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FASTER FINISHING

Lactide can reduce drying time and allow increased solids of alkyd coatings. By Armin Michel, Corbion.

Alkyd coatings continue to be widely used in architectural and decorative coatings. The incorporation of a bio-based lactide monomer in alkyds can significantly shorten drying time. Other benefits include reduced VOC content, a smaller carbon footprint and improvements in some properties.

Ensuring an alkyd based coating dries quickly is a key factor in the quality of finish. Not only does it affect overall appearance, it also plays an indispensable role in protecting the paint against the elements as it dries. Also, reduced drying time allows professional painters to significantly improve production efficiency, allowing them to coat more pieces in a shorter amount of time.

With global construction output expected to surge in the next two decades, driven by growth in the USA, China and India, drying time is becoming an increasingly important factor – particularly in dusty locations or places with poor air quality.

At the same time, there is increased demand for other performance improvements, including improved gloss, gloss retention and ease of use, while coating systems have to meet increasingly strict regulations in relation to Volatile Organic Compounds (VOCs).

More and more paint formulators are therefore seeking alternative resins that can be easily and cost-effectively incorporated into existing formulations and will exhibit improved drying behaviour, as well as meeting additional performance considerations.

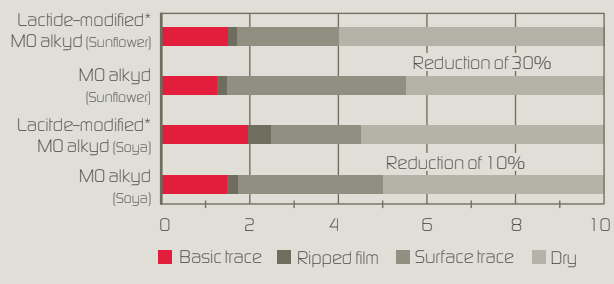
WHY DRYING TIME IS CRITICAL IN DECORATIVE COATINGS

Drying time is a significant factor affecting the overall quality of finish in decorative coatings. A coating with an accelerated drying time is protected faster against spoilage caused by dirt, dust particles and insects etc., thus improving the overall finish of the coated item.

In addition, reduced drying time can also lead to enhanced speed of production for professional and commercial painters. Faster drying time means a second layer of paint can be applied in a shorter amount of time, translating into increased production cycles, improved efficiency and ultimately cost savings for both the contractor and the end customer.

A number of factors affect the drying time of coatings, each of which must be taken into consideration when developing any paint or coating formulation. These include air movement, film thickness, temperature and relative humidity. As a result, painters may sometimes use

Figure 1: Drying speed comparison of unmodified medium oil (MO) alkyds with lactide-modified versions.



RESULTS AT A GLANCE

→ Coatings formulators are under constant pressure to reduce VOC levels while improving coating performance. In exterior applications in particular, fast drying can enhance quality (by reducing the time in which the film can be damaged or contaminated) as well as improving productivity.

→ Alkyd coatings continue to be widely used in architectural and decorative coatings. Results are presented to show that the incorporation of a lactide monomer in alkyd synthesis can shorten its drying time significantly.

→ Resin viscosity can also be substantially reduced, thus producing higher solids coatings with reduced VOC content. Other key properties of the paint, such as gloss retention, yellowing and hardness development, are either improved or largely unaffected.

→ The lactide monomer is bio-based, and this combined with reduced VOC levels significantly reduces the carbon footprint of alkyd paints.

different drier combinations to control these parameters and achieve optimum drying conditions for the perfect finish. The alternative is to choose a paint formulation which already has an accelerated drying time.

USE AND BENEFITS OF LACTIDE-MODIFIED RESINS

For many years, polymers and resins have been formulated from oil-based monomers due to the value of their performance and properties in coating applications. Alkyd resins, in particular, are a popular option. However, following the continual demand for improved performance, paint formulators may look towards new building blocks and raw materials to enhance the properties of existing paint formulations at minimal cost.

These new technologies also provide added benefits for formulators looking to comply with stricter regulations on VOCs. With the emergence of innovative technologies, the industry is, for example, increasingly reformulating with hybrid alkyd systems or the use of additives. When resins are being modified, the system should, however, remain as close to the original as possible, whilst still showing significant improvements in performance.

Extensive research has been conducted to identify monomers that can be incorporated into polymers and resins to enhance the performance of both resin and coating. The unique bio-based lactide building block is an example, with benefits including shorter drying time, as well as improved hardness and excellent gloss retention in the end application. In addition, the lactide chemical structure gives coating performance at least equal to that of petrochemical alternatives, whilst also reducing the environmental impact of solvent-based coatings.

Data shows that lactide-modified resins can significantly accelerate drying time compared to reference resins. For example, in medium oil, alkyd resins lactide modification results in a reduction in drying time of 10% for soya-based alkyd resins and 30% for sunflower-based alkyd resins (see *Figure 1*).

Lactide can be incorporated into alkyd based resins in a cost-competitive manner, using existing production processes and without compromising the performance of either resin or coating. The formulation is modified by using lactide to replace a combination of difunctional glycols (e.g. pentaethylene glycol) and diacids (e.g. polyamide), while maintaining the properties of the resin such as acid and hydroxyl value and molecular weight.

REDUCED VISCOSITY TO CUT VOCS AND IMPROVE APPLICATION

Ease of application is an important consideration for many end users as it determines how much of a coating should be applied to cover a given area. Whether it is for professional painters or industrial use, many look for coatings that offer an instant coverage of the substrate. Thin paints, which usually possess a high solvent content, must typically be applied several times to provide a high quality, even coverage.

Lactide-modified alkyd resins show a significant reduction in viscosity compared to standard reference resins, while retaining the rheological behaviour of the original resin. Tests show that the use of lactide in medium oil alkyd resins delivers a reduction in the viscosity of up to 80% at comparable molecular weight (see *Figure 2*). This results in enhanced levelling and flow behaviour of the paint to give a more consistent coverage.

DURABILITY CAN BE IMPROVED IN SEVERAL WAYS

An important indicator of durability - gloss retention - is an additional performance parameter in the formulation of decorative coatings. As consumers become ever more discerning, formulators must develop products that meet their expectations in relation to retention of the overall appearance over time, to prevent frequent re-purchasing or re-painting.

This is particularly relevant for outdoor applications, which are often subject to weathering when exposed to the elements, including UV light and water. At the same time, white-painted outdoor products have a tendency to yellow over time. In line with consumer demand for high quality, paint formulators are increasingly looking to deliver greater value in the final formulation by ensuring white paint maintains its sheen and colour over time. As a result, they are increasingly looking for solutions that can improve gloss retention as well as reduce yellowing in the final coating formulation. Research shows that lactide-modified alkyd resins demonstrate similar initial gloss values compared to reference resins. A test paint also showed a similar yellowing profile over four weeks, when measured at a storage temperature of 60 °C (see *Figure 3*).

Similarly, hardness is an important measure of durability in coatings. For everyday items such as furniture, wear and tear is inevitable. Ensuring items are not sensitive to sharp objects or scratching is imperative when it comes to guaranteeing the quality of the end application. Tests have shown that medium oil alkyd resins modified with lactide exhibited improved initial hardness development and maintained this hardness development over time. As such, manufacturers of the end application are able to make specific product claims and consumers benefit from a long period of usage.

HOW LACTIDE REDUCES THE CARBON FOOTPRINT OF COATINGS

The reduction in viscosity of lactide-modified resins introduces the possibility of producing higher solids paint formulations, while the viscosity and rheological behaviour of the original polymer resin is retained. The amount of solvent required is therefore significantly reduced and, with a higher material content per volume ratio, the VOC content is lower in higher-solids paint formulations.

There is up to 30% less solvent in certain resin formulations, helping to meet increasingly strict VOC regulations (see *Figure 4*). Furthermore, reducing the solvent content can also lead to cost savings in the final paint formulation.

In addition, by incorporating lactide-modified resins into existing formulations, a CO_2 footprint reduction of up to 21% can be achieved, compared to reference formulations (see *Figure 5*).

Figure 2: Viscosity reduction achieved by lactide modification of two medium oil alkyds.

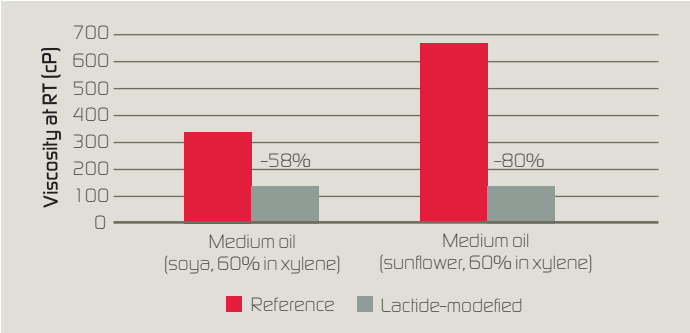


Figure 3: Lactide modification leads to only a slight gloss reduction, while gloss retention is unaffected.

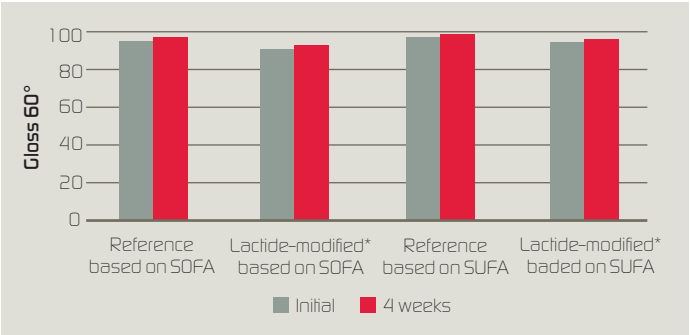


Figure 4: Viscosity comparison indicates the potential increase in solids content achievable by lactide modification.

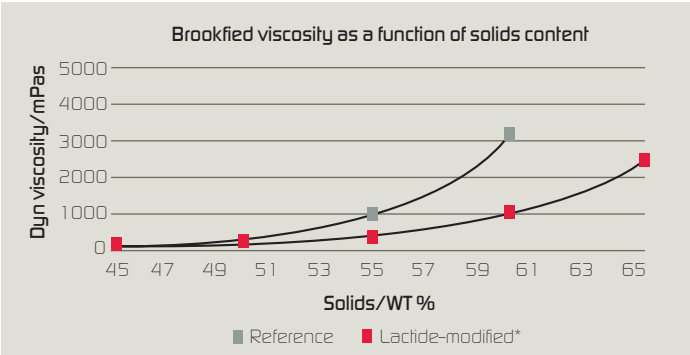
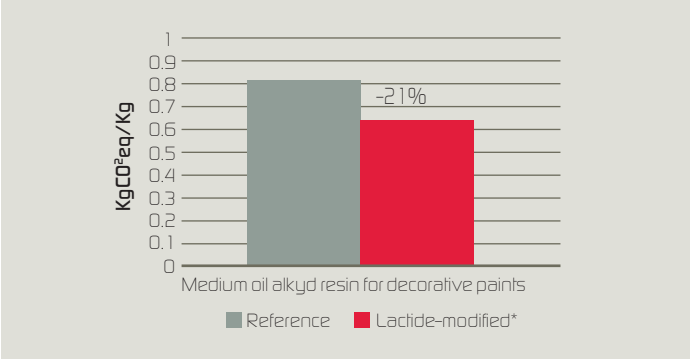


Figure 5: Lactide modification allows the overall carbon footprint of an alkyd paint to be reduced.



BENEFITS OF LACTIDE IN COATINGS SUMMARISED

The incorporation of lactide-based alkyd resins into paint formulations not only helps formulators ensure that coatings dry quickly for a high quality finish, but also allows them to meet increasing demands for additional performance benefits. Meanwhile, they can help coating formulators to meet new targets for lower VOC content and produce coatings with a reduced carbon footprint.
"Puralact B3", is suitable for incorporation into a wide range of coating resins. In addition to shorter drying times, it offers good results in terms of improved hardness and gloss retention and a reduced CO_2 footprint. The lactide can be easily incorporated into alkyd resins at low cost.

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"A relatively new raw material for the coatings industry."

3 questions to Armin Michel

Are there any incompatibilities that have to be considered when formulation with the lactide? *As lactide is a relatively new raw material for the coatings industry, there are some key considerations that formulators should be aware of during product development. Namely, lactide is not simply a drop-in product – it must be chemically incorporated into a resin for ultimate efficacy and performance. When modifying a resin with our product for example, the lactide monomer's chemical structure undergoes a ring opening reaction. Careful consideration of the choice of catalyst supporting this type of reaction mechanism, is required. Catalysts based on zinc, for example, have demonstrated good compatibility with lactide, offering the benefit of tin-free polymerization.*

Can the product be incorporated in all resins? What is the additional cost of using lactides? *"Puralact B3" is a bio-based cyclic di-ester monomer derived from sugar fermentation that can be incorporated into almost any resin that contains monomers with free hydroxyl end groups. Furthermore, the product can be used in polycondensation, as well as ring-opening polymerization reactions. In terms of cost, lactides can be incorporated into resins in a cost competitive manner, using existing production processes, without compromising performance of both resin and coating. In fact, the incorporation of lactide offers multiple advantages to both formulators and end users, including lower solvent cost, improved reaction yield, reaction waste water reduction and reduced drying time.*

How much can hardness development be improved? *Improvement of hardness development with lactide is formulation dependent. Various data reports a hardness increase from 10 up to 50%, depending on the formulation. A key advantage of lactide is to allow increased hardness while maintaining flexibility, resulting in a coating with improved scratch and chemical resistance, without causing brittleness.*