the water has to be drained and the tubes removed in order to clean the reflectors and to replace the lamp. Additionally the water has to be deionised and filtered to ensure that it continues to allow UV through.

The other method, which is the one chosen by Wallace Knight, looks after the substrate and allows the full UV output onto the surface of the material being processed. This is done by placing a water cooled heatsink behind the substrate which maintains the substrate at relatively low temperatures.

In some installations of course where space is restricted water cooled reflectors are also used which prevents excess heat build-up in machinery parts.

Hot air systems

Another method which is gaining some popularity in certain market sectors is to coat conventional inks with a fast drying water based lacquer applied onto wet inks. As can be seen this would again eliminate the need for spray powders.

The advantage is that surface finish is improved and some gloss levels achieved but it must be remembered that the inks will still take the same time or maybe longer to dry for reprocessing. Many printers produce four colour process work on a two unit press using UV drying. Sheets can be printed first with two colours, then, because they are completely dry, they may be turned immediately and sent through the press for a second pass to add the final two colours. When using conventional inks and lacquers in combination with IR and hot air systems several hours must elapse between passes to ensure complete drying of the first two colours.

In the large volume carton industry demands are being made for accelerated drying systems suitable for these water based lacquers.

There has to date been varying opinion on what system is required, from the use of a simple IR system to high volume hot air with a high velocity air knife blowing across the substrate surface.

At Wallace Knight it was decided to design a system which met the large proportion of the demands. This system has a pre-heat infra-red module with high volume warm air removing the water from the substrate and an extraction system to remove the moisture ladened air. Systems of this design can be built into the delivery of sheetfed litho presses.

Electron beam

In a continued search for faster more efficient drying systems the techniques of using high energy electrons to polymerise coatings and inks have been developed. The process had been known for many years but had never been considered as a serious contender to other accelerated drying systems in the printing industry. Within the last few years however, with continued examination of energy costs and emission controls, developments have been made both in equipment design and in suitable inks, varnishes, adhesives etc.

The principle of Electron Beam is that a heated cathode is housed in a vacuum chamber in which a foil window is mounted. This window becomes an anode and a high potential voltage is generated between the two. The electrons at the cathode are accelerated close to the speed of light and at these speeds up to 70% of the electrons produced pass through the window and onto the substrate surface.

When electrons are accelerated at these speeds some radio-active particles are produced, although these are minimal the systems are all shielded to prevent any exposure of these particles.

Currently the systems lend themselves to high speed ink applications and one of the most well known is the production of TETRA PAK cartons. These are produced at 360 m/min, four colours and a varnish, instantly dry.

The two major disadvantages are however, that the cost is extremely high in comparison with other techniques and although there is still extensive development of new systems the units are fairly large and bulky.

Combined drying systems are now being manufactured and the figures below show several machines available on the market. Figure 1 shows a UV/Hot air drying system where waterbased and UV inks are catered for. Figure 2 shows a UV/IR/Hot air drying system. This meets the requirements of both a UV/Hot air system in Figure 1 and a UV/IR system where conventional litho inks for IR assisted drying are also used.

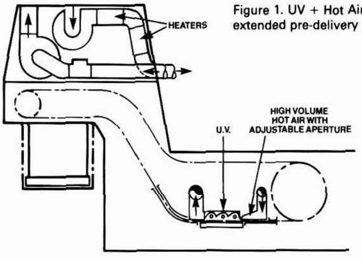

Figure 1. UV + Hot Air Drying System in an extended pre-delivery press section

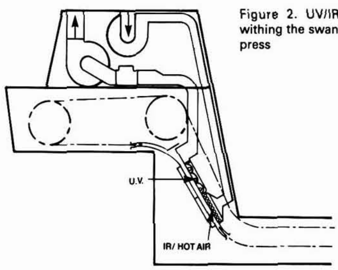

Figure 2. UV/IR/Hot Air Drying System withing the swan-neck section of a high-pile press

Computer assisted match prediction and quality control*

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Abstract

The use of computer assisted match prediction and quality control has become widespread throughout the print industry. This paper: a) gives a brief summary of the colour theory behind such computerised systems, b) discusses the practical aspects involved in the initial setting up of the necessary data bases and c) gives an indication of the major benefits to be gained from the use of instrumental colour control, with particular reference to the ink manufacturer.

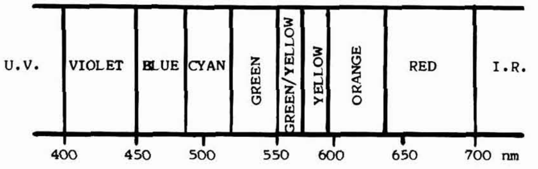

Figure 1. The visible spectrum.

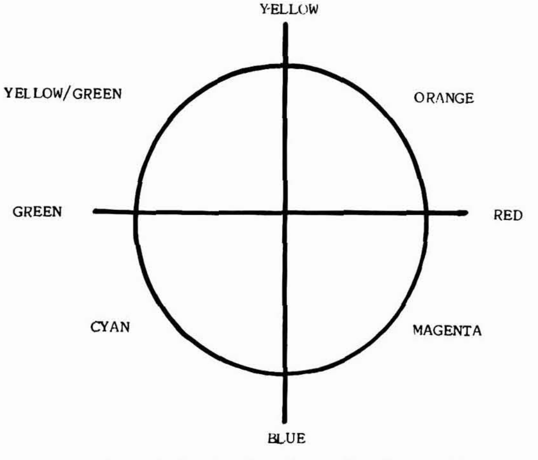

Figure 2. Hue circle showing the major hues which are distinguishable by the human eye.

Why do we need computer assisted colour matching and quality control?

When matching by eye an experienced colour matcher knows instinctively which combinations of inks will give a particular colour. However, matching can often be a lengthy process and need not produce the cheapest or least metameric match. When a computer is involved in the matching, it is able to scan the spectral properties of a number of inks very quickly and should give rise to the optimum match in terms of cost and metamerism. For quality control of inks, it is essential that any adjustments in strength or shade should be carried out as quickly as possible. Although it is relatively easy for an experienced quality control technician to adjust the strength of an ink, the shade adjustment can often cause delays, which can be minimised if computer assistance is involved.

The spectral properties and hence colour of an ink depend on the relative amounts of light of different wavelengths that the ink reflects. Normal daylight ("white light") contains a mixture of coloured lights of different wavelengths, which comprise the visible spectrum (see Figure 1). These are the colours which are seen in a rainbow, or when white light is passed through a prism. Mixtures of different amounts of these colours give rise to the range of shades that we can see around us.

To be able to use computers in match prediction and quality control we must be able to quantify colour numerically. The Munsell system describes colour in terms of three dimensions, Hue, Lightness and Chroma. The difference in colour quality between violet, blue, green, yellow, orange and red is called hue. The human eye can distinguish four distinct hues; blue, green, yellow and red. All others are blends of any adjoining two of these four when they are placed in a circle (see Figure 2).

Colours can also be described in terms of lightness and chroma. By increasing the intensity of a light source the "lightness", or luminence, of a colour can be increased. Chroma gives an indication of the amount of saturation of a colour. The colours of the spectrum are the purest and most colourful that can be produced. They consist of light of a single wavelength and are said to be saturated. If the spectral colour is diluted e.g. with white, then the colour is said to be "desaturated".

The Munsell system is incorporated into the CIE CieLab colour difference equation. This enables the plotting of data so that Munsell colours form nearly uniform circular loci about a neutral point at given value levels. This enables us to express changes in hue, chroma, lightness and overall colour change (ΔE) between two samples in easily understood numerical terms.

Hue (ΔH) = Shade, Colour
Lightness (ΔL) = Lightness, Darkness, Paleness, Greyness
Chroma (ΔC) = Brightness, Saturation, Intensity
ΔE = Total Colour Difference

Generally, the eye can distinguish a difference between two samples (batches) if $\Delta E > 0.7$ CieLab units. However, this will vary somewhat as the eye is more sensitive to certain colours, particularly green.

The colour of an ink depends on which wavelengths of light the ink reflects e.g. a red ink appears red because it

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absorbs all wavelengths of light, apart from those at the red end of the spectrum. If the ink reflects some of the blue light as well as the red, it will appear to be a magenta. It is this property of an ink which is used in a computer colour matching system. The measuring part of the system, the spectrophotometer, records the percentage of light that a sample reflects of each wavelength throughout the visible spectrum. This will produce a "reflectance" curve for the sample, e.g. the reflectance curve for a typical green ink is shown in Figure 3.

If two samples have the same reflectance curves throughout the visible spectrum it can be definitely stated that their colours are physically identical and will appear the same to all observers under *all* conditions of illumination. A problem often encountered in colour matching is *metamerism*. Metamers are pairs of colours which appear the same under certain conditions of illumination, but which have different spectral compositions. By using a computer match prediction system problems of metamerism will be minimised, as the computer can reject any combinations of inks that are badly metameric.

To be able to use the computer for match prediction/Q.C., it is necessary first to load in a data base. The sample preparation for this needs to be done very carefully. For each colour to be used a range of ink dilutions needs to be prepared. In theory any colour can be matched using cyan, magenta and yellow inks. However, these are ideal colours and in practise do not cover the spectral range. Thus other pigments need to be added to the range to give full coverage. When preparing data base samples special care should be taken in weighing, mixing and printing. It is necessary also to decide on which substrate to use for the data base. For printing ink manufacturers that need to use a vast number of boards and tinplates for matching, it will probably be necessary to use a number of data bases on selected substrates. It is always better to use a good quality board or plate as the main substrate rather than a "dirtier" one, as it is much easier to make a matching dirtier than it is cleaner.

The printing technique used for data base preparation is crucial. If using a Duncun-Lynch there are a number of factors that can affect the final print:

1. Operator error. Different operators get different results, thus when preparing data base samples there should be only one operator.

2. Transfer. The same ink can transfer differently depending on a) the state of the blanket on the transfer roller, b) temperature of the unit i.e. if it has been used constantly throughout the day the ink will transfer better, c) laboratory temperature, ideally this should be controlled, if it is not then different ink viscosities result and transfer is affected.

For quality control the issue is complicated further as Q.C. tends to use wet inks with comparisons by drawdown. Therefore, a modified technique needs to be used that takes this into account.

When all of the samples have been prepared they are measured on the spectrophotometer and loaded into the computer. The computer does not use the data in the reflectance form, but instead transforms it into K/S data

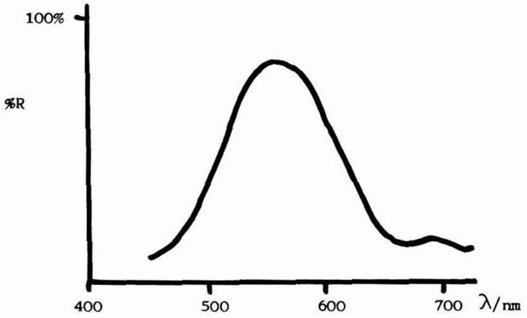

Figure 3. The reflectance curve of a typical green.

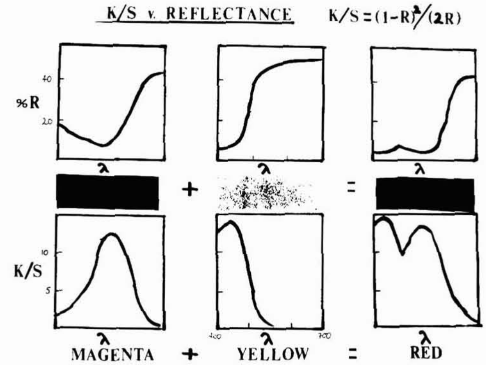

Figure 4. Comparison of the k/s curves with the reflectance curves of magenta, yellow and red inks.

(where K/S is the absorption at a specified wavelength). From the example shown in Figure 4 it can be seen that using reflectance data for a magenta and yellow mix, it is not easy to predict what the reflectance curve for the resultant red will be. However, using K/S plots it is clear that magenta + yellow = red.

Also, K/S can be made fairly linear with pigment conc. Thus if for a single pigment one knows the K/S value at a given wavelength for unit concentration of the pigment, then the amount of pigment can be determined for any K/S value. Further, the K/S function is additive, i.e. at any wavelength the K/S due to one pigment may be added to that due to another pigment in a mixture of the two.

Once the data base is loaded the system can be used for matching and colour difference routines. An unknown sample to be matched is measured by the spectrophotometer. The computer is then told by the operator which data base to use for matching, i.e. carton base, paper, enamel etc. and scans the appropriate K/S data. It then selects combinations of inks which "match" the sample to a fixed limit for ΔE (i.e. overall colour difference). These matches are priced and show the value of ΔE under different light sources, thus indicating metamerism. Match predictions which are a long way off target can be adjusted using the computer correction routine. This program is also used for assessing ink batches in quality control. The computer compares the standard with the ink batch (i.e. either the first match prediction or a production batch) and shows how the batch differs in terms of ΔE and ΔC, ΔL and ΔH under different light sources. It will then give either a new formula or a batch addition. For

Q.C. purposes it is possible to "store" standards of colours in a shade library. Batches can then be compared to the standard and given a pass/fail rating to preset limits. However, to do this for printing inks it must be ensured that the reproducibility of prints/drawdowns is excellent and for ink manufacturers especially should only be done in conjunction with other Q.C. techniques, e.g. white reduction strength tests. The intensity routine in the colour difference program can be used to check incoming pigments. This routine gives apparent strength and actual strength differences between a standard and a batch. These two percentage differences should be identical and preferably zero. If the apparent strength of a pigment batch is higher than the actual strength cf. the standard, then this is an indication that the strength of the batch has been boosted by the addition of black or white.

Summary

Instrumental colour control advantages:

More rapid matching

The system can generate a wide choice of formulations. These are priced and indicate whether the matched will be metameric, thus enabling the colour matcher to select the best match in terms of metamerism and cost effectiveness.

Improvement in QC/production efficiency

Production batches requiring adjustment can be corrected faster.

Shade library

Shade library prevents duplication of matchings and can be used to store standards for QC.

Improvement in ink and board quality

Numerical QC procedures for the evaluation of incoming inks/pigments and boards can reduce production variability. Numerical QC procedures for the colour of finished goods can result in improved consistency of finished goods quality and facilitates agreement of colour tolerances with customers.

next month's issue

The Honorary Editor has accepted the following papers for publication in the March issue:

Colour quality control instrument system with special reference to the printing of gold labels *by C.E.A. Lewandowska, Philips Analytical, Cambridge, UK.*

Sources of toxicological information *by L. A. O'Neill, Paint Research Association, London, UK.*

The influence on corrosion of the adhesion of a coating to a metal substrate *by K. R. Gowers and J. D. Scantlebury, Corrosion and Protection Centre, UMIST, Manchester, UK.*

Water-soluble compositions based on maleinised bisphenol derivatives of fatty acids *by A. M. Ramadan, M. Moustafa, S. I. Darwish and A. M. Naser, Chemistry Dept, Al-Azhar University, Cario, Egypt.*

What can we do when things go wrong in printing processes*

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Abstract

All printing and coating processes are complex in character. This paper attempts to highlight these areas of complexity and the nature of problems which can arise. In order to optimise processes and product quality we must have an understanding of the many types of interfacial phenomena which operate during processing. Although the paper is somewhat general in character, it is hoped that the contents will arouse sufficient curiosity to cause you to ask "What can be done when things go wrong in our printing/coating processes?" Perhaps you will then be motivated towards gaining greater insight of the scientific aspects of printing/coating technology.

One of the features of being involved in the scientific aspects of printing and surface coatings/treatment processes is that it is soon realised that the systems encountered are often extremely complex from various standpoints.

Problems which arise and questions which are asked from many parts of the industries require solutions and answers which can only be acquired after a degree of study or understanding.

Thus, whilst it may not be possible to have a complete understanding of individual processes, it is possible to have a reasonably deep knowledge of systems and to recognise similarities and differences with regard to the various technologies.

It is this search for knowledge and understanding that provides us with a basis for being able to deal with problems as they arise and to cope with the point given in the title 'What to do when things go wrong in printing processes'.

Problems may be met in various ways but each requires a knowledge of the system in hand. This allows us to recognise:

- That something is going (has gone) wrong,
- the need to be able to define the problem in qualitative terms,
- the need to predict the consequences in both qualitative and quantitative terms,
- the need to be able to (free to) communicate the difficulty to others,
- the identification of corrective measures,
- the identification of causes of the problem,
- the need for prevention of recurrence.

The last point is perhaps the most important one. Problems will always be with us as the new technologies continue to encroach on established skills. New concepts, new materials, new designs, new processes, new equipment, indicate that there will always be problems. However the time is long past when problems could be handled on the basis of the application of craft skills. Now we are in the age of requiring to know about, understand and exploit those scientific principles which underlie so much of the work we do.

Perhaps it would be meaningful to rationalise a process in terms of the physical-chemical factors associated with operation.

One key-word which is often bandied around is that of communication. It is a relevant concept in the printing industry and in related fields such as coating, lamination and conversion. Many of our everyday problems could be alleviated if not removed by better communications:

- Within the printing section concerned.
- Between management and work-force.
- Between different, connected sections of same factory.
- Between supplier and user.
- Between user and converter.
- Between converter and packaging/publishing house.
- Between packaging/publishing house and consumer.

The problems thought of as being within the realm of better communication are often limited to public awareness, public and worker relationships and so on. However there is a need for better communication/understanding of the scientific aspects.

The various aspects of problems which arise will be considered, beginning first with attempts to bring various features to the forefront, then rationalisation of the physical-chemical aspects of processes (with reference to some particular instances) and a consideration of what appears to be relatively common and complex sources of problems.

Initial observations

It seems a logical proposition that a solution to problems involves a knowledge of the process or processes in question. This can be taken to include suppliers' incoming raw materials and their quality, the properties possessed by the converted outgoing materials and recognition that the

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industry is a compartmentalised one which implies the need for effective communication and planning. It is a fact of life that problems are rarely anticipated and all too often arise as a very unpleasant surprise and source of near panic. Examples in which the level of compartmentalisation occurs in the printing and related industries can be seen by considering the range of raw materials suppliers, the ink/coatings formulators, the printer/coater, foil blocking/crease and cut, packaging, thermoformer/sealer, distribution/marketing, selling/consumer, and so on.

The problems become more complex when consideration is given to the various printing processes, each of which carries its own special requirements, formulations, and properties. In the modern context, there appears to be an acute shortage of understanding regarding the real nature of systems being developed. There is also a shortage of technically skilled formulators.

In order to understand the nature of the behaviour of what are, after all, complex physical-chemical compositions we must pay attention to aspects such as:

- Formulation and rheology.
- Dispersion and dispersion stability.
- The substrate type, assembly and composition.
- Wetting phenomena.
- Film formation.
- Coating techniques/printing techniques.
- Diffusion and migration effects.
- Adhesion factors.
- Drying/curing behaviour and consequences.
- Film failure.

In several instances, e.g. UV curing, electron beam curing, heat reactive coatings and so on, attention should be given to understanding the fundamental features associated with:

- The nature of the system.
- Mechanistic aspects.
- Kinetic aspects.
- The functionality and changes in functionality.
- Energy input, type and amount.
- The interfacial factors.
- Mixing phenomena.

Rheological factors

Initially we can think of the rheological behaviour of the systems we work with. Their inherent non-Newtonian character can be either a blessing or a nuisance depending on the task in hand. Thus non-Newtonian, good litho formulations can give rise to problems in cleaning-up, etc.

From the rheology standpoint we need to consider:

1. The nature of the dispersion process (What is it trying to achieve?).
2. The nature of the application process (How many shear fields are there and what is their nature? Other similar questions arise).
3. The presence of any opportunities for relaxation phenomena to operate.
4. The effect of temperature variation.
5. The effect of shear rate variation with regard to: processing, storage, application, drying, solid-state properties, the tendency towards settling in terms of stabilisation and compatibility.

From a compositional viewpoint, rheological factors might include:

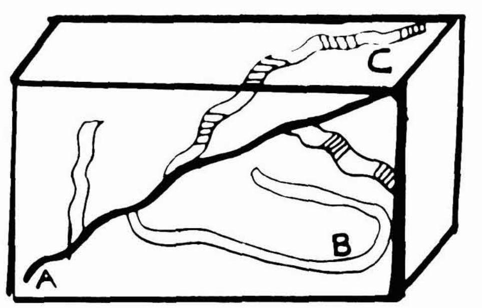
- The nature of the continuous medium.
- Resin types.
- Film formers.
- Reactive diluents.
- Pigment type/loading.
- Additives (used singly or [more commonly] in combinations).
- The development of preferential adsorption phenomena.

Consider just one of these components, either the resin or the film former. Envisage the complexities that can arise when the composition is formulated. The various types of interaction must be understood and catered for if the stability characteristics of the system are to be optimised and maintained. The example shown in Figure 1 relates to copolymeric species and deals with the importance of the microenvironment of the polymeric phase. Similar factors

Figure 1. Schematic representation of the microenvironment of a copolymer system.

A = Backbone polymer, B = Homopolymer graft, C = Block-copolymer graft.

In addition, the backbone may be a block copolymer.



can be envisaged as being important for other species in the composite system.

Figure 1 gives food for thought in this context. The figure shows a complex situation in that it envisages the situation experienced by a graft copolymer containing block copolymeric grafts on a homopolymeric backbone. This is a relatively extreme case. However, many ink and surface coatings formulations are based on various mixtures of homopolymers, copolymers, blends of copolymers with homopolymers, film formers and resins and so on. The continuous medium may comprise a single solvent or a mixed solvent system. The macromolecular species are competing for solvent with pigments and other components which may have large surface areas and be "greedy" for solvent. We should, ideally, be able to provide an understanding of the nature of the microenvironment. This is clearly an impossibility owing to the complex nature of the various types of interaction which operate. Yet the polymer system has to operate in this microenvironment. This implies that various shear zones, temperature effects and heterogeneities will be experienced during such operation. Consideration of these types of factor give a basis to problems which can and, all too often do, arise during changes to operating conditions, composition, technologies and so on. Generally we resort to simplification of the interactions.

Coating factors

Those factors which influence process operation are considered here, concentrating on the printing/surface coatings industries. Features of interest include the following:

- The viscosity/tack of the formulation.
- The ink/coating stability throughout processing.
- Substrate stability, registry and runnability.
- Substrate uniformity.
- Process uniformity in design, delivery, drying/curing and solvent recovery (where relevant).
- Efficient and effective use of coating/ink formulations.
- Achievement of satisfactory physical performance and effects.

Let us consider one area of importance to printing operations; that of wet in wet printing on multicolour presses. Presses are designed in such a way that the time interval between stages varies considerably. This places significant demands on the logic of print deposition and, subsequently on the rheology of formulations. Typically the order of deposition involves the most viscous/tacky system first and the least viscous/tacky system last. This applies to the various multicolour operations whether rotary or sheet fed. It is particularly important when the time interval between stages is short, when the time provided for relaxation phenomena to operate is restricted. Hence the order of application is from higher to lower viscosity in the formulation.

Printing and coating processes are heavily indebted to interfacial phenomena. One is continually trying to bridge or control interfacial regions or barriers in which the zone may concern monolayers or entrapment via multilayers.

Factors influencing coating operations include:

- The coating/printing method.
- The substrate (e.g. porosity and roughness).
- The ink/coating system.
- The presence of anti-set-off agents in preceding layer.
- The possibility of surface activation.
- The type of surface activation.
- The surface tension character of the coating.
- Storage time and conditions applied to printed stock prior to coating.

Coating can be rationalised into three broad categories at each stage of the coating process from delivery to drying. Thus consider:

- Drainage—free or restricted.
- Withdrawal—steady or unsteady.
- Removal—flux parameters, separation, mass loss, positioning effects.

Wetting phenomena

Once the ink/coating has been applied there is a requirement for wetting. Factors of importance include:

- The γ_c of the substrate.
- The surface tension of the coating.
- Contamination of surface.
- Surface roughness or heterogeneity.
- Surface type—i.e. cellulosic, metallic, ceramic, plastic and composite.
- Nature of any modifications to coating deposition.

Behind wetting lies the idea of overcoming the inherent cohesion of the liquid (coating) and using the energy released, together with the surface free energy of the substrate to provide the onset of wetting. Contact angle phenomena can be used. Contact angles can be measured on a surprisingly wide variety of coated, printed or untreated stock. Success depends on the choice of fluids and on a successful measuring technique. Such a technique has been optimised and gives reproducible, meaningful, quantitative results on a large variety of surfaces. Even on more porous substrates, the results can be interpreted in such a way as to provide a very useful, quality-control test of stock uniformity.

With regard to wetting phenomena, one must not restrict oneself to consideration only of surfaces of substrates. An example is seen in pigment wetting during ink assembly in conventional media. This is of vital importance when considering systems containing mixtures of pigments. Such pigments will have different surface areas, chemical composition, densities and hence wetting characteristics. The nature of the stability of each pigment type will also differ. This difference can be enhanced on change of the environmental conditions such as shear or temperature.

Even in simple systems, large differences are seen. In complex media the differences may or may not be greater. The problem lies in being able to define or specify the level of predictability of behaviour of the system. Perhaps we should consider the idea that the practically ideal system is a thermodynamic disaster in the sense that it is far from being thermodynamically ideal. Equally a thermodynamically ideal system would be well understood, but useless.

Routes to pigment stabilisation in media have taken various forms which can be summarised loosely into two general areas namely stabilisation by electrokinetic phenomena and steric stabilisation as shown in Figure 2.

In steric stabilisation we use interference with the natural tendencies of particles to associate, as a means of providing stability for the dispersion. Such stability might still have a basis in electrokinetic phenomena (electrosteric stabilisation) but can also arise purely because of the presence of attached, bulky chains. Care needs to be exercised over relationships between the bulky chains and solvents or continuous media. In the absence of such care problems arising from solvent/media depletion may occur, each leading to instability resulting in the onset of flocculation.

Again one recalls that the inks and coatings formulations are handled in a dynamic fashion in various shear zones. Thus we are deeply involved in electrokinetic and steric-kinetic phenomena which may assist or inhibit stabilisation depending on the nature of the individual system. Perhaps we should emphasise the individuality of each system so that generalisations concerning assumed behaviour can be avoided.

If wetting is a requirement, then the golden rule is that the surface free energy of the substrate must be greater than the equivalent surface tension of the material being deposited. The surface can be temporarily activated in various ways. Equally, coating formulations can be modified to produce novel migratory effects to yield differential surface tension characteristics.

The wetting tension value of various substrates is shown in Table 1. This gives a clear insight into the nature of difficult materials in terms of wetting.

Thus we need to acquire the surface tension of a series of liquids and monitor the angle of contact, θ, which is formed when these liquids are placed on the substrate in question. This usually involves the plotting prodecure shown in Figure 3. Extrapolation to $\cos\theta = 1$ ($\theta = 0$) implies that the condition of complete wetting would be achieved by a liquid composition of the particular surface tension characteristics. Table 1 also shows the significance of surface activation and of the inclusion of wax additives in formulations. Generally, the less the level of adhesion, achievable as a consequence of wetting, the steeper is the gradient of the cos θ versus $\gamma_{S/L}$ plot. Treatments designed

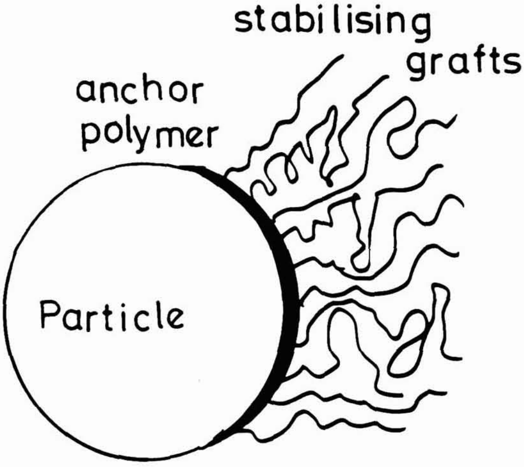


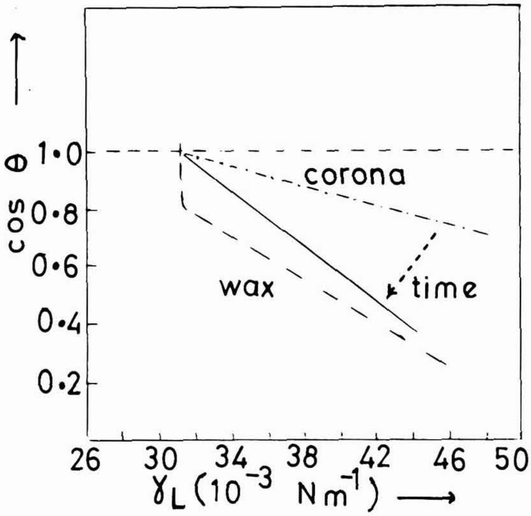
Figure 2. Approach to the steric stabilisation of heterogeneous particles.

Table 1

Critical wetting tension values of typical polymer surfaces

Material	γ_c of Solids (20°C) γ_cx10^{-3}Nm^{-1}
PTFE	18.5
PVF	28
PET	30
PE	31
PS	33
RCF	34
PValc	37
PMMA	39
PVC	40
Nylon 66	47
Metals	~57

Figure 3. Aspects of surface activation by corona discharge treatment.



to improve wetting and adhesion can be assessed for their effectiveness by use of this relatively simple procedure.

Examples of application are shown in Tables 2 and 3. Table 2 shows that surface brushing of a variety of printed surfaces, markedly enhances the wetting tension of the prints and renders them more amenable to subsequent coating by a wider variety of coating formulations. Table 3 reviews the effectiveness of various activating treatments. One can draw various conclusions from these data. Again caution must be used since each system should be considered because of its individuality. Naturally, similarities in behaviour are seen but this should not be used as an excuse for not seeking and appreciating unexpected behaviour.

Surface activation provides a temporary change in wetting behaviour. The activation shows decay patterns which are time and humidity dependent. Generally, the concern lies with creating an enhanced degree of surface polarity which can be utilised in establishing wetting.

The surface tension character of a variety of coating systems is shown in Table 4. Relating these to substrates can give obvious selections, if wetting performance is the main criterion.

The nature of the inter-relationships which can be achieved is seen by viewing the critical wetting tension characteristics of a series of polymeric solid surfaces as shown previously in Table 1. Here poly(ethylene ethylene) PTFE, poly(vinyl fluoride) PVF, poly(ethylene terephthalate) PET, poly(ethylene) PE, poly(stryene) PS, regenerated cellulose film RCF, poly(vinyl alcohol) PValc, poly(methyl methacrylate) PMMA, poly(vinyl chloride) PVC, Nylon 6, 6 and various metals. Again we note that the relationships, in terms of achieving successful wetting, require that the surface tension of the coating/printing fluid should be less than the critical wetting tension of the substrate being coated or printed.

Adhesion

Having generated a situation where wetting is a reality we are now in a position to consider the question of adhesion. Here we must not get confused with mechanical entrapment. These are two different effects, each of which is of importance to printing, coating and lamination processes.

Various theories have been developed to explain the mechanism of adhesion. These include the adsorption theory, electrostatic theory and the diffusion theory. Most systems show great sympathy with the concepts that develop from consideration of adhesion as having its basis in all three theories. Generally the dominant feeling from the applications viewpoint considers adhesion to develop into a diffusion based process. Thus the temperature, the pressure and the time dependence of many adhesion/entrapment processes can suggest the relevance of a diffusion theory.

One can speculate that the faster the drying/cure rate, the more likely it is that the process relies on adhesion rather than mechanical entrapment.

Problems in adhesion arise from many fronts including:

- Migration of species from within the substrate to the surface.

Table 2

Influence of various activation methods on the surface wetting tension values of printed substrates. Activation: Base inks, no additives, activated, no spray.

	Surface Wetting Tension (mNm^{-1})				
	No activation	Brushed	IR	UV*	Ionised
Black	33.7	35.7	33.4	33.1	36.7
Lightfast Scarlet	33.2	36.1	33.3	32.8	37.5
Orange	33.3	35.9	33.2	33.1	36.9
Varnishable Scarlet	33.8	35.9	33.3	33.2	37.8
BS Red	32.7	35.9	34.0	33.1	35.7
Crimson	32.9	35.9	33.0	33.7	35.4
BS Blue	33.5	36.0	33.4	32.9	37.1
GS Blue	34.4	36.7	34.4	33.4	35.4
Royal Blue	33.4	35.9	33.5	33.0	34.8
Violet	33.4	36.4	32.9	33.2	36.1
RS Yellow	34.2	35.9	33.8	33.2	36.8
GS Yellow	33.5	36.3	33.4	32.7	35.3
Green	33.0	36.2	32.8	34.0	37.1

Table 3

Influence of drying conditions, after activation by brushing, on the surface wetting tension values of printed surfaces. Effect of drying conditions: Base inks, activated by brushing, no spray, no wax.

	Surface Wetting Tension (mNm^{-1})		
	Open Drying	Stack Drying	No Brushing
Black	35.6	35.9	33.1
Lightfast Scarlet	36.2	36.0	33.2
Orange	36.0	35.9	33.2
Varnishable Scarlet	36.0	36.0	33.7
BS Red	36.0	35.8	32.9
Crimson	36.1	35.9	32.9
RS Blue	36.3	36.2	32.9
GS Blue	36.7	36.7	33.0
Royal Blue	36.2	35.8	33.5
Violet	36.4	36.2	33.0
RS Yellow	36.1	35.9	33.7
GS Yellow	36.1	36.3	33.4
Green	36.3	36.2	32.9

Table 4

Wetting tension values of selected, commercially available varnish types

	Varnish Wetting Tension Values	
Supplier	Application	Wetting Tension @ 25°C in Nm^{-2}
Coates Bros	Rollercoat	32.9
Process	Rollercoat	28.6
Crown	Rollercoat	25.3
Macpherson	Rollercoat	28.2
Swale	Rollercoat	36.5
Process	Litho	25.7
Coates	Litho	27.2
L & B	Litho	29.2

- Unfavourable molecular configurations.
- Low molar mass impurities in the surface.
- Insufficient work of adhesion.
- Lack of diffusion, cut or entrapment.
- Insufficient wetting.
- Incorrect speed/rheology factors.
- Insufficient time.
- Too rapid an onset of drying/cure.

Various routes to adhesion promotion arise. Perhaps two can be considered here. The first involves the use of anchor bridging systems as shown in Figure 4, while the second is based on dual cure involving ring opening: e.g. lactones in UV curable systems.

Figure 4 shows the spacer approach to achieving promotion of adhesion. The linking (anchoring) unit could be thought of as a reasonably high molar mass, aliphatic hydrophobic grouping which carries one or more terminal carboxylic acid groupings (or alternative polar group). The polar groups provide affinity with the substrate and the hydrophic unit provides the link with the coating. On drying, integral character is achieved.

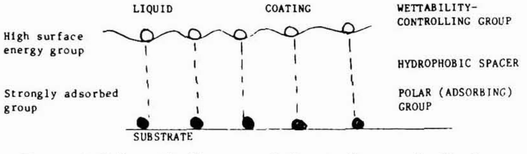


Figure 4. Schematic diagram relating to the use of adhesion.

Drying

With regard to over-rapid cure, attention needs to be given to reactive formulations particularly with regard to composition. Care needs to be taken, for example, over the choice of pigments used in UV curable formulations. Also consideration needs to be given to mixing processes.

Thus, generally, the greater the efficiency of mixing a pigmented UV based formulation, the lower will be the shelf life owing to involuntary curing. It has been shown that care may need to be taken over storage conditions with reactive inks, again because of curing being initiated involuntarily by the container components. Thus, gelation may occur in unexpectedly short periods of time under certain conditions.

Experience has shown that black pigmented poly(ethylene) containers provide the best storage conditions for UV curable inks. Storage in glass and metallic containers carries the risk of unwanted premature curing in the container.

On the theme of drying, one aspect is often neglected. This concerns the redistribution of forces which takes place during the reduction in volume leading to shrinkage, wrinkling and so on. Hence one needs to compensate for these effects. A good example concerns the drying of

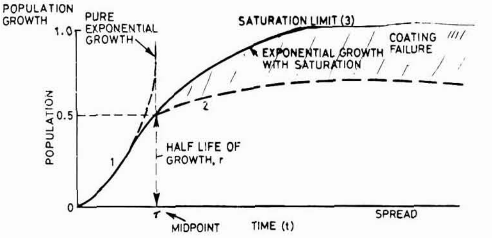


Figure 5. Population dynamical view of film failure in surface coatings.

dispersions containing polymeric species which are not in true solution. The drying process takes two stages. The first concerns removal of the continuous medium while the second involves development of coalescence between the particles. The approach to drying/coherent film formation can be dealt with in terms of population growths. This leads to the idea of film failure as envisaged using a catastrophe theory model as depicted in Figure 5.

Figure 5 indicates that if the saturation limit level occurs with regard to the development of coherence before a specific number of growth points have become involved, then failure will occur. In practice, this involves overcoming the modulus of rigidity of the polymer used in the dispersion. The concept has wider application in view of the many composite systems used in printing/coating assemblies. Here, total coherence cannot always be guaranteed.

Before moving on to peripheral points, summarised below are typical problems which arise in the printing and surface coating industries which regularly require the provision of solutions or compromises. These concern:

- reticulation
- wetting
- migration
- fastness
- raw materials
- taint and odour
- match prediction
- adhesion
- mechanical entrapment
- ghosting
- dark-storage instability
- overdry/overcure
- colour matching
- blocking
- heat build-up in stack
- unpredictable changes in rheological behaviour

- unpredictable changes in the temperature of the system or parts of the system
- problems in clean up operations
- dispersion stability
- training needs

There are also the problems associated with topics such as blanket stability and standardisation of test methods. It might be argued that these last two points are among the more neglected parameters in day to day industrial practice.

Often the lack of standardisation and the use of in-house test routines leads to inter-company confusion.

Problems which might be classed as peripheral but are in fact of great importance include the following:

- over ambition in design in packaging
- incorrect colour associations
- occurrence of colour defect problems
- metamerism effects
- interference factors
- juxtapositional problems

These are of importance and are worthy of considerable attention.

Finally perhaps we can summarise on what to do when things go wrong in terms of routes to solutions:

- choose correct printing character
- evaluate wet in wet character
- investigate possibility of computerised matching systems
- watch for wet or dry pick
- stabilise particles in formulation
- watch for storage instability
- watch for storage container problems
- blanket problems
- problems originating in mixing
- watch for reticulation problems
- watch for phase-interaction problems
- watch for mark-off
- watch for ghosting
- watch for chemical interactions
- watch for migration
- watch for poor resilience effects
- train people to think scientifically and recognise symptoms
- become involved in training programmes and retraining programmes

In summary, it is clear that the solution to problems which arise in the printing and surface coatings industry lie in knowing the system being utilised, employing trained personnel capable of interpreting warning signs and data in a scientific way, retraining employees in the new, rapidly developing technologies, taking advantage of new measurement techniques, applying better communication routes, developing and maintaining standardisation in procedures and maintenance of specification in supply, design and delivery.

Eastbourne

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Details of the lecture programme appear in the January issue of the *Journal*. Further copies of the registration brochure can be obtained from Priory House. Photostats of the registration form (both sides) are acceptable but must be accompanied by the appropriate remittance.

The formulation of high durability exterior varnish stains

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Abstract

High quality exterior varnish stains for timber protection are a complex mixture of ingredients carefully chosen and balanced in order to achieve maximum performance. The effect of a number of parameters on durability over a 3-5 year period in botht he UK and Florida, USA, has been studied. The choice of media is important and the results obtained from studying a variety of alkyds demonstrate the long term advantages to be gained from the use of resins specially developed for exterior varnishes which produce highly extensible coating films. The selection of transparent oxides, waxes, flatting agents and fungicides is also discussed together with the advantages to be gained through the incorporation of controlled thixotropy into the wet varnishes. A number of starting point exterior varnish stain formulations are included.

Introduction

For many years, there were three types of material associated with the exterior treatment and protection of wood—preservatives, paints and conventional varnishes. Over the last few years a fourth category has been added—the exterior varnish or wood stain. Of the four systems, only conventional varnishes and stains contribute to the enhancement and preservation of the natural appearance of wood and the purpose of this paper is to demonstrate the superiority of the wood stains in this regard.

Before doing so, a brief commentary on the contribution made by the other methods of treatment is necessary.

Wood preservatives

Tar oil preservatives such as creosote have been known for many years and, when properly applied, can afford excellent durability and an attractive finish. Other wood preservatives are not designed as surface finishes, their main function being to penetrate the timber to protect against microorganisms and insect attack. However, unlike the tar oil preservatives, they can be subsequently coated with an appropriate finish. Because surface finishes cannot provide the same degree of biological protection, it is essential for exterior wood to be treated with preservative before the surface coating is applied.

It would be a waste of time and effort to apply expensive paint or wood stain to exterior wood not previously treated with preservative.

Paints

Painting—most often by applying an alkyd based gloss finish—has been the traditional way of providing exterior wood finishes in the United Kingdom. Applied to a properly prepared surface, paint should last at least five years. The deficiencies, however, are well-known. It obliterates the natural finish and completely seals the wood, preventing the escape of water vapour. Blistering and cracking are the inevitable result.

Conventional varnishes

Whilst wood preservatives will prolong the life of timber without necessarily protecting it against surface degradation, the use of wood for decorative as well as structural purposes requires a surface finish that will maintain the original appearance of the wood. Until recently, clear varnishes have been the only choice for protecting the natural appearance of wood. They tend to have a short life, because of their brittleness on ageing. In the early life of the coating it is flexible enough to withstand the continuous swelling and shrinkage caused by changes in the moisture content of the wood. With age, the varnish film becomes more and more inflexible, resulting in cracking which allows water to penetrate and promote the development of stain and mould fungi.

The second disadvantage of clear varnishes is that they afford no protection to the wood substrate from ultra-violet light. On prolonged exposure to light, the surface wood cells are broken down to leave a thin layer of loosely matted delignified wood fibres.

Unless frequent maintenance is economically acceptable, conventional varnishes are not recommended for exterior woodwork.

It is because of the deficiencies exhibited by alternative wood finishes that the development of exterior wood stains assumed such importance, and their use has grown considerably since their introduction in the 1960's.

Before introducing some of the results obtained by our own studies of wood stain formulations, it might be helpful to outline the background to the development of this new approach to wood finishes.

A new approach to wood finishing

Two objectives underlie the development of modern wood stains:

- The desire to enhance the natural appearance of wood rather than obscure it with paint.

- The need to prolong the life of such finishes and introduce cost effective maintenance cycles.

The obvious route was to combine the advantages of paint and varnish systems and eliminate the disadvantages.

Paint obviously possesses the unique advantage of deflecting, and in the case of certain pigments such as carbon black, absorbing ultra-violet light. Conventional varnishes allow the natural beauty of wood to show through. The introduction of transluscent finishes incorporating pigments which deflect ultra-violet light, yet insufficiently pigmented to obscure the wood grain pattern was a natural development once the necessary raw materials became available.

The next requirement was to select appropriate media to enable moisture vapour to escape from the timber, yet provide an impermeable barrier to water in liquid form. A common characteristic of alternative finishes is that the wood is sealed, preventing the loss of excess moisture. However, water absorption by capillary action at inadequately sealed end grain, especially in joinery assembled prior to coating, can be substantial and will eventually lead to blistering and biological attack, unless the coating is permeable.

Although some extravagant claims have been made concerning the water permeability and "microporosity" of some surface coatings, including paints and woodstains, there is no doubt that considerable improvements to enable vapour movement to take place with humidity changes, have been made.

Modern woodstains no longer present the impermeable barrier to moisture movement that traditional paints often do. In addition, wax additives ensure that the coating is able to shed surface water.

Finally, it was necessary to provide a system which promoted a simple maintenance schedule. Because of the nature of the deterioration of conventional finishes, unless remedial action is taken quickly the elaborate maintenance process of paint or varnish removal by stripping or burning is necessary. This must then be followed by a complete repainting schedule, and in the case of varnishes, often the staining of bleached areas.

Exterior wood stains tend to erode rather than fail through embrittlement. Colour loss is gradual and the maintenance schedule is much simplified, usually involving washing down to remove surface dirt, drying and applying two coats of wood stain. More protected areas will require less maintenance and one coat will often suffice.

Developing wood stain formulations

Hill[1] discussed the theoretical requirements for a water repellent finish as follows:

1. Resistance to ultra-violet radiation by the use of iron oxide pigments.
2. Breakdown by erosion and not by cracking and flaking.
3. Good water repellency.
4. A drying rate enabling maximum penetration to take place.
5. A degree of preservative activity to complement the preservative pretreatment.
6. Good colour retention.
7. Low dirt retention.
8. Available in a range of colours sufficiently transparent to enhance the grain pattern rather than obscure it.

It was inevitable that to meet all these requirements, a complex blend of ingredients would characterise a successful wood stain formulation. The complex structure of wood and the very different nature of hardwood and softwood must also be considered when recommending particular formulations.

Wood structure

Although it is not the purpose of this paper to go into any detail on the nature of different wood substrates, it might be useful to remind ourselves of the essential characteristics of wood.

Hardwoods from broad-leafed trees and softwoods from conifers vary considerably in their structure and durability properties. In softwoods the greater part of the wood consists of longitudinal tracheids, which constitute the characteristic fibres of softwood. It is through these fibres that sap is transferred. The structure of hardwood is much more diverse and more kinds of cells are present. Fibres are present in a much smaller proportion than in softwood and their regular arrangement is disturbed by the presence of cell vessels or pores through which water is transferred from soil to the leaves.

The growth rings of both hardwoods and softwoods are made up from the larger cells formed early in the year when growth is at its maximum. During the remainder of the growing season, the activity decreases and summerwood or latewood is laid down. Earlywood and latewood differ in chemical composition and in the physical structure of the cellulose fibre, with earlywood being less dense and therefore softer.

The outer growth rings, known as sapwood, contain the active cells, transferring water from roots to leaves and acting as food storage zones. After a period of years, chemical and physiological changes occur in the wood formed at an earlier period. The portion towards the centre of the stem ceases to function, the cells die, and the tissue becomes heartwood.

These different mechanisms, and the wide variety of different cell formations and sizes, explain why such an infinite variety of grain patterns exist.

Another key factor to the appearance and ultimate durability of wood is the direction of cut. The wood may be cut at right angles to the longitudinal axis to give a transverse cut exposing the ends of the vertical cells (end grain); radially by cutting along the radius of the stem to expose the wood rays; or tangentially with a cut parallel to the centre of the stem, exposing the ends of the rays. The direction of cut obviously affects the physical and mechanical properties of wood and its appearance.

These many differences in the structure and surface presentation of wood substrates account for the varied performance both of the wood itself and any coating applied to it. To achieve a uniform finish, allowance has to be made for the uneven penetration into the wood which inevitably occurs. Because earlywood is less dense, it tends to absorb more of the surface coating, especially the low build type of stain, leading to uneven patches unless care is taken over the application. Conversely, wide bands of latewood, which often occur when wood is sawn tangentially, will absorb little of the coating. This is probably an important contributory factor to the loss of adhesion of coatings on ageing, when the coating covering latewood tends to fail sooner than that covering earlywood, because of lack of penetration into the wood.

Degradation of wood

It is well-known that all timber is subject to degradation caused by various agencies. The extent and rate of degradation depends not only upon the nature of the wood—hardwood or softwood, sapwood or heartwood etc, but also on the climatic conditions to which the timber has been exposed. The Building Research Establishment in the United Kingdom have published a number of articles on the subject[2-4].

The most important factors affecting wood decay are weathering and fungal attack.

Sunlight (UV) breaks down lignin in the wood to water soluble byproducts and these are subsequently removed by rain water. It is also known that photoxidation of the cellulose molecule takes place resulting in a loss in tensile strength.

Colonisation of wood by micro-organisms is a major problem to contend with in considering the protection of wood. Three forms of fungal attack are important.

Surface mould growth in the form of green and black spores. These are unsightly and will result in a more permeable surface which in turn accelerates wood decay.

Blue stain fungi attacks sapwood causing an unsightly grey-blue staining effect which occurs not only on the surface but also penetrates the interior of the wood.

Decay fungi, unlike blue stain and mould, actually attack the cell structure of the wood causing cell breakdown, loss of strength and rotting.

In addition to these processes the water content of unprotected wood can vary considerably. Bravery and Miller[3] show that painted Scots Pine L sections can change from 10 to 35% moisture content when weathered. This in turn affects the dimensions of the wood causing it to swell and contract as the moisture level varies.

Selecting the raw materials

The two most important contributors to any successful wood stain are the pigment and the medium in which it is dispersed.

Media

Alkyd resins still remain the favourite choice for wood stain formulations despite their inherent disadvantages when exposed to exterior conditions. A capacity to absorb ultra-violet radiation, resulting in hardening and embrittlement, and hydrolysis of the ester linkages causing breakdown of the coating structure are reasons why alkyd resins might be considered less suitable for such conditions. Nevertheless, alternative resin systems such as polyurethanes, acrylics and silicone resins also have their deficiencies and are not used to any extent in wood stain formulations.

A number of alkyd media were selected for our work which included standard alkyd resins as well as some experimental products. The alkyds chosen were as follows:

1. 73% oil length, linoleic rich, low viscosity alkyd Synolac 77W.
2. 65% oil length, linoleic rich, high viscosity alkyd Synolac 66W.
3. Experimental, very low viscosity, 85% oil length linoleic rich terephthalic acid based alkyd.
4. Two experimental, medium viscosity, 68% oil length alkyds based on a special fatty acid with low level of unsaturation.
5. Flexible, exterior quality medium viscosity 65% oil length linoleic rich alkyd Synolac 6005W.

In systems 1-4 15% of a thixotropic alkyd (Super Gelkyd 391W) was incorporated to prevent pigment settlement. In most instances approximately 20% of Synolac 34, a 30 poise long oil alkyd grinding medium was also incorporated. The presence of the low viscosity alkyd at the pigment dispersing stage is essential in order to prevent gelation when the pigment powder is being used. System 5 was not included in the main body of this evaluation but is discussed separately in the section "High durability flexible alkyds".

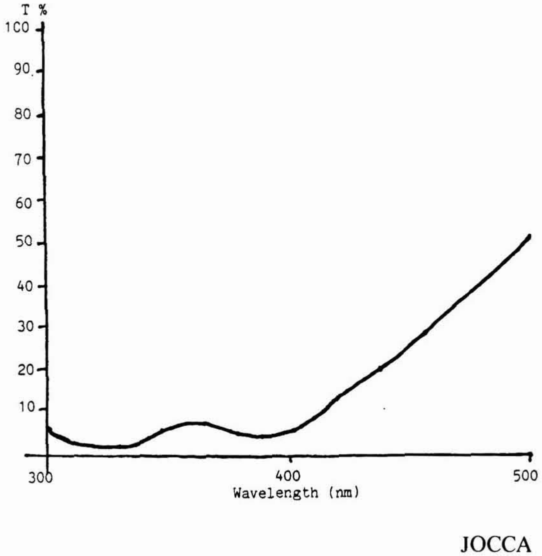
From the six basic alkyds referred to above it was possible for us to produce both high build formulations (45-55% vehicle solids) and low build formulations (30-36% vehicle solids).

Pigments for wood stains

The development of ultra fine particle size synthetic iron oxide pigments has significantly improved the performance of wood stains. Providing such pigments are evenly dispersed throughout the media—often a problem with traditional iron oxide pigments which tend to form into clusters—transparent finishes can be obtained which do not transmit in the ultra-violet region. They have the unique combination of transparency in the visible regions of the spectrum whilst being opaque to UV, Figure 1[5].

When formulating varnish stains with these pigments it is important to bear in mind that they have a significantly higher oil absorption than their opaque counterparts and are much more difficult to disperse.

Figure 1. UV Spectra of Trans iron oxide L2817 (BASF)



The pigments are therefore available not only in powder form but also as predispersed pastes. The powders are best dispersed using a low reactive, low molecular weight alkyd to avoid gelation of the millbase; to achieve the full transparency of the colours, grinding in a steel ball mill using a low viscosity mill charge produces the best result. The pigment pastes are obviously much easier to use, being supplied in dispersed form in a long oil alkyd.

The range of transparent iron oxides include yellows (Colour Index No. 77492), oranges and reds (Colour Index No. 77491) and from these a wide range of natural and colour stable wood stains can be produced. The colours can be further enhanced or tinted to particular shades by using small quantities of other pigments such as carbon black, phthalocyanine blue etc.

In the original work pigment levels between 5% and 15% (based on solid binder) were examined but it subsequently became clear that 5% was a more appropriate level to use. Studies on pigmentation included three main shades, namely:

Walnut

Yellow

Dark Oak

Promoting water repellency

Because wood stains are specifically designed to be permeable, it is essential that a water repellent is included in the formulation to prevent absorption of liquid water. Hydrocarbon waxes provide the simplest solution to the problem, but must be used at a concentration sufficient to provide water repellency yet not at a level to provoke adhesion failure of the film, or cause recoating difficulties. Paraffin wax is the cheapest route to improved water repellency, although polypropylene and polyethylene waxes are more effective.

Polytetrafluoroethylene wax in combination with a polyethylene wax proved to be an extremely effective water repellent, although the recoat properties of the resultant film are suspect. Studies suggest a combination of polypropylene wax and paraffin wax is suitable to provide water repellency during the early life of the coating.

Both the type and level of paraffin wax used in varnish stain formulations are important parameters to take into account. Too soluble a grade or too high a level can impair the drying properties of the varnish. Our results indicate that paraffin wax with a melting point around 45°C, incorporated between ½ and 1% on the total formulation, was satisfactory.

Gloss and matt finishes

Low build wood stains containing wax tend to be semi-gloss in nature and require little or no flatting agent. The higher build film forming types will have gloss finishes and will need to be flatted to achieve the more desirable matt or satin finish. The use of fine silicas is recommended, even though their hydrophilic nature contributes to a loss of water repellency. Minimum quantities should be used, sufficient to achieve the desired level of sheen.

A range of silica/polymer wax blends were used in combination with the paraffin wax for the high build formulations. Generally the 60° gloss of the varnish films varied from 20 to the mid 40s.

Achieving structured wood stains

The wood stains are provided at low application viscosity (40-100 centipoise) to encourage penetration and it is essential that a degree of thixotropy is introduced:

1. A degree of thixotropy is introduced to minimise settlement of the transparent iron oxides which occurs in spite of the ultra fine nature of their particles.

2. To allow cleaner application of the varnish. Brushing of products with such low intrinsic viscosities can be a very messy affair and the presence of some thixotropy goes a long way to alleviating this problem.

Silicas contribute towards structure, but the use of thixotropes is considered essential. Organophilic clays or hydrogenated castor oil types can be used, although at the level required to ensure pigment suspension, flow and penetration into the wood can be adversely affected because of the rapid set up. Conventional thixotropic alkyds based on polyamide chemistry have been used to introduce structure into wood stain systems, but they do suffer a disadvantage in that after prolonged storage the stains tend to be lumpy when stirred prior to use. We have found that the non-melting type of thixotropic alkyds such as Super Gelkyds(R) have ideal properties for use in exterior varnish stain formulations. They produce products with a round creamy structure which stir down to a completely homogeneous condition even after lengthy storage. Thixotropy introduced by such a route also offers consistency over a wide temperature range.

® Registered trade name Cray Valley Products Ltd.

Preservatives

Fungal attack of wood causing an unsightly appearance and, eventually, rotting or decay was discussed earlier. The use of various microbiocides can significantly retard the development of such fungi. Treatment of the wood with these compounds can take place at the factory using pressure/vacuum impregnation techniques or alternatively on site with a preservative solution applied prior to varnishing. The former route is preferable since the preservative penetrates deep into the pores of the wood. However, in the absence of factory treatment a preservative solution applied on site is an acceptable alternative. In addition a "topping up" of preservative activity may be achieved by incorporating a suitable microbiocide into the exterior varnish formulation. This also helps to prevent mould fungi colonising the alkyd films.

The experiments described in this paper do not include a study of the efficiency of the types of preservative chemicals available but a selection of compounds which have biocidal or fungicidal activity are listed as follows:

Tributyl tin oxide (TBTO)

Pentachlorophenol (PCP)

Copper 8—quinolinolate

PACKENIUS, KIENPOINTNER, VANDENBERG.

Busan 1009 mixture of methylene bis thiocyanate and 2-(thiocyanomethyl thio) benzothiazole blend (Buckman Laboratories Inc.)

Acticide DW (Thor Chemicals Ltd)

Preventol A4 Fluorodichloro methyl sulphonamide (Bayer)

Zinc naphthenate

It should be appreciated that not all of the preservative chemicals are as effective as one another and that some are more active for certain types of organisms than others. Unfortunately the most effective compounds tend to be the most toxic. Since regulations governing their use vary from country to country, users are advised to check with their suppliers before incorporating such materials into their formulations.

In our work three fungicide systems have been used:

1. 1% PCP on total formulation.
2. 1-2% BUSAN 1009 (Buckman Laboratories Inc.)
3. 1-2% of a 3/1 mixture Preventol A4 (Bayer)/TBTO

The latter combination, at the 2% level is particularly effective against blue stain fungi.

The preparation of varnish stains

Although the wood stains contain a number of ingredients, their preparation is quite straightforward provided some simple guidelines are followed:

1. The Super Gelkyd is dispersed in most of the long oil alkyd under high shear to avoid the prospect of gel particles in the finished product.

2. If silica is being used in a high build system to achieve a flat finish, it can be dispersed directly into the Super Gelkyd/alkyd blend under high speed stirring.

3. Most of the micronised polymeric waxes can be added directly to the blend under high speed stirring or preferably as a predispersed paste in white spirit.

4. Paraffin wax and some polyethylene waxes need to be melted into solution and stirred whilst cooling to prevent precipitation. The melting point of the paraffin wax is important. Harder grades are more prone to precipitation causing poor drying and patchy gloss. A convenient way of adding wax is to warm it into solution in dilute resin before adding to the stain. A suitable composition is:

	%
Paraffin wax	2
Resin solids	48
White spirit	50

5. The method of incorporation of preservatives will depend on the nature of the additive. Tributyl tin oxide can be added directly to the varnish solution and Preventol A4, being powder, should be incorporated under high speed dispersion during stages 1 or 2.

If pentachlorophenol is used, because it is only sparingly soluble in white spirit a concentrate should be made to the following formulation:

	%
Pentachlorophenol	20
Resin solids	40
Pine oil	20
White spirit	20

The blend should be heated to 80-90°C until the pentachlorophenol has dissolved.

6. The selected pigment should be dispersed in a low viscosity long oil alkyd such as Synolac 34 by ball milling, preferably for a prolonged period to develop the full transparency of the colours. The use of flushed pigments already dispersed by the supplier eliminates this stage. The predispersed pigment should be added to the blend, followed under minimum shear by the necessary driers, a polar solvent to develop the optimum structure of the Super Gelkyd and an antiskinning agent. The wood stain is finally adjusted with white spirit to the appropriate viscosity (20-90 centipoise @ 2,500 sec^{-1}).

Provided these basic steps are followed thixotropic wood stains free from pigment settlement at low viscosities will be obtained.

Panel preparation and exposure testing

The wooden test panels were prepared from carefully selected Parana pine timber and sanded to remove all rough edges to produce a smooth surface. Three coats of varnish were brush applied and allowed to dry for at least seven days before placing on test.

Two locations were used:

1. *Florida 45° South*

One series commenced May 1982.

2. *Rural site, Kent, UK 45° South*

Two series under test
(1) Commenced December 1980
(2) Commenced May 1982

Results and Discussion—Florida Test Series

In the three years since the series was placed on test in Florida a number of trends and guidelines have emerged which are pertinent to varnish stain formulations.

Media choice

As expected the performance of the clear varnishes was much inferior to the varnish stains. All of the unpigmented media had failed by cracking, flaking and blistering within 16 months and were withdrawn at this stage. In contrast however, most of the varnish stain formulations remain intact after three years and only show either very fine checking or erosion. This can be seen from the photographs illustrated in Figures 2 and 3. Nevertheless the trends picked up on the clear finishes are important as they reflect the general trends observed with the formulated varnish stains over a much longer time span. Ashton[6] studied the performance of various alkyds in clear varnishes for the change in tensile and elongation properties after natural and accelerated weathering. He concluded that both oil length and oil type are important and that an optimum oil length exists for maximum durability. Molecular weight of the alkyd was one of the parameters not investigated by Ashton. Our results suggest that molecular weight is also an important factor in maximising the contribution of the media to performance of the final wood stain.

It can be seen in Table 1 that significantly superior performance is obtained from the high viscosity 65% oil length alkyd, Synolac 66W, whilst the 85% low viscosity terephthalic alkyd (Exp. alkyd I) shows extremely poor performance. It is believed that this is primarily due to the free oil present in such a long oil alkyd and the resultant low tensile properties of the film. The use of terephthalic acid may also be a contributory factor since it is known that this can give poorer durability than o-phthalic or isophthalic based products (e.g. oil free polyesters). This could be linked to its resistance to UV since this same alkyd performs extremely well when UV protection is provided in the form of the transparent iron oxides.

On the other hand the theory that low levels of unsaturation in alkyd media will result in a system with reduced degree of embrittlement on ageing and therefore improved performance does not bear fruit. In clear varnishes (Table 2) little difference is seen between the 73% linoleic based alkyds and its low unsaturation counterparts Exp. alkyd I and II. However, as a formulated varnish stain dramatic differences are obtained (Figure 4).

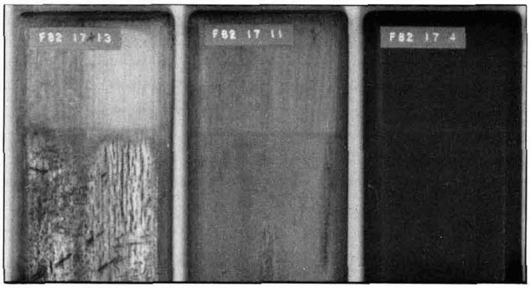
Kent UK Test Series

The results obtained in the United Kingdom have yet to show the same level of deterioration as those in Florida and at the time of writing the formulated varnish stains exposed in the first series (total 4½ years) and the second series (total 3 years) do not show signs of significant failure or the erosion which is a feature of the Florida panels (Figure 5).

High durability flexible alkyds

In recent years much has been said concerning the value of

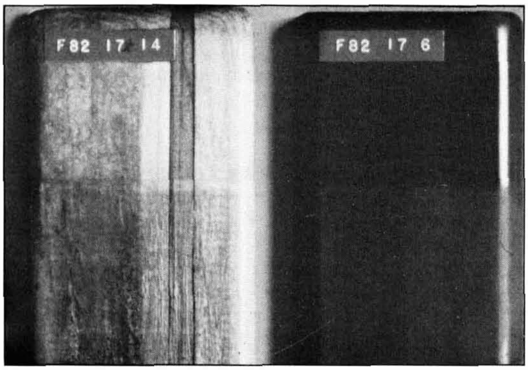
Effect of transparent iron oxides.



Clear 16 months — Yellow Shade, Walnut Shade 3 years

Florida Exposure 45° South

Figure 2. Comparison of high build varnish media with varnish stain counterparts (Florida exposure).



Clear 16 months — Varnish Stain 3 years

Florida Exposure 45° South

Figure 3. Comparison of low build media with a varnish stain counterpart (Florida exposure).

introducing breathability into coating films as a route to extending their life. Equally, if not more important are the tensile and elongation properties of the film. In a separate, but associated, programme of work we have developed an alkyd with exceptional flexibility and retained flexibility for exterior quality paints and varnishes. This product, reference Synolac 6005W is a 65% oil length alkyd which shows a significant improvement in flexibility on

Table 1

Effect of alkyd type on durability of clear varnishes in Florida

Base Alkyd*	Type	Mol. wt.		Checking/Cracking	
		(no. av.)	(weight av.)	Commenced	ASTM 16 months
Synolac 77W	73% Linoleic	4,000	38,000	12 months	2
Synolac 66W	65% Linoleic	4,500	140,000	16 months	6
Exp. alkyd I	85% Linoleic terephthalic	1,800	15,000	9 months	0
Exp. alkyd II	68% Low level unsaturation	4,300	80,000	12 months	2
Exp. alkyd III	68% Low level unsaturation	5,000	110,000	12 months	2

*Complete alkyd media includes 15% Super Gelkyd 391W thixotropic alkyd and 20% long oil dispersing medium Synolac 34 (7.5% in the case of Synolac 66W).

Table 2

Effect of decreasing unsaturation level on durability of varnish stains—Florida 45° South

Varnish stain based on	Approximate iodine value of fatty acid	Checking/Flaking	
		Commenced	Comments at 36 months
Synolac 77W	145	33 months	ASTM 9 checking
Exp. Alkyd I	125	30 months	ASTM 8 checking Some flaking
Exp. Alkyd II	100	17 months	Complete failure

accelerated weathering and natural weathering tests. After 2,000 hours in a QUV weatherometer in white paint film applied to a soft aluminium substrate has three times the extensibility of a conventional alkyd based paint (Table 3). These results are supported by five year durability data obtained in Kent, UK, on both paints and varnishes applied to wooden panels where the Synolac 6005W shows a significant improvement in resistance to cracking (Figure 6).

Table 3

Effect of accelerated weathering on flexibility of film

	Percentage Extensibility*	
	Initial	2,000 hours QUV
Conventional long oil alkyd	>30%	8%
Flexible long oil alkyd Synolac 6005W	>30%	23%

*White gloss paint films applied to soft aluminium.

Preferred media

The requirement in the market for both high build and low build varnish stains lead us to recommend more than one media system and these are summarised in Table 4.

Table 4

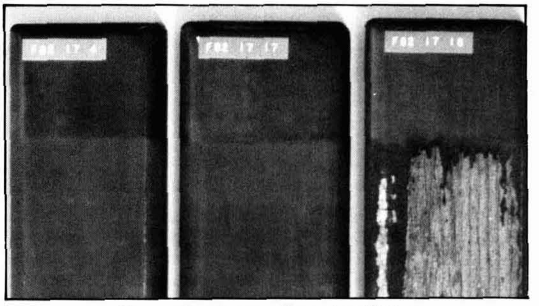
Media recommended for high durability varnish stains

	High Build*	Low Build*	Low Build "Flexible"*
Synolac 77W	65%	—	—
Synolac 66W	—	77.5%	—
Synolac 6005W	—	—	80%
Synolac 34	20%	7.5%	3%
Super Gelkyd 391W	15%	15%	17%

*Figures based on solid resin

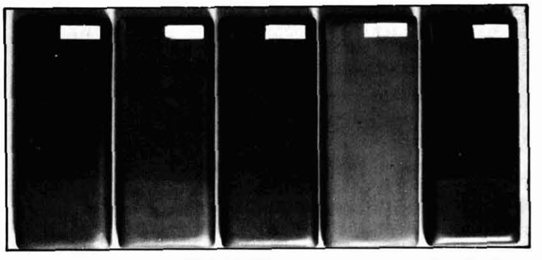
No long term durability data has been obtained on the low build flexible system but data on fully formulated varnish stains based on both the low build and high build systems are indicated in Table 5.

It can be seen that excellent performance is achieved with



Decreasing degree of unsaturation →
Florida Exposure 45° South, 3 years

Figure 4. The effect of decreasing unsaturation level on varnish stain performance.



High Build Low Build
Kent, UK Exposure 45° South, 4½ years

Figure 5. The exposure of varnish stains in the UK.

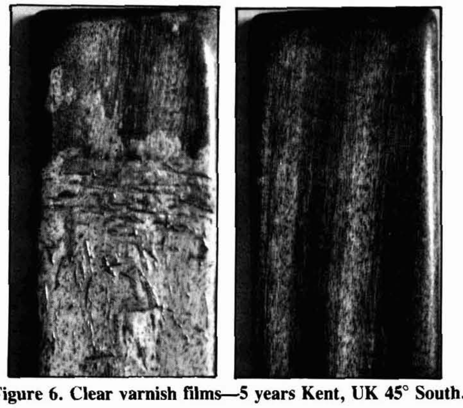


Figure 6. Clear varnish films—5 years Kent, UK 45° South.

Right: Panel Synolac 6005W clear varnish.
Left: Panel Conventional long oil alkyd clear varnish.

Table 5

Performance of varnish stains in Florida and UK

Location	Varnish stain system†	Reference‡	Vehicle solids %	Viscosity cps. 2,500 sec^{-1} 25°C	3 years exposure	
					ASTM checking	60° gloss
Florida	High build	F.32418A	49	90	9	0
	Low build	F.32450A	33	35	10	6
Kent, UK	High build	F.32418A	49	90	10	15
	Low build	F.32450A	33	35	10	30

†Three coats on Parana Pine panels
‡Details found in Table 7

Table 6

Effect of silica/wax ratio on Florida durability walnut shade high build varnish stain

Extender ratio*			Weathering results				
Silica (%)	Polyolefine wax	Paraffin wax	60° Gloss			Loss in WR†‡	Checking commenced†
			Initial	1 year	3 years		
6	4	2.5	10	3	0	3	30
4	7	2.5	12	4	0	3	30
2.5	6	2.5	17	7	0	3	30
—	10	2.5	45	16	11	6	>36

*Based on solid binder †Months ‡WR = Water Repellency

both the high and low build stains and indeed precursors to these systems have lasted 5½ years (at the time of writing) in the UK without film breakdown. Both the Florida and UK results suggest that longer life will be obtained with the low build flexible system based on Synolac 6005W.

Pigment choice and level

Both pigment content and shade have been investigated. In early trials between 5 and 15% of the transparent iron oxide pigment was used but the higher levels tend to result in too strong a colour with a notable reduction in transparency. More than adequate protection is achieved at 5%. In terms of colour shade it might be expected that the darker colours would provide greater protection than the yellow shade. The results obtained to date have not proved this to be the case and a light yellow varnish stain based on the high build media system is giving excellent results in both Florida and the UK. The inclusion of these pigments not only extend the life of varnishes many times but also change the mode of failure. With one or two exceptions, particularly where a poor binder system has been used, attack by the elements causes gradual failure via a fine checking pattern and film erosion. This is not typical of non-pigmented varnishes which fail through cracking, ingress of moisture followed quite rapidly by catastrophic failure of the protective film. The permeability of the varnish stain type of formulation partly accounts for the difference. The use of flexible media (Syn6005W) will further enhance overall performance.

Incorporation of silicas and waxes

It is evident that synthetic silicas are necessary in certain systems in order to achieve the desired gloss and sheen. This is particularly so in the high build systems. The polymer waxes are more expensive and must be used at higher levels to achieve a given gloss level. This is important in high build varnish stains but not in their low build counterparts which are easier to flat. Our results indicate that silica flatting agents are detrimental to long term performance and if possible should be avoided. Table 6 illustrates this point.

Added UV Absorber

Gabriele and Iannucci[7] claim that incorporation of light stabilisers extend the service life of biocides in surface coatings. The effect of such compounds in varnish stains was also briefly examined in our study. It was found that a combination of 0.5% benzotriazole UV absorber (Tinuvin[(R)] 900) with 0.5% of a hindered amine (Tinuvin[(R)] 292) not only has a slight positive effect on the control of mildew growth but also improves the resistance of the film to stress failures such as checking. Percentages are based on solid binder.

Formulary

Based on the work discussed above we have developed a number of wood stain formulations, both high build and low build types, which have proven performance. Some of these formulations are listed in Table 7.

[(R)] Registered trade name of Ciba Geigy.

continued overleaf

Table 7

Selection of exterior varnish stains

	High Build		Low Build	"Flexible" Low Build
	Med Brown F32418A	Yellow F32421	Med Brown F32450A	Mid Brown F32813
Alkyd Dispersion Yellow 10-5C-A232(1)	3.34	6.80	2.30	4.2
Alkyd Dispersion Red 10-5C-A103(1)	2.78	—	1.90	1.1
Black Tinting base, Black Tinter L0063(2)	0.83	—	0.57	0.1
Synolac 77W	35.60	35.60	—	—
Synolac 66W	—	—	38.90	—
Synolac 6005W	—	—	—	39.8
Synolac 34	6.90	6.16	0.74	0.9
Super Gelkyd 391W	11.90	11.90	8.20	9.1
Silica(6)	2.60	1.75	—	—
Crayvallac 62(3)	1.80	3.10	3.60	3.29
Paraffin wax (110-115°F)	0.20	0.20	0.15	0.21
Preservative(4)	1.00	1.00	1.00	0.54
Tri butyl tin oxide	—	—	—	1.03
Pine Oil	1.00	1.00	0.75	—
Polar Solvent(5)	2.00	2.00	1.50	1.69
10% Calcium Drier	0.40	0.40	0.30	0.63
36% Lead Drier(7)	1.14	1.14	0.40	—
12% Zirconium Drier	—	—	—	0.38
12% Cobalt Drier	0.23	0.23	0.16	0.21
MEKO	0.13	0.13	0.09	0.11
White Spirit	28.15	28.59	39.44	36.71
	100.00	100.00	100.00	100.00
Viscosity @ 25°C 2,500 sec^{-1}	90 cps	90 cps	35 cps	35 cps
Vehicle Solids %	49	49	33	36
Pigment/Binder Ratio	0.05/1	0.05/1	0.05/1	0.05/1

(1) Hilton Davis Dispersions
(2) Bayer
(3) Cray Valley Products Ltd
(4) e.g. Preventol A4 Bayer AG Germany; Busan 1009 Buckman Labs, Inc. USA; Penta chloro phenol
(5) e.g. Dowanol PM or DPM Dow Chemicals
(6) e.g. TS100 Degussa Syloid 167 W. R. Grace
(7) Formulations containing lead free drier combinations have subsequently been developed.

Conclusions

The durability of varnishes is markedly improved by the incorporation of transparent iron oxides which not only provide UV protection but also enhance the appearance of wood. This study has shown that care in the choice of the alkyds used to formulate such stains pays dividends and extends the life of these varnish stains. It is predicted that using specially developed flexible alkyds will further improve the quality of solvent based varnish stains.

Imparting some thixotropy to varnish stains is important in providing better application properties as well as reducing pigment settlement. The characteristics of the non melting type of thixotropic alkyd such as Super Gelkyd 391W are particularly suited for this use.

The choice and level of flatting agents incorporated into the formulation is also important in maximising their weathering properties. Synthetic silicas appear to have a slightly deleterious effect and their use should be controlled carefully.

The erosion of varnish stains compared with the cracking and flaking of varnishes is a strong argument for their use since refinishing of the former coating is far simpler and of course much quicker.

Acknowledgements

The authors wish to thank the Directors of Cray Valley Products Ltd for permission to publish this paper and to Peter Maddock and Steve Rees for the experimental work as well as help and advice in preparing the text.

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President's Page

Last year I risked my message dropping through the letter box with the inevitable January bills, and hence its reception may have been overshadowed by more pressing considerations.

This year I have allowed time for you to recover from January's ills, and hope that you will have more time to reflect on the issues which influence and are influenced by your Association.

The protracted negotiations with the New Zealand Division have been successfully completed. The members in New Zealand have been presented with a package of prosposals produced by the Working Party and approved by Council, and have responded positively with a vote of more than 80% of their members in favour of an autonomous association of oil and colour chemists in New Zealand. Consequently The Oil & Colour Chemists' Association New Zealand was born on New Year's Day 1987. This new association now stands alongside OCCA and OCCA Australia as the third independent member of the broader concept of "OCCA" which is embodied in OCCA International. All members of "OCCA" (OCCA, OCCAA, OCCANZ) are also members of OCCAI, and this concept which has been struggling to find its feet over the past six years, may now get the chance it deserves to bring a new dimension to the meaning of "OCCA". I am sure you would want me to send a special message of congratulation to all members of OCCANZ, and in particular to its new President.

We are all aware of the tremendous success which was "SURFEX 86", and I can but offer humble thanks to Fred Morpeth and his team, including all at Priory House, who worked so hard to ensure that success. The need for a theatre style exhibition has been confirmed, and providing the exhibitor can get prompt, friendly service, in a pleasing environment, at modest cost, and providing the organisers remain sensitive to the changing needs of the industry (exhibitors and visitors), then the future success of SURFEX is assured. Make a note of the return of SURFEX to Harrogate in 1988.

Our natural enthusiasm for our new style exhibition must not detract from an equally important event which takes place in the alternate years, and which returns to Eastbourne in June 1987 after ten years in venues as far apart as Stratford and York, Bath and Edinburgh. The work involved in gathering a technical programme which relies on more than 20 speakers, will only be fully realised by the few people who have risen to the task. John Taylor has tried to produce a programme which is broad in concept and yet arouses specific interests. I believe that he has again achieved the nigh impossible. It is timely to be thinking about filling in your application forms for your Conference at Eastbourne. The event will be enhanced by incorporating the celebration by London Section of their Golden Jubilee.

It is quite customary, in fact, essential, that work is initiated on a conference some three years before the event, and so Tony Jolly is well on with the preparations for our 1989 Conference in Chester.

Peggy and I have again represented the Association overseas. At the FATIPEC Congress in Venice we were privileged to meet the principal officers of that European Federation, together with the Presidents of the American FSCT, Scandinavian SLF, and Japanese JSCM. Your Association was honoured by the request that I should make the response on behalf of overseas visitors to the address of welcome by Dr Poluzzi.

Our visit to South Africa was particularly important because of the increasing political stress surrounding our members there. I believe that an international association such as OCCA is tested when part of its membershp, although in continuing accord with the Association, find themselves increasingly isolated on the platform of international politics. We must take care to remember that our Association has no political affiliations, and our Memoranda and Articles of Association make no reference to political dogma or moral code. It is my wish that OCCA will draw people together in a world which becomes increasingly devisive. I believe that a person's membership of OCCA will be judged by their contribution to the growth and well-being of the Association, and that the colour of their skin, their political persuasion, and their mother tongue have no relevance in that judgement.

You will be aware of the advertisement for a General Secretary Designate which appeared in the Daily Telegraph on 27 November, The Times on 4 December, the December Issue of JOCCA, and the January Issue of a publication by the Chartered Institute of Secretaries and Administrators. More than 60 people have responded and an eight-man working party are busily engaged in the selection process.

It is important that you should understand the critical nature of this appointment. We are attempting to engage a person who is multi-skilled in managing a small staff to achieve a wide ranging service to our multi-national membership. We are depending on the commitment of our Honorary Officers to provide direction and guidance to this person, and shall expect the person to be equipped to advise and clarify, while implementing the decisions of Council.

The task in hand serves to emphasise the degree to which we have come to rely on our Director and Secretary who for some 36 years has been a dedicated servant of OCCA. His impending well-earned retirement in July marks the end of an era in which OCCA has matured and set new patterns for its future. Bob Hamblin has seen the emergence of independent bodies of OCCA, who manage their own affairs while jealously guarding the principles on which OCCA has been based since its formation in 1918. He has been the adviser to, and servant of Council for those many years. He has represented permanence in an ever changing pattern of Council members. His advice and foresight have always helped to crystallise the deliberations of Council, whether they concurred or opposed his suggestions. He would wish to leave OCCA in good hands, and that must be the charge that you place on me and Council in the coming months.

There will be many of you who would wish to mark the occasion of Bob's retirement with a suitable gift. The Association's bankers have kindly agreed to receive contributions with the special form enclosed with this Journal and I shall be pleased to receive any suggestions for its use at my home address: 305 Bolton Rd, Edgworth, Bolton BL7 0AW.

Finally, you will have appreciated that my term as President has absorbed very substantial support in time, resources and finance. A lot of time, most of the resources, and nearly all of the finance has been provided by Crown Paints, and in thanking them most sincerely, we must remember the part played by many companies in our industry to support the activities and image of OCCA worldwide.

F. B. Redman

occa conference

OCCA Conference 1987 Eastbourne

"Advances and application of science and technology in surface coatings"

OCCA's Biennial Conference will be held at the Grand Hotel, Eastbourne, from 17-20 June 1987 on the latest advances/applications of science and technology to the Surface Coatings Industry. Full details of the lecture and social programmes, registration fees etc are given in the Conference Brochure, copies of which are available from Priory House. Below, further summaries of the papers and the biographies of their authors are presented, several summaries/biographies appeared in the December and January issues of the *Journal.*

Summaries of papers and biographies of authors

New propylene gylcol ethers for water borne coatings

J Spauwen

Summary

In water borne coatings, both in dispersion coatings as well as in coatings based on water soluble resins, substantial amounts of butyl glycol are used as a coalescing aid and/or co-solvent.

Dow Chemical Europe has developed new, propylene glycol based, butyl ethers: Dowanol* PnB, propylene glycol n-butyl ether, Dowanol* DPnB, di-propylene glycol n-butyl ether. These products have shown to be real technical alternatives for the ethylene glycol based butyl ethers. Their pronounced lypophylic character offers technical properties superior to ethylene- and diethylene-glycol monobutyl ethers.

The technical features of Dowanol* PnB and Dowanol* DPnB will be highlighted by means of examples of applications in water borne coating systems.

* Trademark — The Dow Chemical Company.

J. Spauwen

Biography

Jo Spauwen obtained a degree in process technology and chemistry from the Technological Institute at Heerlen, Netherlands in 1968. After a short period in paper coating technology development, he joined Vredestein, Netherlands, as a development engineer and production supervisor in polyurethane foam production. In 1977 he joined Dow Chemical Europe, Horgen, Switzerland, as a technical service and development engineer in the Urethane Department. In 1985 he switched to his present position as project engineer in the Glycol Ethers R & D Department, Horgen.

Novel polyamide epoxy curing agents

R. H. E. Munn

Summary

The use of polyamide resins containing free amino groups as curing agents for polyepoxy compounds is well established and such systems are widely used as the basis for high performance coatings. These systems are renowned for their toughness, chemical and corrosion resistance and excellent adhesion to a wide range of substrates. However, when used with some types of epoxy resins, such polyamides are less than satisfactory. Drying times may be extremely long and surface defects such as residual tackiness, blooming, cissing or rivelling may be apparent especially under adverse conditions such as low temperature and/or high humidity. Another important aspect is the initial incompatibility of this type of polyamide resin with low molecular weight liquid epoxy resins leading again to surface defects which

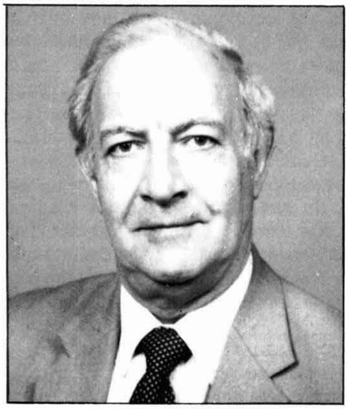
often precludes their use in high solids coatings.

Using novel chemistry it has been shown that polyamide resins can be produced which retain the essential desirable features of this resin class yet which overcome the defects referred to above and additionally, enable the formulator to produce high solids coatings.

The chemistry and performance of these novel polyamide resins will be presented.

Biography

R. H. E. Munn entered the Resin Industry in 1946 and following a three year period with a paint manufacturer, joined Cray Valley Products in 1965. He has worked in a variety of technical and management roles including a two year period in France and is now Market Development Director of the Company. A graduate of London University, he is a past Chairman of OCCA London Section, past Chairman of the OCCA Technical Committee and currently Chairman of the British Resin Manufacturers' Association. He has lectured widely both in the UK and overseas on a variety of technical subjects.



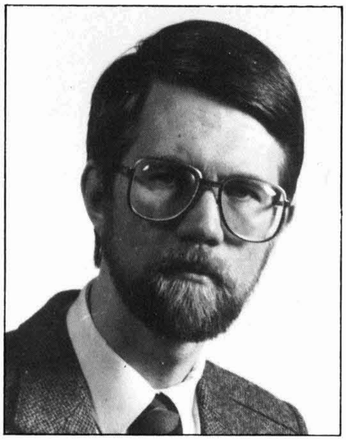
R. H. E. Munn

A novel water-based coating system for wet areas

I. Sarvimaki

Summary

This lecture will describe problems and requirements of painting systems used in wet rooms, especially bathrooms and houses. After reviewing some recent published literature in this area a short description of a novel coatings system will be given. Testing methods and the results of these tests will be presented. Finally, consumer acceptance of this system will be discussed.



I. Sarvimaki

Biography

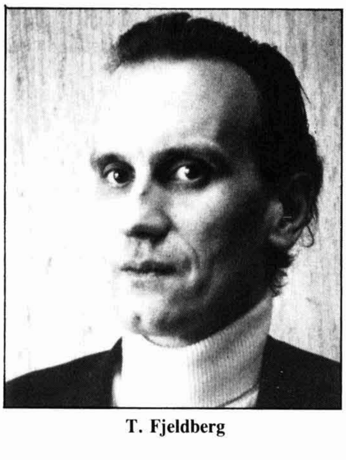
Ilkka Sarvimaki obtained a Dipl.Eng.(Chemistry) from Helsinki University of Technology in 1975. He joined Tikkurila Oy in 1975 and has worked at the Kemira research centre since 1984. He is currently Research Manager (Trade and Retail Paints) for Tikkurila Oy.

Alkyd emulsions properties and applications

T. Fjeldberg

Summary

This paper will consider the factors influencing the quality of alkyd emulsions. Their important properties for the formulation of interior and exterior paints, stains will be discussed. Formulations of anticorrosive primers will be given. Finally, future applications of alkyd emulsions in industrial finishes will be presented.



T. Fjeldberg

Biography

Thor Fjeldberg gained a degree in Chemistry from Goteborgs Tekniska Institut in 1963. He joined Dyno Industrier A/S in 1968 after working for several different paint companies. He has held various positions within the sales and technical service section of the coating resin department and is currently Sales Manager.

Advances in ink jet printing and ink jet inks

Dr W. G. Erskine

Summary

Ink jet printing is a versatile electronic imaging technology with increasing market penetration in a variety of application areas. Technology developments and refinements are entering the marketplace at an accelerating rate. The three major ink jet printing applications are colour hard copy, industrial printing and office and data computer printers. There are two main ink jet technologies in commercial use today—continuous ink jet and drop-on-demand—and their mode of operation will be presented.

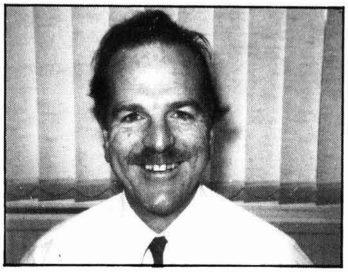
There are three main categories of low viscosity inks which can be applied by ink jet printers to a variety of substrates—fast drying ketone inks, alcohol and water based inks. Recently Domino Amjet has introduced UV Curing inks particularly for security applications and electronic parts marking. The physical and chemical properties of liquid inks required for continuous ink jet printing will be presented as will the ink's properties for drop-on-demand ink jet printing.

Recent improvements in inks and printers have led in the industrial sector to the printing of high quality, high speed single or multiline messages from a single jet and in-colour hard copy to the printing of photographic quality full colour images. The role played by the inks in these electronic ink jet printers and coders will be discussed.

Biography

Dr Erskine has 16 years of experience in non-impact printing technology and has specialised in ink jet and electrophotography. He is Research Manager of Domino Amjet Ltd, a leading European manufacturer of industrial ink jet printers. Prior to joining Domino, Dr Erskine held technical executive positions in contract research organisations responsible for non-impact printing, firstly with Battelle Research Centre, Geneva, and then with the International Research and Development Co, Newcastle upon Tyne. He holds several patents related to ink jet and high speed electrophotographic duplicators. Dr Erskine is a graduate of the University of Strathclyde, Glasgow, and completed post-doctoral work at Sunyab, New York, in 1968. He is a member of the British Institute of Management.

Dr W. G. Erskine (right)



OCCA Ties

OCCA ties are now available from the Association's offices, with a single Association Insignia on either a blue or maroon background.

The price is £4.25 each (including VAT) and orders **(by prepayment)** to Priory House should state the number and colour(s) required.

occa meetings

Bristol Section

Surface coating formulation optimisation

The first lecture of the 1986/87 session was a sponsored lecture by Tioxide UK Ltd, and given by Mr L. Cultrone on the subject "Surface coating formulation optimisation using three component plotting techniques". It was the first lecture at the new venue, the Bowl Inn, Lower Almondsbury, Bristol. The lecturer gave an excellent account of the use of trilinear co-ordinate paper for the assessment of paint formulation for the required physical properties. The complexity of evaluating multicomponent systems as found in paint formulations was discussed including the early work such as that of Claringbold and Scheffe. It was stated that others in the field had developed efficient experimental designs and models for mixtures and had facilitated the understanding of the applications of mixtures designs as well as the analysis of the resulting data. The most frequently used model was that of Taylor Series using the special cubic equation. The coefficients are functions of the measured responses. The experimental error can be determined by replicating the responses.

Examples of using this system for the development of various paints such as a latex paint (semi gloss) were examined. It was possible to plot the effect of the addition of an extender such as clay or calcium carbonate on the cost factor, scrub resistance and contrast ratio etc, by the use of a Tiosoft Conplot 111 software in the computer. The programme is written in Basic Language and runs on a Hewlett-Packard or Gould or any other IBM compatible plotter. The software is available from Tioxide Group plc.

The lecturer clearly showed the value in time and work of the use of such a programme and a lively discussion followed from the audience.

The Chairman Mr Prigmore asked Mr Newton to propose a vote of thanks to the lecturer.

J. R. Taylor

Irish Section

Paste inks

A meeting of the Irish Section was held on 3 December 1986, at the Ashling Hotel, Dublin, when Mr P. J. Hutchinson, consultant to Croda Polymers International, delivered a lecture entitled "Paste inks, past, present and future".

Mr Hutchinson explained that progress in printing inks over the last 15 years or so has been influenced by a number of factors; the demand for higher production rates on faster printing presses; the increasing variety of new substrates; the oil crisis of the mid-1970's adversely affecting prices and availability of raw materials for inks; an uncertain economic climate worldwide; the impact of health and safety legislation and environmental pollution problems.

The speaker traced the development of conventional offset litho inks which had led to improvements in the setting, drying and gloss of inks for coated papers and carton boards. In sheet-fed printing, substantial reduction or elimination of spray powder application could be achieved by accelerating ink drying with the use of Infra-Red heating. In this technique, short to medium wave-length infra-red heating modules could be inserted in the delivery of the press. In carton printing, another aid to spray powder reduction was the application of rapid drying emulsion varnishes, wet-on-wet to freshly printed litho ink films, by means of converted dampener systems on the last printing unit, or by special coating units attached to the press.

A significant advance in ink technology was the development of ultra-violet radiation curing inks which had the advantage over the conventional inks, of instantaneous drying hence complete elimination of spray powder. The low odour of the UV cured ink film ws an important advantage for the printing of the outers of food and confectionery wrappers and cartons. Considerable interest had been shown in the Electron Beam Curing of printing inks that are based on a chemistry similar to that of UV inks. Commercial applications of EB inks and overprint varnishes were in the web-offset printing of board stocks for the in-line production of record sleeves and in the printing of cartons for milk and fruit-juice packaging where the low print odour was an advantage.

Advances in inks for heat-set web-offset printing included low emission inks and inks that could be dried at lower than normal web temperatures. In discussing some possible future trends in ink development, attention was drawn to a number of outstanding problems. Thus with conventional offset litho inks, film forming properties could be adversely affected by entrapped molecules of the high boiling solvent component. With UV inks their relatively high cost was a continuing disadvantage and more research was needed to upgrade lithographic performance.

The lecture which was excellently attended was based on the paper given to the Manchester Section OCCA symposium held in April 1986, the text of which will be published in JOCCA, early 1987.

A vote of thanks was proposed by Mr John Downing and carried with acclamation.

R. C. Somerville

Manchester Section

Colouration and colour enhancement of inks by nacreous pigments

The second lecture of Manchester Section's Programme directed specifically towards the Printing Ink industry, was presented to the section by Mr. G. Houseman of Merck. Forty-five members and guests attended the lecture, which was held in the staff common room at Salford University on the 17 November 1986.

Initially, the structure of the pigments was described; these consisted of a fine laminar particle of mica surface coated with titanium dioxide, the colour of the pigment depending on the thickness of the surface layer. The pearl lustre effect is created by the partial transmission and partial reflection of light at each boundary, due to the large difference in refractive index between the mica and the titanium dioxide.

The pigments are added at the last stage of manufacture, using the minimum of energy, as it is essential not to fracture the pigment particles. For colour variation it is possible to add other pigments, but these must be transparent absorption pigments, or the pearl lustre effect will be lost.

Nacreous pigments have poor opacity, therefore they should be used in a top coat, applied over a solid colour background.

After outlining the above general concepts, the lecturer completed his talk, by outlining the film thicknesses one would normally anticipate with various printing methods, and therefore the effectiveness of the different grades of Iriodin pigments, in inks formulated for, and applied by the different processes.

After a comprehensive question and answer session, a vote of thanks was proposed by Graham Fielding, and those present were able to partake of a buffet sponsored by BDH.

The magic of chemistry

The Manchester Section family lecture was held at Salford University on 3 December 1986. The lecture was well attended by 70 members, wives and families.

The lecture this year was entitled "The Magic of Chemistry" and was presented by Dr Brian Iddon of Salford University. Being the 200th presentation of this lecture, the proceedings were also attended by a reporter and photographer from the Manchester Evening News.

The lecturer brilliantly outlined the spectacular side of chemistry producing vivid colours and dyestuffs, polymers, bright lights by chemiluminescence, loud bangs, bright flashes and clouds of smoke.

A vote of thanks was proposed by the section chairman's wife, Mrs M. Windsor, backed by rapturous applause from those present, and the evening's activities were concluded with an excellent hot buffet subsidised by the section.

M. G. Langdon

Midlands Section

Artifical weathering

The second lecture of the Midlands Section was held on 20 November 1986, at the Clarendon Suite, Stirling Road, Edgbaston, Birmingham.

Members and guests heard Mr M. Camina of the Paint Research Association give a talk entitled "Artifical Weathering—do results correlate with natural exposure?"

Mr Camina said that all coatings when exposed to the weather degrade to a certain extent but to what extent this degredation is acceptable depends on the articles. For example in an automobile finish a loss of gloss of 50% in 1-2 years would not be acceptable but for a decorative paint it may be.

Various machines are available that will accelerate natural exposure but care must be taken to fully evaluate the light source and mode of operation as this can have a pronounced effect on the coating. With carbon arc lamps, fading is more severe while Xenon lamps chalking and loss of gloss are worse.

The speaker then spoke at some length on the methods for analysing the loss of gloss of a coating and showed numerous graphs to illustrate the effect of various machines, light sources and exposure sites on various paints. Exposure of panels for one type of paint for 4,000 hours in a QUV (A) cabinet gave good correlation with 13 months expsoure in Dubai, but the same paint exposed at Innisfail did not correlate. The same effects are seen when examining chalking, a silicone alkyd paint in the QUV (A) cabinet gave bad chalking results while in other machines and natural exposure performed very well.

To conclude his talk, Mr Camina said that the spectral distribution of the light source was important. When evaluating the durability of a surface coating it is dangerous to use only one type of machine or exposure site. He had shown during his talk that even using the same machine but by changing the light source could produce a different set of results.

After a short question time the meeting closed with a vote of thanks proposed by Mr H. J. Clarke.

B. E. Myatt

Midlands Section Trent Valley Branch

Bronze flake pigments

On 27 November 1986, Wolstenholme Bronze Powders Ltd were the sponsors of our meeting at the British Rail School of Engineering, Derby. A most lavish buffet preceded the slide and lecture presentation by Dr Dennis Cleaver, Technical Director, the subject being "Bronze Flake Pigments—their manufacture and use in Printing Inks, Paste and Liquid".

This most absorbing and excellently presented paper traced the history of metallic flake pigments, discussed the nature of metallic flakes, process technology and the application and control of properties.

Bronze flakes are manufactured by foundry techniques using a variety of Copper, Zinc and Aluminium ratios. The melt is exposed to high pressure compressed air and the nodules collected. These irregular particles are stamped or ball-milled into flakes, the resultant product being classified into a range of sizes and finally polished in a drum polisher. All these processes were featured on projected slides of the production units in the Wolstenholme factory.

The physical and optical properties of the flakes were discussed followed by information on their properties with respect to their use in ink formulations.

After such a comprehensive and informative lecture a lengthy question period followed. Tarnishing, surface treatments, leafing, colour and health and safety matters were all discussed.

The vote of thanks for the generous sponsorship, and quality of presentation was proposed by Derek Grantham and heartily endorsed by the members and guests present.

J. C. Ellis

Newcastle Section

Silicone paint additives

The third meeting of the 1986/7 session was held on 4 December 1986, at St Mary's College, Durham and was sponsored by Byk Chemie. Mr B. Dawid delivered a lecture entitled "Silicone Paint Additives—a Map of the Minefield".

Flow and levelling are markedly affected by coating viscosity, surface tension and thinner-flash-off time. With coatings the surface to volume ratio is very high and surface tension effects become more important, yet formulators generally pay most attention to pigment/resin fastness and other physical properties.

Mr Dawid showed tables of surface tension values for a variety of resins and solvents, as well as typical substrate materials. Surface defects resulting from gross differences in these values between coating and substrate were demonstrated e.g. cissing on oily surfaces, cratering from dusty overspray and crawling in draughty conditions, Béard cell effects were also placed in the same category.

He then introduced silicone oils as surface tension modifiers to overcome such defects. The original additives marketed were dimethylpolysiloxane oils varying in molecular weight and hence viscosity. Typical uses range from simple flow control with very low viscosity silicones, to slip enhancement, defoaming and hammer-finish effects as the silicone viscosity increased. Silicones have since been synthesised with various polyether and polyester groupings built into the polysiloxane chains; such modification altering compatibility with different coating resin/solvent blends, films activity and concentration effects. These molecular structure changes directly affect the distribution of silicone molecules within the coating, with a tendency to crowd at the film surface or within the bulk of the film according to the changes introduced.

Mr Dawid mentioned surface defects caused by silicone contamination of surfaces before painting and demonstrated "cratering", "ghosting/telegraphing" effects. Finally, he discussed heat stability in stoving systems, showing how polyether-modified types can degrade above 150°C and thus lose activity. Studies made using a heat-gradient oven showed how polyester substitution of polyether groupings gives more heat-stability.

After the vote of thanks given by the Chairman, Mr R. G. Carr, members and guests enjoyed an excellent buffet supplemented by splendid German beer and wines.

J. Bravey

Ontario Section

Aluminium organics

On the evening of 19 November 1986, 24 members and guests attended the meeting to hear Mr David Love of Manchem Ltd (Manchester, England) speak on "Aluminium organics for rheology control in printing inks".

Mr Love began by describing the synthesis of aluminium alkoxides from aluminium and alcohols, and subsequent reactions with water, other alcohols, phenols and carboxylic acids. He went on to describe how the use of enols such as ethyl acetoacetate could be used to make chelates with aluminium. Such chelates undergo similar reactions, but are much more stable. Finally, he described the synthesis and reactions of the related polyoxo compounds which are more stable again.

Since offset varnishes contain reactive elements such as water and carboxylic acids, the addition of these aluminium compounds results in reactions which form polymeric species, leading to an increase in viscosity. Mr Love described how controlled addition could avoid local gelation, and noted the importance of knowing the acid value of the resin, and the nature of the minor components of the varnish. He then discussed the benefits obtained from these aluminium derivatives, namely, greater press speeds, better dot resolution, and improved heat set properties.

After an interesting question period, Mr Purnell, the Chairman, proposed a vote of thanks.

Tribology

The Ontario Section met on 17 December 1986, at the Cambridge Motor Inn. 24 members and guests gathered to hear Dr Gaston Vandermeerssch, President of Gavarti Associates Ltd of Milwaukee, Wisconsin speak on "Tribology in the ink industry".

Tribology is the science of wear, and Dr Vandermeerssch began by reviewing the Sutherland ink rub tester which was developed 40 years ago, and by listing the basics of tribology, namely, pressure, frequency, span and time. The need for improved equipment which could provide objective, reliable, and reproducible results allowing unambiguous communication between suppliers, manufacturers and clients was described. Finally, Dr Vandermeerssch described a newly available abrasion tester which satisfies these requirements.

Following a question and answer period, the speaker was thanked by the Program Officer, Mr Hazen, for a most informative presentation.

P. Marr

Scottish Section

Colour match prediction

The first meeting of the new session was held on 9 October 1986, in the Hospitality Inn. A paper entitled "How match prediction helps you get it right first time", was presented by Paul Bowman and Peter Leban of Instrumental Colour Systems Ltd.

Using the ICS equipment they demonstrated the speed and accuracy available with the package now on the market. This meant that one control unit would service several terminals with little or no delay time. A measure of the degree of metamerism was predicted from a match obtained from the users library of pigments for a customer's pattern. This allowed one to determine the acceptability or otherwise of the degree of metamerism.

Three models were available all derived from the basic model allowing a user to expand his usage as demand dictates by adding on to the basic model.

A probing question session followed, after which J. Harte proposed a vote of thanks.

Further discussion and demonstration continued using samples supplied by the audience, while a light buffet was provided by courtesy of ICS Ltd.

R. L. Barrett

Thames Valley Section

Powder coatings

Mr Jim Watts of MacPherson Drynamels Ltd gave a talk on 20 November 1986, to members and guests of Thames Section, entitled "Powder Coatings—or Problems Without Solutions". The lecture began with a potted history of this young technology with its beginnings in the early fifties.

The lecture continued with a comparison of the resins currently available for use in powder coatings with a detailed account of both their physical and chemical characteristics and suggested areas of application for individual resins.

The second part of the evening was devoted to an amusing and interesting question and answer session using a written questionnaire supplied by the speaker entitled "Which Powder Please?"

The evening closed with a lively discussion regarding the future of the UK paint industry, powder versus wet paint, and a vote of thanks was proposed by J. A. Gant.

J. A. Gant

news

BP acquires Owens-Corning's HITCO

BP has acquired the HITCO subsidiary of Owens-Corning's Aerospace and Strategic Materials Group for $240 million. From its base in Southern California HITCO has a significant presence in the US advanced composites industry with sales of $150 million in 1985. HITCO has interests in both advanced materials and the fabrication of end products for the aerospace, automotive and marine industries.

Resinous Chemicals Saves It

Resinous Chemicals Ltd, part of the Hoechst Group, has won the 1986 Shell Energy Award. The aim of the award scheme is to monitor energy consumption and hit energy saving targets. Contributing to the company's success was the devising of energy saving procedures that can be applied in other firms.

Mr C. Hall (left), Chief Engineer, Resinous Chemicals Ltd, receiving the 1986 Shell Energy Award.

Mercury Plastics acquires Foscolor

Mercury Plastics has reached agreement with Foseco Minsep plc for the acquisition of their subsidary, Foscolor Ltd. Mercury Plastics of Watford, Herts, was established 12 years ago and is the leading UK supplier of universal colour masterbatch for the pigmentation of all types of plastics. Foscolor of Wigan, Lancashire, are also specialist manufacturers of colourants sold to the plastics industry and in addition are manufacturers of pigment dispersions for printing inks, paints and other surface coatings. The two companies will retain their identities, names and products and they both view the acquisition as complimentary to their product ranges.

Mr C. Denza, Managing Director of Mercury on the left and Mr F. Morpeth, Managing Director of Foscolor.

Th. Goldschmidt's new HQ and Warehouse opens

Th. Goldschmidt Ltd's new headquarters and Southern UK warehouse at Tego House, Victoria Road, Ruislip, has opened. Office space exceeds 6,000m^2 and warehouse space is a further 7,000m^2. Also opening on the same site is a technical service laboratory for dealing with customers' routine requirements.

Steetley Berk Ltd formed

The similar industrial trading activities of Steetley Chemicals Ltd of Basingstoke and Steetley Minerals Ltd of Worksop will be combined to operate as Steetley Berk Ltd, a wholly owned subsidiary of Steetley plc. Though the name has changed the location and people at both companies remain the same.

products

BP Chemicals develops underwater coating

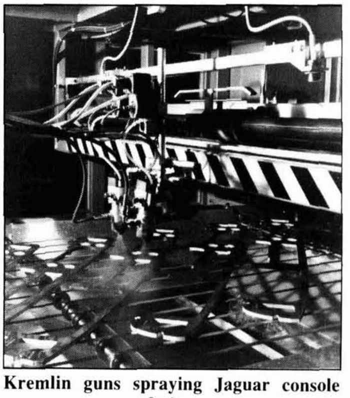
BP Chemicals of Sully, South Glamorgan, has developed an anti-corrosion coating and sealant system which can be applied underwater. The new product, *Epron Subseal,* is intended primarily for subsea maintenance in the offshore energy industry. Using underwater mixing techniques, Epron Subseal can be applied to either steel or concrete to give a damage resistant coating. The system can be used for repairing neoprene coated risers and pipelines, replacing coatings removed for inspection purposes or damaged by abrasion. Epron Subseal is a two-part epoxy based elastomeric material specially designed for subsea use. It is available in free flowing or thixotropic form. For small to medium repairs the product is supplied in cartridge form and for larger areas in bulk packs.

Reader Enquiry Service No. 20

Kremlin airmix spray guns

Kremlin Spray Painting Equipment Ltd of Slough has installed *Airmix* spray guns at Jaguar Cars for application of a UV cured acrylic based lacquer to wood veneers of console facias. The veneers receive three coats of the lacquer of thickness (dry film) 3.2 thous. The veneered components are conveyer fed into a Falcioni Automatic Spraying Unit fitted with two pairs of Airmix guns. The UV lacquer is fed to the automatic spray guns using a Kremlin diaphragm pump fitted with a return valve.

Reader Enquiry Service No. 21

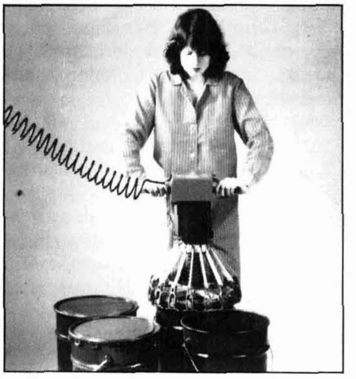


Kremlin guns spraying Jaguar console facias.

Deritend drum closing tools

Deritend of Liverpool has developed a range of *"Crosshall"* lid closing tools for metal containers, pails and drums. The range encompasses simple hand operated pneumatic devices to completely automated filling lines. Various sizes are available to suit containers ranging from 160 to 375 mm in diameter.

Reader Enquiry Service No. 22



Top seal

literature

Glasurit ink brochure

A brochure outlining its range of web and offset ink vehicles has been published by Glasurit Beck Ltd, a subsidiary of BASF. In January Glasurit Beck changed its name to BASF Coatings & Inks Ltd. Copies of the publication, called 'Get Set for Colour', are available from Glasurit Beck Ltd, Slinfold, Horsham, West Sussex RH13 7SH.

New Road Traffic Regulations

Following the recent introduction of The Road Traffic (Carriage of Dangerous Substances in Packages etc) Regulations 1986, general goods vehicle operators, drivers and consignors of dangerous substances have been given new responsibilities. Hazchem Signs Ltd of Edgware has published an operators guide to the regulations. The free guide is available from Hazchem Signs Ltd, 11-13 Whitchurch Parade, Whitchurch Lane, Edgware, Middlesex.

meetings

Colour basics

A short course of lectures and demonstrations covering the basic principles of colour physics and colour measurement will be held on 1-3 April 1987, at UMIST, Manchester, UK. For further details contact The Director of Communications, UMIST, PO Box 88, Manchester M60 1QD.

people

David Henley has been appointed Business Division Manager, Alcohols and Esters at BP Chemicals Head Office in London.

Natal Section

11th National Symposium

At the end of October, the South African Division held its 11th National Symposium at the Elangeni Hotel in Durban. For the first time in South Africa, a Trade Show was held concurrently with the symposium and although the number of exhibitors was lower than anticipated, the standard of the exhibits was very good.

The symposium was very well supported with over 200 delegates from both suppliers and manufacturers throughout South Africa, attending. It was also most gratifying to note that the symposium attracted a high percentage of overseas speakers. The programme was well balanced with seven local and eight overseas speakers presenting papers over the three day period.

A Wild West evening provided the speakers and delegates with a lively interlude, and an opportunity for everyone to get to know each other in a social environment.

All in all it appeared as if everyone found the symposium interesting and enjoyable.

Mr D. Philbrick (right), Chairman Natal Section, thanking Mr M. Brett of Michael Brett and Partners for his address given at the annual Natal Section Christmas cocktail party.

Annual Dinner Dance

On the 28 November, the Natal section of OCCA held its annual year end social function at the Royal Hotel in Durban. After having a dinner dance last year, the Committee decided to revert to the traditional cocktail party. An excellent spread of hot and cold snacks was provided by the hotel, and the bar was operated on an open account, both of which were paid for through generous sponsorship from suppliers and manufacturers.

During the course of the evening, Michael Brett addressed the members and guests, and was presented with a small gift by our Chairman, Dick Philbrick.

B. P. Rijkmans

"Captured" at the South African Division's 11th National Symposium, Durban, 21-24 October 1986. Left to right: Mr F. B. Redman, President; Mrs C. de Villiers, Chairman Cape Section; Mr K. Engelbert, Honorary Member and Treasurer, Natal Section; Mrs M. Engelbert; Mr D. Philbrick, Chairman, Natal Section; Mrs P. Redman; Mr P. Quorn, Chairman, Transvaal Section. Kneeling: Prof D. Williams-Wyn, S.A. Vice-President.

Obituary

T. A. Fillingham

G. Hutchinson writes:

After a long illness, Alan Fillingham died on 25 November 1986, at the age of 73. The announcement was made to the Hull Section on the occasion of its third technical meeting in December and was followed by a short period of silence as a mark of respect to him.

He was Hon. Secretary at the formation of the Hull Section in 1943, Chairman 1949-1950, Representative on Council 1951-1953 and a Vice-President 1953-1955.

He was for a time, Hon. Social Secretary and for various periods a member of the section committee. He was admitted to FTSC in 1972.

Alan was a tireless and enthusiastic worker for Hull OCCA especially during the difficult war years and the decade that followed. He was one of the old school of oil chemists with a fund of practical experience in drying oils. One is fortunate to have been associated with Alan at Hamilton's Humber Oil Works in the years following the last war, during a period of interesting developments in the chemistry and applications of drying oils. These were informative yet challenging times and Alan was a helpful and considerate colleague, especially to those of us who were newcomers to the industry.

After Hamilton's, he was employed at Marfleet Oil Refinery where he was involved in research on the use of fish liver oils in surface coating media and for a few years before retirement as technical training officer.

Alan will be sadly missed by his many friends and colleagues and one has the happiest recollections of working with him.

He is survived by his widow, Marjorie, and a son, Howerd, and daughter, Jane.

News of members

Dick Woodbridge, Technical Director of Berger Decorative Paints, has been elected President of the Paint Research Association. Installed at the end of November he will hold the position of President for the next two years. Mr Woodbridge entered the paint industry in 1941 with Bristol-based John Hall & Sons, which became part of the Berger Jensen & Nicholson Group in 1971. In May 1986 he was appointed Technical Director of Berger Decorative Paints.

Brian F. Gilliam (Hon. Treasurer) has joined the Colchem Group of Companies heading S & M Lacqers Ltd, suppliers of colours, pigments and fillers, and may be contacted on 01 501 1210.

Mr T. Entwistle FTSC passed away suddenly on 4 January 1987. Mr Entwistle was a past Vice President and currently represented the S. African Division on Council. At the request of his family a donation has been sent by the Association to the British Heart Foundation. An obituary will be appearing in the Journal in the near future.

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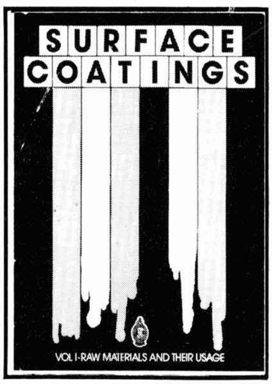

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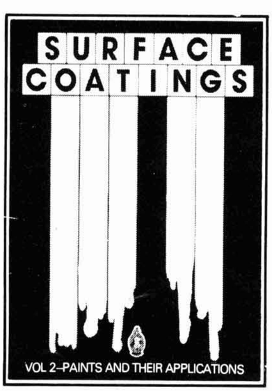

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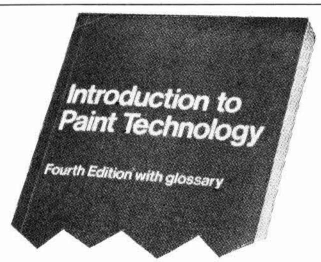

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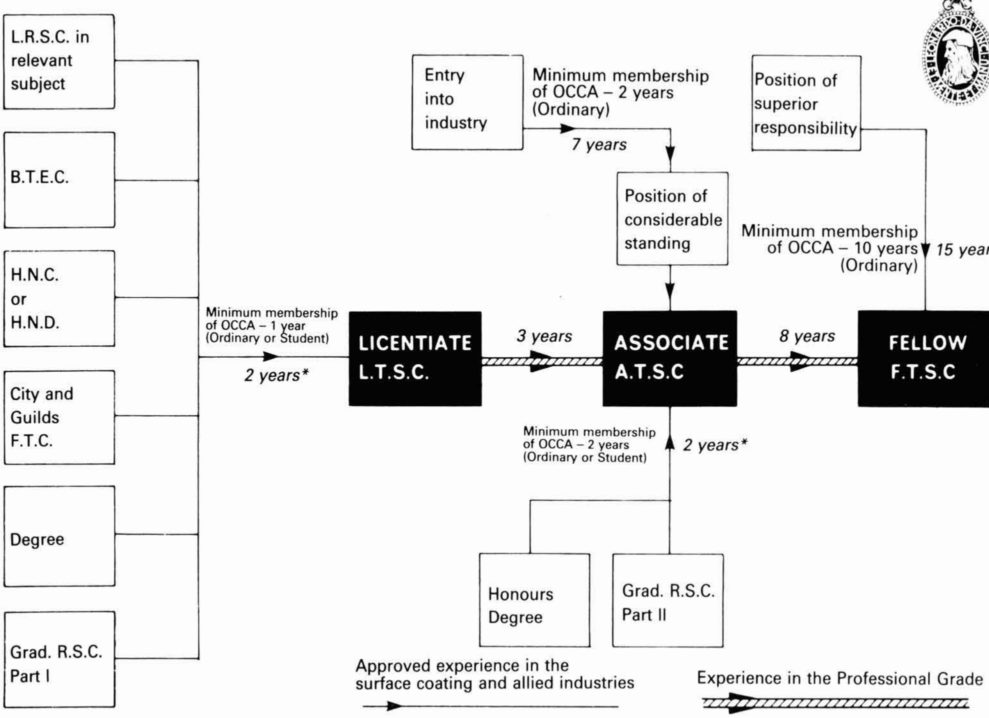

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