# The rediscovery of ancient wisdom

*Eco-paint, Green paint, Alkyd paint, Acrylic paint? Confused? Architect Kevin Davies explains the revival of traditional linseed oil paint.*

## The humble flax plant.

Turquoise blossoms of the flax plant, Skane, SWEDEN.

The cultivation of Flax (*Linum usitatissimum,* Linaceae) dates back several thousands of years. Flax seeds and woven cloth have been found in Egyptian tombs. The Bible mentions 'fine linen', this was spun from Flax. It has been used for millennia in all manner of ways. Today you may have some lino or linoleum covering the kitchen floor, it's made from solidified linseed oil (linoxyn) or fed the birds some flax seed or taken a drop yourself for nutritional purposes. Flax contains the highest level of omega-3 fatty acids among all vegetable oils. If you play cricket you have no doubt applied linseed oil to protect your beautiful willow bat, you have done this because everyone knows linseed oil is good for wood, don't they?

Well yes, aside from using the flax plant for making cloth, sails, lamp wicks, cord, lino, for medicinal & nutritional purposes etc (it's a very useful, versatile & pretty little plant) linseed oil has been pressed from the flax seed and used to protect timber for thousands of years. The 'chemistry' may not have been understood, as it is today, but it's performance as a protective and extremely durable coating is not disputed.

## Some technical explanation.....

We actually differentiate between two basic types of flax – oilseed flax and spinning flax. Oilseed flax grows with shorter fibres and produces seeds that are rich in oil. In contrast, spinning flax has long fibres, but with less oil in its seeds. Linseed oil (or flax seed oil) is referred to as a 'drying oil', meaning the initial material is liquid but after a period of exposure to air it hardens to a tough, solid film. The 'drying' process (there is no evaporation) is the result of an oxidative reaction (or oxidisation) where oxygen attacks the hydrocarbon chain and as a result the oil polymerizes forming long chain-like molecules. As time passes the polymer chains cross-link resulting in a vast polymer network. The result is an aged material that is stable and rigid but remains somewhat elastic. Most applications of linseed oil exploit these drying properties.

Linseed oil molecules are also small, and aided by an expansion in volume of around 10% during drying, it offers excellent penetration into wood pores, both visible and microscopic but without expanding the wood itself. Linseed oil is also hydrophobic, its molecules are repelled by water. Droplets of water will form on the linseed oil film much like morning dew on grass or on the surface of a leaf. We can begin to

appreciate how linseed oil can protect not only our cricket bat but most surfaces exposed to the elements.

It wasn't long before colour pigments were 'suspended' in the linseed oil and its use as the preferred supporting medium (binder) for making oil paint. Linseed oil paints have been used in Europe and England since the 13th century and were widely adopted as an artistic medium during the Renaissance period. Pigments are essentially 'fillers' that serve to thicken the film, increase the volume of paint and provide colour, they also affect drying time and durability. Natural granular solids were typically used including clays, oxides and carbon, with these pigments a palette of natural earth colours can be achieved including sienna, ochre and umber. These traditional linseed oil paints have lasted centuries and continue to protect exterior timbers, our windows, doors and iron-mongery. Paint failure was unheard of.

Restoration of 19th century shopfront using linseed paint. Quincaillerie Mallet, Mirambeau, FRANCE.

**All was well….aside from some poisonous pigments.**

Various poisonous minerals and metals have been added to paint over the years. Emerald Green is a pigment based on arsenic and Vermilion on mercury. These were favoured colours by the impressionist painters. Cezanne developed severe diabetes (a chronic form of arsenic poisoning), Monet went blind and Van Gogh suffered neurological disorders. These illnesses may also in part be attributed to use of other commonly used substances including liquor & absinthe, solvents such as turpentine and lead pigment. The addition of lead as a pigment did improve paint performance and increase durability. It is a 'dryer', resists moisture and retains the paint appearance. Lead was used in high levels in paint between the 1930's and mid-1950's, including for domestic use, and in significant quantities up to the early 1960's. Lead is however poisonous, particularly for younger children, and can cause nervous system damage, stunted growth, delayed development and kidney damage. European Union legislation banned the sale of lead based paint to the public and this took effect in the early 1990's.

In France a lead survey, referred to as a Diagnostic Plomb: Constat de risqué d'exposition au plomp (CREP) is obligatory if selling or letting property constructed before 1st Jan 1949. More information can be found at www.afnor.org, search for 'peintures au plomb' or www.defra.gov.uk, search for 'lead paint.'

Unless you are involved in the restoration of paintings, by for example one of the Dutch-masters, who favoured a yellow pigment called orpiment (made from arsenic & sulphide), or are exposed to the risks of existing lead based paints, our health today, and that of the painter, has been and is to a much greater extent affected by the use of solvents in 'modern' paints.

## The introduction of modern paint

Since the 1940's the paint industry moved away from traditional (linseed) paint production in favour of chemical, petroleum and solvent based paints (Alkyd & Acrylic). Paint manufacture became a high-tech industrial scale process, think large carbon footprint, which continues to this day. Vast quantities of paint could be made at relatively little expense, thanks to the use of fossil fuels. Post war perhaps one can argue (although I would hesitate) that the low cost and availability of oil paint outweighed the negative environmental and health impacts. We are now in a period of 'green enlightenment', it's unlikely we would have chosen the petrochemical and paint industry giants solutions if they were proposed today, even with the marketing departments telling us otherwise.

Typical example of modern paint failure.

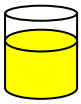
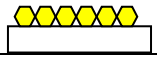
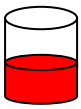
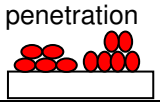
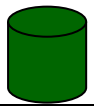
*Alkyd paint (artificial oil paint)* – linseed oil is replaced with synthetic alkyd resin oil then dissolved in petrochemical solvent. Polyurethane paints and varnishes contain urethane binders or urethane-modified alkyds. Whilst the alkyd resin oils are often derived from plant products (the fatty acids may come from safflower, sunflower or fish oils) the solvents that evaporate as the paint dries are harmful. Toluene, benzene, acetone, paraffin oil (white spirits) and ethanol contain high levels of volatile organic compounds (VOC's) and exposure to high concentrations has been the cause of ill health among painters for decades. Most of us will have at some time experienced the general narcotic effects of using solvents – headaches, drowsiness, dizziness & nausea. The dangers of long term exposure to solvents can be much more serious, the World Health Organisation reports a 20% increase of cancers and in Denmark a chronic cerebral syndrome is referred to as 'painters dementia.' It is not surprising then that there has been a demand to reduce the amount of VOC's emitted from many products and this includes oil paints, varnishes and wood stains. In the European Union this has resulted in directive 2004/42/EC which came into effect on January 1st 2010. All manufactured decorate coatings have to comply with new VOC limits. There are many who believe that these limits are still too high, the paint industry giants were certainly reluctant to change and effectively lobbied government to ensure that some of their products (albeit modified) could comply and profits could be maintained. The VOC limit for solvent based oil paint for wood is 300 g/l, traditional linseed paint will contain less than 18g/l.

*Acrylic 'latex' paint (plastic dispersion)* – this is a fast drying paint containing pigment suspended in an acrylic polymer emulsion. A rapid drying time enables a painter to apply two or three coats in a day and move onto the next job, this is very advantageous. These paints are often sold as environmentally friendly because the

solvent used is water. As the paint dries water evaporates and the acrylic polymers fuse. VOC emissions are low and the painter will suffer no ill-effects. The downside, and it's a big one, is that acrylic polymers are derived from petroleum products, it's plastic! Acrylic paint consists of polymethyl methacrylate (PMMA) suspended in water and you need 2 kg of petroleum to make 1 kg of PMMA. Clever marketing by the paint industry perhaps but since when has using non renewable fossil fuels become 'eco', 'green' or environmentally friendly?

If we can put aside for one moment the image of oil refineries and demented Danish painters we should consider the other aspects of paint that are of concern to us i.e. performance, durability and cost.

**A Paint Comparison** – for exterior application on new timber

| Paint Group | Dry matter content | Coverage ($m^2$/litre) | Surface penetration | Drying time (top coat) | Longevity | Cost (1$m^2$ all coats) |
|---|---|---|---|---|---|---|
| **Alkyd oil**[1] (artificial oil) | ± 55%  | ≤18 (top coat) | No penetration  | 16 hours | ±6 years | £5.49 |
| **Acrylic**[2] (plastic) | ± 40%  | ≤12 (top coat) | No penetration  | 4 – 6 hours | 4 – 6 years | £8.12 |
| **Linseed oil**[3] | 100%  | ≤20 (top coat) | Penetration  | 24 hours | ±15 years | £5.03 |

Notes
1. Quality UK branded paint - one coat primer, two coats undercoat, two coats top coat gloss.
2. Quality UK branded paint - two coats primer/ undercoat, two coats top coat eggshell (micro-porous).
3. Swedish paint – three coats linseed oil paint, one coat boiled linseed oil after 6 – 8 years.

Acrylic and Alkyd paints have a dry matter content of around 40% and 55% respectively, the remainder is solvents and these evaporate as the paint dries. So, about half the 'paint' in the pot actually goes into the atmosphere, not on the surface being painted. By contrast linseed paint 'dries' through oxidisation, the dry matter content is therefore 100%. Drying time for the Acrylic paint is rapid, four to six hours is typical for the topcoat but primers and undercoats can dry within one or two hours. Alkyd oil and linseed oil paints can generally be recoated once every twenty four hours i.e. one coat per day. Recoating time for linseed paint also depends on the quality of the oil used, here we have selected a Swedish linseed paint. Oilseed flax cultivated in northern latitudes (cold & damp climate) is high in linolenic acid, this contributes to a faster drying time of the linseed oil and therefore the paint. The proteins have also been removed from the oil. The higher the protein content the longer the paint will take to dry.


Protein removal from linseed oil.

Coverage rates for the Alkyd and Acrylic paints are between 10% & 40% lower than for the linseed paint, meaning you need more paint to cover the same area. Lower coverage rates combined with the necessity to apply primers and undercoats (top coats do not stick to wood) result in higher overall costs for the application of the modern paint system. If a higher paint cost corresponded to an increased longevity this would be acceptable, on a typical project the cost of the paint represents less than 10% of the overall cost, however this is not the case here. The modern paints have a claimed life expectancy of around six years, this is less than half that of the linseed oil paint. Why is this? Well the answer lies in our earlier explanations. Modern paints have been unable to successfully replicate the properties of linseed oil. Modern paint does not penetrate, breathe or remain elastic as linseed oil paint can and has proven to do so for generations. So our modern paints don't last very long, are rarely green, but are expensive. We have paid a high price for paint failure.

We are fortunate then that, although in decline since the 1960's, the linseed oil pressing industry did not completely vanish with the advent of modern paints. Today linseed acreage is actually on the increase and raw cold-pressed linseed oil is being produced in northern Europe, Canada and in the United States. Furthermore a combination of traditional European skill, ancient wisdom, modern production techniques and cooperation with farmers, has enabled the development of a new generation of linseed oil paints. These contain no solvents or poisonous pigments. They do however last a very long time……and they're green.

Restoration of 18th century doors using linseed paint. Hôtel des Gendarmes, VERSAILLES.

As they say in Sweden 'we have to look back if we are to see the future' and we must therefore 'rediscover the ancient wisdom.'

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