

Linseed Oil Paint As An Alternative To Wood Preservatives

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Summary: For reasons of sustainability great efforts have been made to find environment-friendly alternatives to paints and wood preservatives. This paper presents results from a project where efforts focused on the use of linseed oil paint, which is well known from old buildings.

The painting process of using linseed oil paint is quite complicated, and moreover several dogmas attach to the use of linseed oil, whereas scientific evidence is lacking. An investigation was performed in order to see if a correlation could be detected between the composition of the paint, the workmanship and the environmental conditions at the time of application. As it proved difficult to find projects, where sufficient information was available, only 10 projects were surveyed. The result was that no definite answers could be given as to the importance of each individual factor. However, some general conclusions can be given. It appears that the most important factor for a good result was a successful pre-treatment, i.e. the substrate should be dry and in good condition and the linseed oil should be able to saturate the wood completely. Of importance is also the weather at application, that application is performed in thin coats, and that apparently it is necessary to use small amounts of preservatives for the most exposed parts of the window.

Keywords: Wood, windows, durability, painting, renovation.

1 INTRODUCTION

Exterior woodwork must be treated with wood preservatives and/or paint to prevent decomposition of the wood due to the action of light and humidity. In Denmark most new windows are vacuum impregnated before they are painted. However, the use of preservatives is not without problems. Much simplified the known products are either not effective enough or they are poisonous or in other ways a strain to the environment. The production of the preservatives may involve extensive use of energy or they might be produced from non-renewable raw materials. Wood preservatives thereby become one of the big environmental problems in building.

Wood preservatives cause problems throughout their life cycle: in the production, in the application, and in the disposal – problems to surroundings as well as work environment.

Till the end of the 1970s wood preservatives and paints in Denmark were almost entirely based on different oils diluted with turpentine or other organic solvents. These products caused problems with the work environment and led to the development of emulsion paints and wood preservatives based on water which was good for the painters but hardly so for the wood. The first generations of these new paints had very poor properties.

These experiences combined with a growing concern about the environment have led to a renaissance of linseed oil paint that has been the traditional product for surface treatment of wood for centuries. Linseed oil has become a popular commodity - the market received it well. However, the products used today are not the same as the "historical products". Among other things the old linseed oil paints contained large quantities of lead, which is a most efficient fungicide.

In reality, very little or no documentation at all exists for surface treatments with modern linseed oil products. In turn many myths have prevailed about linseed oil and its properties. Therefore, the current knowledge of linseed oil paint needed to be summed up and its suitability as wood protection to be assessed.

2 THE INVESTIGATION

The main purpose of the investigation was to get an impression of how the products functioned in practice. This was to be done by performing a condition assessment of building parts that had been painted with linseed oil paint and had afterwards been exposed to wind and weather for some years. To be able to draw conclusions from the condition assessments, it was required that:

- The age of the surface treatment should be 5-10 years and preferably no maintenance should have taken place
- Treatment should be linseed oil products only, i.e. no emulsion and alkyd paints etc.
- It should be known what products had been employed
- It should be known how the work had been carried out including the time of the year the treatment was applied.

However, it turned out to be difficult to find suitable objects for examination. This was partly due to the fact that only a limited number of modern linseed oil treatments existed before 1995. Partly because many of the objects are not very well documented or mixed treatments had been used, e.g. alkyd paint used together with linseed oil paint.

Another characteristic is that linseed oil is employed especially in the restoration of historical buildings or by private "do-it-yourself-people". This was reflected in the identified buildings where linseed oil paint had been used namely 6 mansions and listed buildings, 6 cottages at the Open Air Museum plus one single family house and one apartment block. The latter was the only example of an "ordinary building" where painting had been applied in a professional manner.

All the examined products had been applied by brush and all executed on existing woodwork of which some had been mended with new wood.

Some manufacturers have in recent years developed linseed oil paint that can be sprayed on and which is primarily used for factory treatment of new windows. These products have not been on the market long enough to be part of this investigation.

Also, it should be noted that in a lot of cases the products employed no longer exist on the market. Some manufacturers have closed down and others have changed their recipes and ingredients.



Figure 1. Mending of sashes in old wooden windows in order to preserve as much as possible of the original sashes.

2.1 The surveying procedure

Nine projects were identified which roughly fulfilled the requirements. For each project the following was recorded:

- Identification of the building, its owner and its use.
- The building components treated including wood species and age (original, old, new).
- When and how the surface treatment was applied.
- The product used.
- The orientation of the treated surface and any external conditions of importance.
- Any subsequent maintenance.
- The condition of paint and wood – assessed in the same way as surveyors normally do.
- Possible causes of damage.

The condition assessment is based on a combination of the visual appearance of the surface, e.g. gloss and chalking, measurements of moisture content of the wood (combined with weather conditions, season and orientation) and the physical condition, e.g. whether the wood is soft or hard or whether the paint adheres to the wood or not.

Generally two investigations were performed for each object. First a single person performed a thorough investigation of wood and paint as a basis for assessing the correlation between the present condition and the possible causes for any failures. Afterwards, all projects were further surveyed by two or three persons in order to ensure coherence in the condition assessment.

It should be emphasised that although the employed products were recorded, it was not possible from this project to assess exactly which factors resulted in the longest service life. The reasons were that the number of objects was small, the pre-treatment of the wood is very different, the paints are different and the workmanship is different. It should also be noted that many of the products are no longer on the Danish market either because the factory has closed down or because the recipe has been changed.

2.2 Observations Made During The Surveys

The performance of the objects were quite different ranging from good condition after 8+ years exposure to deterioration of paint after about 2 years.

The observations are summarised in the following two lists which are examples of positive observations and problems respectively.

2.2.1 Positive observations during the surveys:

- The surface treatment was in good condition and protected the wood well. Probably the reason was that the initial quality of the wood is good and that the workmanship – including the priming – has been performed with care.
- The painting was in excellent condition (after 8+ years) probably due to a combination of high quality of the wood, protection by design, careful workmanship, long drying time between applications.
- Generally the paint was in good condition (after 7 years).
- Woodwork was generally in a good condition even though some flaking of the white paint was found (whereas black and green paint on the same building was still adhering well).
- Woodwork was generally in a good condition even though the lower parts had become soft (start of deterioration). This building is a barn and it is cleaned using a high-pressure hosepipe.
- Woodwork was in excellent condition probably due to a thorough renovation of the windows before painting. Paint adhered well to the surface.
- Generally woodwork was in good condition and paint was adhering well (6 historical houses in the Open Air Museum). Generally the paint and the maintenance appears to be effective. There were no marked differences between older and newer treatments probably because the woodwork was maintained well (every 5 years with a mixture of turpentine and linseed oil).



Figure 2. Linseed oil painted door with good performance after 8+ years. The wood quality is good and the workmanship of high quality.

2.2.2 Problems encountered during the surveys:

- The fittings were the most vulnerable parts of the objects as they were not sufficiently protected by the linseed oil products. This is a remark generally valid for most of the surveyed buildings.
- Windows in upper floors showed most chalking probably due to a greater exposure to sun. The paint film was quite unacceptable – appeared like crocodile skin – probably due to evaporation of thinner after the linseed oil had dried.
- The surface was relatively susceptible to dirt.
- The paint film had deteriorated and had not protected the wood sufficiently.
- The paint film was deteriorated and did not provide sufficient protection of the wood. This condition was achieved in a couple of years after painting and is probably due to imperfect priming, wrong succession of the applications of paint (thicker paint applied before thinned paint), too thick layers, insufficient drying between applications.
- The painting was deteriorated and has not provided sufficient protection of the wood (the surface treatment was 11 years old and had not been maintained). The paint was flaking. The mending of the wood had deteriorated somewhat. The reason for the insufficient durability was not clear as the surface treatment and the workmanship was not well described.
- Prevalent chalking of paint due to a combination of too much filler, too thick layers of paint, application in cold weather.
- Not all pigments were stable which was reflected e.g. in the colour of the green paint that varied from almost black to turquoise-green.



Figure 3. Bad performing linseed oil paint after about two years of exposure. Probably the problems encountered are due to insufficient cleaning of the window before application combined with poor workmanship and unfavourable weather conditions at application. The photo also demonstrates that linseed oil does not provide sufficient protection to sash-angles and other metal parts.

3 GENERAL RESULTS

As mentioned earlier it was not possible from this project to assess exactly which type of paint had the longest service life. However, it was possible to derive some general results from knowledge about the products used, the application conditions, the orientation of the surface treated surfaces and the observations from the surveys. Also general knowledge from earlier projects (Brandt, E. 1999), (Lading, T & Brandt, E. 2000), (Hjort, S. 1995) etc. was taken into account when assessing the results. The results are given below divided into factors considered most important for the durability

3.1 Product imperfections

There is a pronounced difference in the quality of linseed oil products, considered to be due to the fact that there is generally too little knowledge of the factors affecting the properties of linseed oil. Also a number of product imperfections suggested that not everybody in the trade had the necessary professional background and expertise:

- Lack of quality control and homogeneity in the production
- products from the same manufacturer, which ought to be alike, may vary in properties and quality from batch to batch
- Too much or wrong filler
- filler was added partly to make the paint fuller (which means that the viscosity is enhanced to make the application easier), partly to make it cheaper. Too much or wrong filler will result in chalking, wrong viscosity etc. There were examples of thinner being needed because too much filler had been used in the first place!
- chalk is often used as a filler, but along with the subversion of the linseed oil it might become visible as chalking; the surface becomes lustreless and gradually gets a white, foggy surface; at the same time it becomes more susceptible to humidity – this was especially distinct upon dark surfaces.
- Lack of production tests
- usually manufacturers of paint and varnish save test samples of the production so later examination is possible in case of problems - some suppliers of linseed oil products were not in line with that.
- Lack of knowledge of basic chemistry
- when marketing a thinner for linseed oil paint that takes longer to evaporate than the linseed oil takes to dry.
- further, there have been examples of products, e.g. containing boron (used as a fungicide), introduced as totally harmless and almost eatable in spite of the fact that boron is suspected of giving embryonic damages, and that it is on the list of substances that should be phased out.
- Contents of unhealthy substances

- especially organic solvents such as turpentine which some products contain to a larger or smaller extent – and which is usually not necessary
- Lack of documentation for products that are sold in connection with linseed oil
- e.g. some manufacturers introduced citrus seed oil as a natural and harmless fungicide with no documentation of the correctness of this and without information of possible unhealthy side-effects.

It should be stressed that also a lot of good products are found on the market. The problem is the difficulties of finding out which products are good and which are not.



Figure 4. Repair of linseed oil painted window where the paint used for the repair differs significantly from the original due to a larger content of chalk filler.

3.2 Fungicide

The only linseed oil products on the Danish market with fungicide against dry rot are primers, which also might contain other oils and turpentine. It was not possible in all the investigations to find out whether the woodwork, apart from having been treated with linseed oil products, had also been treated with primer oil against dry rot.

Woodwork treated with fungicide against dry rot is probably, other things being equal, in a better position to resist a wrong application than wood with no treatment. Conversely, a correctly performed treatment, where priming with oil has been properly carried out, will probably provide sufficient protection. Humidity will not be at such a high level that mould and dry rot will develop. However, it is important to maintain the treatment. The linseed oil paint (the topcoat) should preferably have fungicide against mould and mildew added in order to prevent growth of fungi.

There is a potential in limiting the use of fungicide to those places only, where it is necessary instead of treating all woodwork (as done with vacuum impregnation). Normally, it is easy to predict where the risk of is, e.g. 95% of the rot attacks in windows are found in the bottom part of sashes and frames.

3.3 Application

The application condition and the application process are crucial for achieving a good result.

The protection of the wood is based on the combined action of the primer and the paint (topcoat).

The function of the topcoat is twofold namely to protect against water as well as against degradation from UV-light. However, the most important factor for the protection of the wood is the priming that protects against humidity even when the topcoat is degraded. In order to protect the wood the primer should saturate the upper layers of the pores in the wood completely so that there is no "room" for liquid water. To assure a sufficient saturation it is therefore important that the wood is dry (max. humidity 12-15%) when the primer is applied.

The linseed oil paint should be applied in thin layers and one layer must be thoroughly dry before the next one is applied. If paint is applied in thick layers, it wrinkles and gives the surface the look of crocodile skin. Also the paint is not solid until it has dried up and consequently it is more susceptible to destruction until it has dried completely. In cold weather, i.e. below 5-10° C, it is difficult to apply thin layers and drying becomes slower. The same occurs in damp weather. Therefore, generally

skilled users are required to obtain a satisfying result, as it e.g. is a matter of experience to apply a coat of paint in a thin layer and to assess when the previous layer is sufficiently dry to proceed.



Figure 5. Paint looking like crocodile skin due to application in too thick layers.

3.4 Logistics

Linseed oil treatment does not fit in very well with the logistics at a modern rational building site – especially not if other work is to be carried out at the same time. Long drying hours and sensitivity to dust are examples of the factors that make the use of linseed oil products difficult.

The most durable of the surveyed treatments had been performed most carefully: after priming the windows, 5 coats of linseed oil paint were applied with at one-week intervals, that is, a total duration of more than 6 weeks. Such a long time interval will be hard to fit in with ordinary building procedures, e.g. within urban renewal.

Preferably, linseed oil painting should be performed in a workshop. If the treatment is performed on the spot it should, preferably, not be performed simultaneously with other work. The need for scaffolds in an extended time because of the long drying hours further increases the price of using linseed oil products.

3.5 Potential

It may be possible to make use of the good properties of linseed oil and still take into consideration logistics and application criteria if linseed oil is used as a primer and a 'modern' paint (e.g. aqueous alkyd) as topcoat. The paint should preferably be marketed in *systems* to ensure compatibility and product guarantee.

A good linseed oil system should include:

- An all round primer based on heat-treated linseed oil.
- A special primer with fungicide against dry rot for treatment of the most exposed areas.
- A 'modern' topcoat paint that has sufficient adherence to the primer and that dries fast

3.5.1 New windows

New factory-made windows treated with linseed oil products are marketed but are more expensive than similar windows with ordinary paint. This may be compensated for by its durability that eventually will result in a better over all economy – but as far as it is known, no actual documentation for improved durability exists.

A new windows treated linseed oil should have:

- An accelerated ageing test to assess the durability of new industrially treated windows.
- Documentation of performance of factory applied paint systems including durability.
- A calculation of the overall economy compared to traditional windows.
- A labelling scheme to make it easier for the builder/user to compare products including their impact on the environment.

4 CONCLUSIONS

With linseed oil products it is possible to obtain a good protection of wood as well as a durable result, but things may also go awfully wrong. Some of the surveyed treatments proved to have excellent durability – others absolutely not. In some cases the wood was in good condition even though the paint film did not look very well. In turn, no examples were seen of wood in a poor condition under an almost intact coating – something that may be seen in connection with e.g. latex paint.

On the whole, too many imperfections were found even though the investigation only included a relatively moderate number of treatments. The imperfections were found in both workmanship and products.

In all surveyed examples (except a barn in Vemmetofte) professional technical consultants had taken part in the construction work – also consultants specialised in restoration. Still, there turned out to be big differences. This was mainly due to the quality of the wood, the products and the application.

There are several reasons for linseed oil treatment not having been used on a large scale outside restoration of historic buildings and private use.

- Good linseed oil products can be found on the market but not an optimal system. Surface coatings are normally found as *systems* which include products for priming, intermediate coating and top-coating. Similar systems are not found for linseed oil products, which make it more difficult to use as compatibility of the different products must be assessed individually. It is obviously difficult for both consumers and professionals to get the right information and to choose the right products. Differences in quality often do not become evident until after several years, and the purchase of linseed oil products is therefore a matter of trust.
- There is a lack of documentation and product development
- In general it requires skilled users to obtain a satisfactory result, as e.g. it is a matter of experience to apply a coat of paint in a thin layer and to assess when the previous layer is sufficiently dry to proceed.
- The current linseed oil treatments do not fit very well with the logistics on a modern building site especially because of the long drying hours.

In conclusion the prerequisites for obtaining a good result are:

- The wood must be sound and dry.
- The weather must be 'good' during application – i.e. low RH and a suitable temperature.
- The products - primer and paint - should be of a good quality. Product development is needed.
- The priming should saturate the wood completely with linseed oil in order to protect the wood against liquid water and thereby fungus and dry rot.
- The application must be correct - several thin layers that are allowed to dry sufficiently in between applications.
- Maintenance should be performed in due time.

5 ACKNOWLEDGMENTS

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6 REFERENCES

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