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WATER PERMEABILITY OF TWO DIFFERENT WOOD LASURES

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Abstract:
Due to recent developments more and more new coatings appear on the market being proposed by the manufacturer for outdoor use. One major group of new products targets the reduction of harmful emissions (RDS) and thus instead organic solvents water is used as dispersing agent and also new resins in their composition. In the present study a classical alkyd based solvent-borne thin layer lasur was compared with a water-borne thixotropic wax, by monitoring water uptake during long term soaking. The samples treated with wax showed 4% mass increase relative to the initial mass after 156 hours, whilst the solvent-borne lasur treated samples showed 4% mass increase after 456 hours. Based upon the upper considerations the solvent-borne lasur performed 3 times better than the wax based one. It is supposed that the water permeability behaviour can be connected to lifetime performance also. Molecule size investigations are needed in order to explain the results.

Key words: *solvent-borne; water borne lasures; tixotrophic wax; Birch; soaking; water permeability.*

INTRODUCTION

Water-borne paint systems and as such water-borne lasures also, were developed in a legislative environment strongly driving paints towards VOC free or at least reduced VOC varnishes. In this term the water-borne systems are much younger than the solvent-borne ones. Their overall performance has improved since they were first introduced in the early 1970s, but the products still require special handling (Cox 2003). Unfortunately water brings operational disadvantages and in the case of wood this includes increased grain raising, and problems arising from the high latent heat of water particularly under industrial conditions (Bulian – Graystone 2009). Alcohol does not raise the grain of the wood as much as waterborne stains (Cox 2003). On the other hand the use of water-borne systems can considerably reduce the emission of organic compounds (VOC) during surface treatment, drying and also from the product (Prieto-Kiene 2007). A further step towards environment friendly coating systems can be the use of waxes.

Wax additive is an important functional additive for waterborne wood coatings. There are different kinds of wax additives available for wood coating films. Shengwen and colleagues reported that after being added in the wood coatings, the wax particles were homodispersed in the coating films, and could improve the tackiness resistance and the scratch resistance of coating films. But in the same time large size of wax particles, affected negatively the gloss of the film (Shengwen 2007). Generally waxes are supposed to be hydrophobic and thus acquiring the same properties as well to the objects treated with. Lesar et al. (2011) also presumed, that wax treatment will reduce water uptake and thus reduce or slow down photo-degradation processes of Norway spruce specimens. Three differing types of waxes were used: an emulsion of montan wax (LGE), an emulsion of polyethylene (WE1) and an emulsion of oxidized polyethylene (WE6) wax. Besides FTIR spectroscopy and SEM analysis the water uptake after artificial ageing was also evaluated. They concluded that: impregnation of wood with waxes influences the performance of wood during artificial accelerated weathering. Treatment of wood with high loadings of wax reduces moisture absorption by wood subjected to accelerated weathering and restricts photodegradation of wood. Among selected waxes, montan wax was the most effective at restricting photodegradation. However, wax treatments reduce the photodegradation only to certain extent. Scholtz et al. (2010) did investigations on migration and deposition of hot melting wax in wax-treated pine sapwood (Pinus sylvestris L.) and beech (Fagus sylvatica L.). Three waxes were used, which did not show distinct differences in their deposition patterns. An intensive wax deposition could be observed within the vessels, tracheids, and fibers. In P. sylvestris the ray tracheids were penetrated in a lateral wood penetration process, from the outer to the inner wood. In general, no wax penetration was visible within the parenchyma tissue and epithelium cells. Cracks were detected within the wax deposits as well as secondary microcapillaries, which were visible between the deposits and the cell walls. Esteves et al. (2012) did preliminary investigations on *Pinus pinaster* wood impregnated with paraffin to different levels using a hot-cold process. Weight gain, density, equilibrium moisture and dimensional stability (ASE) at 35% and 65% relative humidity and termite durability against *Reticulitermes grassei* (Clément) were determined. The best anti shrinking efficiency (ASE) was obtained for a combined treatment at 180ºC (4h) and 61% WG. The preliminary tests with paraffin impregnation showed that wood has lower equilibrium moisture, higher dimensional stability.

In Hungary, those wood coating materials which are proposed for outdoor use are called lasures, mostly deriving from the German terminology. Lasures due to their specially designed molecule size which allows water vapour to penetrate the layer are the most appropriate varnishing materials for outdoor exposure (Posch 1996). They show further special properties as they protect the wood surface from liquid water, but in the same time allow the water vapour diffusion through the coat and also protect the wood surface from the UV radiation, ensureing this way a longer service life for the coat than the one of the traditional oil based glazes. Lasures are produced with differing amount of resin and they are distinguished accordingly as: thin layer and thick layer lasures. According to the layer they are used in and also to the type of protection they exhibit, they are called sometimes intermediate isolating,- protective,- fiber binding etc. lasur layers. For the recent study an acrylic acid ethyl ester type wax based lasur was used, described as system deeply penetrating the wood, but after several application steps, in last layers forming also a film. From the range of available lasur types the thin layer one was chosen for comparison, as they behave in the same way as the wax described above: they penetrate the wood tissue and after several steps of application they also form a comprehensive layer. The principle of comparison was that after several steps of lasur application the dry amount to be the same. This idea was also supported by the description given by the manufacturers, as they gave suggestion on several steps of application without strictly limiting the upper border. The all over study on comparing the water uptake of wood samples coated with water-borne wax and solvent borne conventional lasur was conducted in order to describe the possible differences in the behaviour of the two differing coating systems.

MATERIAL AND METHOD:

The wood species chosen for sample preparation was Birch (*Betula pendula).* When choosing Birch wood for sample preparation, two considerations were made: it is a diffuse-porous wood species, with relatively homogeneous anatomic structure, having earlywood and latewood vessels of closely constant diameter, and deriving from the anatomic structure even water uptake could be supposed. The average density of Birch samples was 688kg/m^3 (st dev. 11kg/m^3), after brought from the factory, all were conditioned at 20^{o}C±2^{o}C and 60±% relative humidity in laboratory, having in average 9,2 MC.

Sample preparation:

Boards of 800x100x20mm all kiln dried, of selected furniture quality, with selected homogeneous, tangential and partly radial cut Birch boards were used for the present study. Prior to be cut to the testing size, the whole boards (2/lasur type) were coated using a roller. Two types of lasur were used: an acrylic acid ethyl ester type wax based lasur (Pigrol), and a thin layer solvent-borne alkyd based lasur (Xyladecor). The wax was described as system deeply penetrating the wood, but after several application steps, in last layers forming also a film. From the range of available lasur types the thin layer solvent-borne one was chosen for comparison, as they behave in the same way as the wax described above: they penetrate the wood tissue and after several steps of application they also form a comprehensive layer. After each step of lasur application the surfaces were dried according to the manufacturer’s recommendations. The drying time of wax was approx. 2 hours, whilst the drying time of solvent-borne lasur was approx. 24 hours. Both finishes were applied in several steps, after each step the surfaces were dried, the dry samples were weighted, and compared with the untreated status the applied dry amount of finish was calculated. In case of wax 146g/m2,- whilst in case of solvent-borne lasur 143g/m2 dry finish was applied.

As originally from the factory 800 mm long samples were brought, they were cut to size of

150x70x20mm according to EN 927-5 (2006). The five untreated surfaces of the samples were sealed using transparent silicon, overlapping even the test face by 2mm. Untreated control samples were also prepared in the same size. According to the standard the treated samples were supposed to a pre-soaking in distilled water, as according to previous observations the water permeability of some types of coatings can change markedly during a relatively short period of exposure to water. For such coatings the values of water permeability after a short period of contact with water may not be representative of those obtained during long term service. Thus a repeated pre-soaking is suggested, aiming leaching of some leachable substances: 24 hours soaking of the test face, 3 hours drying at room temperature, 3 hours drying at 50^{o}C and 18 hours at room temperature (2x).

Treatment:

All three types of samples were weighted to the nearest 0,01g, mass recorded, and were laid with the unsealed face down on a special tray, containing distilled water, not covering the samples, but ensuring a continuous immersion of the test face. The level of the distilled water was kept nearly the same by manually replacing the consumed amount.

Testing:

Water uptake showing the water permeability of the lasures was monitored by mass measurements. Contrary to the suggestion (72 hour) of EN 927-5 mass measurements were continuously performed at 0; 1; 2; 3; 4; 5; 6; 7; 8; 9; 11; 13; 15; 17; 19; 21; 23; 24; 27; 39; 42; 46; 50; 62; 67; 72; 84; 90; 96; 108; 120; 132; 144; 156; 168; 180; 204; 216; 228; 240; 252; 264; 276; 288; 300; 312; 324; 336; 348; 360; 372; 384; 396; 420; 432; 444; 456; 468; 480 hours.

RESULTS AND DISCUSSION:

Evaluating the water uptake graphs a surprising statement can be done. Contrary to the expectations the samples treated with water-borne wax showed higher water uptake from the beginning than samples treated with solvent-borne lasur. In both cases the water uptake was much lower than the water uptake of untreated samples, showing that the wax also acted against taking up water, but its measure of resistance was lower than the one of the solvent-borne lasur.

The samples treated with wax showed 4% mass increase relative to the initial mass after 156 hours, whilst the solvent-borne lasur treated samples showed 4% mass increase after 456 hours. Based upon the upper considerations the solvent-borne lasur performed 3 times better than the wax based one. It is supposed that the water permeability behaviour can be connected to lifetime performance also, in terms that a more intense water uptake is supposed to cause the deterioration of the coat film in shorter time. It was stated that no sample reached the saturation point during the 456 hours of soaking, although the increase was very slow: for untreated samples in 12 hours approximating for example 0,7521g (168 hour and 180 hour), for wax treated samples in the same time period 0,1221g, whilst for solvent –borne lasur treated samples 0,04g. Based on theoretical considerations the reason of the high water uptake in case of the wax was supposed to be due to a high molecule size. In a further study the molecular weight of the two lasures is going to be investigated.

CONCLUSIONS:

Evaluating the water uptake graphs the following statement was done: contrary to the expectations the samples treated with water-borne wax showed higher water uptake from the beginning than samples treated with solvent-borne lasur. The samples treated with wax showed 4% mass increase relative to the initial mass after 156 hours, whilst the solvent-borne lasur treated samples showed 4% mass increase after 456 hours. Based upon the upper considerations the solvent-borne lasur performed 3 times better than the wax based one. It is supposed that the water permeability behaviour can be connected to lifetime performance also. Molecule size investigations are needed in order to explain the results.

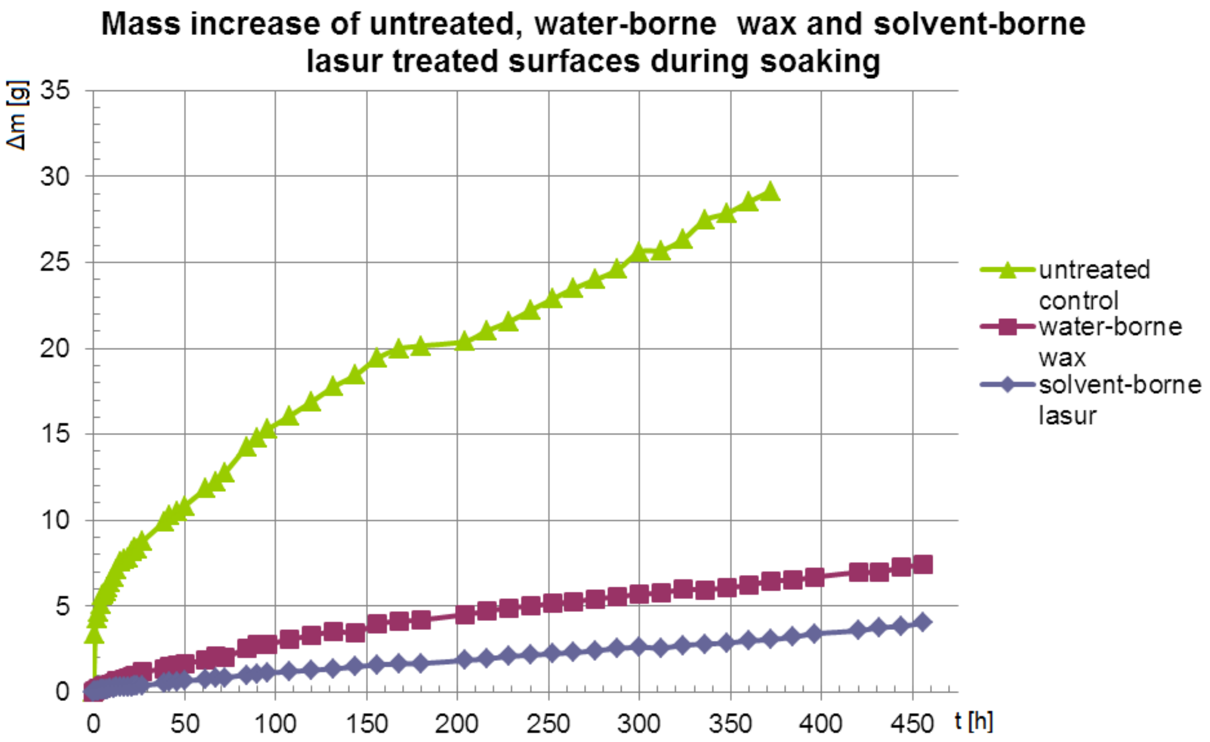

Fig. 1.
Mass increase of untreated, water-borne wax and solvent –borne lasur treated surfaces during soaking.

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