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(54) Title: A METHOD FOR TREATMENT OF RESIN-CONTAINING WOOD

(57) Abstract: The invention relates to a method for treatment of resin-containing wood substrate which method comprises the step of hardening at least a part of the resin in said wood substrate.
The invention relates to treatment of resin-containing wood.

In building-components made of wood it is requested that the wood has an aesthetic appearing surface and of course good strength and durability. This is particularly relevant within the field of manufacturing window-frames and doors of wood. In such uses it is important that the wood appears substantially free of errors and free of cracks and knots. But in order to use as much as possible of the wood, without repairing all errors, a number of small cracks and small knots are normally allowed.

However, even small cracks and small knots are critical, as there will always occur a certain degree of exudation of resin via those cracks and knots in the wood. This will leave the wood with sticky spots on the surface causing trouble when paint or other surface coating is applied to the surface due to difference in adhesion, and furthermore the spots of resin may lead to discoloration of the wood.

In time this stickiness will fade out or vanish, but due to the exposure of the ordinary daylight and temperature conditions, the resin probably will normally shrink i.e. it does not retain its dimensional stability and/or accuracy. This phenomenon will normally lead to unstable knots or even to completely loose knots which eventually will fall out of the wood, i.e. leaving a hole in the wood surface, and in relation to cracks especially those filled with resin, the phenomenon can eventually also lead to holes or indentations. This making it even more difficult to treat and maintain the wood surface, i.e. by painting. Repairing or replacement of the damaged piece
of wood could become an option, which situation is highly undesired.

The problem is enhanced with modern forestry where the trees are cut down all through the year including in the springtime where the turgescence is at the highest level. Furthermore the methods of preservation may enhance the exudation of the resin, as preservation often includes use of organic solvents which will dissolve the resin and cause it to flow more easily.

Several methods to stop the exudation resin* from resin-containing wood are known. Among them is sealing of the surface with different sealing agents. The drawback of those methods is that they do not stop the exudation of resin completely, but only temporarily, as long as the active part of the sealing agent is functioning.

As examples of the above-mentioned methods are application of primer/wax-systems or shellac to the surface of the wood.

Japanese patent application no. JP3166905A discloses a method where wood is impregnated with a melamine-based resin, followed by drying with high frequent heating (micro-waves).

Another method is immersion of the wood in hot water followed by immersion in an impregnating liquid which demobilizes the resin.

Other known methods are laminating by coating the wood with paper or HDF-boards.
The known methods are all characterized by the use of an active sealing or coating agent to prevent the exudation of resin from the wood. The application of the sealing or coating agent is usually followed by an after-treatment which is often a heat-treatment.

The known methods all comprise application of at least one agent to the surface of the wood. This is a step in the production line which is costly and requires extra time. Moreover the known methods are often based on the use of chemical agents which are not environment-friendly, and may cause trouble when the wood is to be removed as waste-material.

The sealing of the surface of the wood will loose its effect if the sealing, which is relatively thin, is destroyed. Hereby it is possible for the resin to exudates through the broken parts of the sealing.

Due to the drawbacks of the known methods there is a need for a method of treating resin-containing wood, which is simple and which does not need application of sealing or coating agents.

The object of the present invention is to provide a method for treating resin-containing wood, which will provide a permanent sealing of at least a part of the surface of the wood to prevent exudation of resin.

Another object of the present invention is to provide a method for treating a resin-containing wood substrate which is cost effective and time saving to carry out.
A further object of the present invention is to provide a method for treating resin-containing wood that does not require application of a sealing or a coating agent.

These objects and other objects are all met by the method according to the invention as defined in the claims.

The invention is based on the surprising finding that it is possible to harden the resin in a resin-containing wood substrate. In growing trees the natural present resin is normally under pressure and exudes from the wood through small openings in the bark of the trees. When the trees are cut down and de-barked for industrial use a lot of openings in form of canals, cracks and knots are laid open. This will of course heavily enhance the natural tendency of the wood to exude resin to the surface of the wood leaving sticky spots on the surface. During time the natural resin will harden and the stickiness will vanish, but the natural hardening of the resin is a process, which continues for several years. The hardened resin appears with a smooth relatively hard surface like the one of synthetic hard plastic.

The natural present resins in wood are a relatively complex mixture of various substances including terpenes. The natural resin in wood comprises normally oleoresins like monoterpenoids, diterpenoids and parenchyma resin comprising triterpenoids and steroids. Furthermore the resins may comprise a mixture of non-volatile, partly unsaturated compounds including esters and free acids. As mentioned the resin forms an extremely sticky gum which is capable of undergoing a certain slow hardening when exposed to the air.
By use of the method according to the invention the hardening of the resin, in particular the resin in the surface of the wood appears substantially instant. In fact the time for hardening is reduced to seconds or a few minutes. The method provides wood with a dry and relatively hard surface without any lose knots, indentations or holes and which has excellent properties for further treatment like application of paint or other coatings.

The invention provides a method for treatment of resin-containing wood substrate, which method comprises the step of hardening at least a part of the resin in said wood substrate.

The resin, which is hardened, is the natural present resin in the wood substrate. The hardening of the resin will prevent the resin to exude from the wood substrate and hereby prevent the formation of sticky spots of resin on the surface of the wood substrate. The term wood substrate designates a substrate for the hardening process which may be a typically shaped wood article, structural wood, timber, poles, etc., but encompasses also material comprising comminuted wood such as chips or building plates, etc.

In a preferred embodiment of the method according to the invention the resin is hardened in a layer extending from the surface of the wood substrate and at least some distance into the wood, preferably said layer has a thickness between 0,001 - 5,0 cm, more preferably a thickness between 0,01 - 1,0 cm.
According to the above-mentioned preferred embodiment the resin is hardened in a layer extending from the surface of the wood substrate and at least some distance into the wood substrate. Hereby it is achieved that at least a surface layer of the wood substrate comprises hardened resin. Hereby the surface layer seals the surface and prevents un-hardened resin within the wood substrate to exude to the surface of the wood substrate.

In an alternative preferred embodiment of the method according to the invention substantially all resin present in the wood substrate is hardened. This method will be advantageous, if the wood substrate is to be subjected to a further treatment like cutting or drilling. Although such treatments lay new surfaces of the wood substrate open, no resin will exude to these surfaces.

In a preferred embodiment of the method according to the invention the resin present in canals and/or cracks and/or knots in the wood substrate is hardened. The natural present resin in wood is flowing in canals or resin canals from which in unhardened condition it may penetrate to the surface of the wood substrate e.g. via cracks or knots in the wood substrate. As exudation of resin mainly appears from canal, cracks and knots, it is preferred to harden the resin present herein.

In one embodiment of the method according to the invention the resin is hardened by cross-linking of monomers and/or polymers in the resin by use of UV-radiation, IR-radiation, high frequent heating, laser-radiation, corona treatment, plasma treatment and/or
heat-treatment in fluid bed. Preferably the resins are cross-linked at elevated temperatures.

UV light may be applied with wave-lengths within 250 to 400 nm and 300 - 600 WPI lamps is useful.

The treatment of the surface disclosed above may be in combination with or subsequently followed by a treatment of the surface with a suitable gas, e.g. oxygen or ozone.

In order to establish an understanding of which of the above-mentioned hardening methods, i.e. which curing method could be successfully used several tests have been made and in the following paragraph the observations made in this respect will be mentioned.

A wood surface, which is to be treated by the hardening method, can have almost any surface configuration. This will have that consequence that not all of the mentioned treatments can be recommended in all cases. If for instance the wood surface is having variations in height then the laser-radiation (the laser could be a Nd:Yag or argon laser) is a better choice than UV-radiation, IR-radiation or micro-wave treatment. Tests have shown that there seems to be no decrease in the laser cured bond (the cross-linking) strengths with increasing distance whereas there seems to be a measurable decrease with the other types at distances greater than 0,5 mm.

Typically the surface to be treated is moved in the longitudinal direction with a speed from 0,5m pr. minute and up till i.e. over 30 m/min. The amount, size and position of knots are being recorded using standard wood-
recognition equipment equipped with standard image processing and evaluation equipment. If the knots or cracks identified in the wood surface are of the potential dangerous kinds, i.e. of the sticky or exuding type a signal is sent to a treatment station (radiation, "beam" or like source) further downstream. Here will be applied a calculated measurement (dependent of a number of factors such as exposure time, size and intensity of the "beam") while the wooden sample passes the source in the station (it could of course be several different and/or individually placed sources).

The beam can be of different types such as UV radiation (UV light), a laser, or IR or microwave type. The requirement is that it has the ability to accelerate the natural bonding (cross-linking) taking place in natural resin when exposed to normal weather conditions i.e. daylight and air. This effect will mainly be caused by the locally heating process of the resin and thus accelerate the natural ageing processes within the surface of the resin facing the exterior of the wooden profile of the resin.

It has also been observed that in order to obtain a good dimensional stability and accuracy of the resin, i.e. surrounding a knot or lying in a crack, then a treatment with microwaves is preferred over IR radiation, UV radiation.

Likewise is has been observed that at shorter hardening time can be obtained while using laser curing over UV
radiation, i.e. up till 8 times faster with no significant loss in shear-peel bond strength.

The hardening of the resin may be enhanced by subjecting the monomers and/or polymers in the resin to a treatment that will increase the number of free radicals significantly. Hereby it is possible to reduce the time required for hardening the resin significantly. In most resins present in wood the base monomer is isoprene like in natural rubber, therefore the different polymers contain double bonds which can be the basis for derivatisation in the form of oxidation, coupling, addition of other groups, etc. Like in natural rubber the isoprene-type double bonds are the basis for cross-linking and hardening of the resin.

In an alternatively preferred embodiment of the invention the resin is hardened by cross-linking of monomers and/or polymers in the resin by applying a reactive chemical, preferably selected among sulphur, sulphur trioxide, peroxide, nitrogen-oxides, phosphor, halogens or ozone. The reactive chemical is preferably applied in a gaseous or vapour state.

Furthermore it is preferred that the resin-containing wood substrate is subjected to a heat-treatment step after a reactive chemical has been applied. The heat treatment may be heating by IR-light, microwaves or by hot steam e.g. under pressure.

In the alternatively preferred embodiment the cross-linking is initiated by reactive chemicals, whereby the resin is vulcanised to provide a smooth and hard surface.
In a preferred embodiment of the method according to the invention the resin is further cross-linked to the natural present cellulose in the wood substrate. In this embodiment of the invention a double vulcanisation is created as the resin is cross-linked to resin and cellulose of the wood substrate. The bondings may be formed via double bonds in the resin and free OH-groups of the cellulose. It is possible to obtain strong bindings between resin and cellulose and an effective sealing of the surface can be achieved. The cross-linking process can be initiated by UV-light, high frequent heating, reactive chemicals, etc., as described above.

A preferred embodiment of the method according to the invention for treatment of resin-containing wood substrate comprises the steps of:

- identifying resin canals and/or cracks and/or knots in said pieces of wood, and

- hardening at least a part of the resin in said resin canals and/or cracks and/or knots in said pieces of wood by cross-linking the monomers and polymers in said resin.

By use of this embodiment it is possible to treat the wood substrate in a very economical and cost-effective way. As explained previously the natural present resin in wood is flowing in canals or resin canals from which it may penetrate to the surface of the wood substrate via cracks or knots constituting weaknesses in the wood substrate. Therefore exudation of resin substantially appears from canals, cracks and knots, whereby it will
normally be sufficient to harden the resin present herein.

The canals, cracks and knots can be identified using a known wood sorting system like WoodEye from the company Innovativ Vision AB, Sweden. Once the canals, cracks and knots are identified, the resin present herein can be hardened e.g. by subjecting the canals, cracks or knots to UV-light or high frequent heating which will initiate the cross-binding and hardening process of the resin. The process can be controlled by a computer and run automatically.

Preferably the hardening by cross-linking of the resin naturally present in the canals, cracks and/or knots is done by use of UV-radiation.

For some purposes a preferred embodiment of the method according to the invention further comprises the step of coating said resin-containing wood substrate with a coating material e.g. shellac or paint.

In the two-step way the first step comprises hardening of the resin naturally present in the wood substrate. Hereafter the surface of the wood substrate is coated with a coating material, which are allowed to harden or dry.

In the one-step way the resin-containing wood substrate is coated with a coating material wood and the resin in the wood substrate and is hardened and the coating material is hardened dried simultaneously.
The entire wood substrate may be coated or the coating may be limited to the canals, cracks and/or knots in the wood substrate.

Coating of the wood substrate may be an advantage when the wood substrate is designated for use in wet environments with changing temperatures.

The invention also relates to a resin-containing wood substrate wherein at least a part of the resin is hardened according to the above-described method. Embodiments of the invention are illustrated in the following examples.

Example 1

A resin containing wood substrate constituted by a lath of pinewood having the dimensions 4 x 8 x 50 cm is subjected to manual inspection were openings of resin canals and/or cracks and/or knots is visually identified and marked with a red ink.

The identified resin canals and/or cracks and/or knots are subjected to a treatment with UV light.

The marked spots on the surface of the wood are subjected to a treatment with UV-light from a medium pressure mercury vapour lamp (300 WPI, approx 365 nm) from a distance between 10 and 15 cm for 20 to 40 seconds.
It is observed that the naturally occurring resin in the treated spots are hardened in a thickness extending from the surface and into the wood from 0.2 mm to 0.8 mm.

Example 2

A resin containing wood substrate constituted by a lath of pinewood having the dimensions 4 x 8 x 50 cm is subjected to a treatment with UV light on one surface.

The surface which is subjected to treatment has the dimensions 8 x 50 cm.

The surface is moved in the longitudinal direction with a speed of approximately 0.5 m/min and exposed to UV light from a fixed UV lamp. The UV lamp is a medium pressure mercury vapour lamp (300 WPI, approx 365 nm) placed at a distance of approximately 10 cm over the moving surface, which is treated.

It is observed that the naturally occurring resin in the surface is hardened in a thickness extending from the surface and into the wood from 0.1 mm to 0.3 mm.

Example 3A

A wood substrate constituted by a lath of pinewood with a resin filled crack having the dimensions of 4 x 2 mm was subjected to a treatment of an UV radiation source. With an intensity level of 500 mW/cm² at 450 +/- 25 nm, and an exposure time of 40 sec and a distance between the source
and the substrate at 1,5 mm. This specimen had a measured mean shear-peel bond strength at 12,3 MPa.

Example 3B

A wood substrate constituted by a lath of pinewood with a resin filled crack having the dimensions of 4 x 2 mm was subjected to a treatment of an argon laser source. With an intensity level of 500 mW/cm², and an exposure time of 5 sec and a distance between the source and the substrate at 1,5 mm. This specimen had a measured mean shear-peel bond strength at 11,8 MPa.

From the above mentioned examples 3A and 3B it can be seen that a 5 second laser cure using an argon laser produces bond failure loads comparable to those obtained after 40 seconds of UV radiation cure. No significant loos in bonding strength was observed, but a dramatically reduction in curing time is obtained (factor 8).
Claims

1. A method for treatment of resin-containing wood substrate which method comprises the step of hardening at least a part of the resin in said wood substrate.

2. A method according to claim 1 wherein the resin is hardened in a layer extending from the surface of the wood substrate and at least some distance into the wood, preferably said layer has a thickness between 0.1 - 5.0 cm.

3. A method according to claim 1 wherein substantially all resin present in the wood substrate is hardened.

4. A method according to claim 1 wherein substantially all the resin present in canals and/or cracks and/or knots in the wood substrate is hardened.

5. A method according to any of the preceding claims 1-4 wherein the resin is hardened by cross-linking of monomers and/or polymers in the resin by use of UV-radiation, IR-radiation, high frequent heating, laser-radiation, corona treatment, plasma treatment and/or heat-treatment in fluid bed.

6. A method according to any of the preceding claims 1-4 wherein the resin is hardened by cross-linking of monomers and/or polymers in the resin by applying a reactive chemical, preferably selected among sulphur, sulphur trioxide, hydrogen-peroxide, nitrogen-oxides, phosphor, halogens or ozone, preferably the reactive chemical is applied in gaseous or vapour state.
7. A method according to claim 6 wherein the resin-containing wood substrate is subjected to a heat-treatment step after a reactive chemical has been applied.

8. A method according to any one of claims 1-7 for treatment of resin-containing wood substrate, which method comprises the steps of:

- identifying resin canals and/or cracks and/or knots in said pieces of wood, and

- hardening at least a part of the resin in said resin canals and/or cracks and/or knots in said pieces of wood by cross-linking the monomers and polymers in said resin.

9. A method according to claim 8 wherein the hardening of said resin by cross-linking is done by use of UV-radiation

10. A method according to claims 1-9 which further comprises the step of coating said resin-containing wood substrate with a coating material.

11. A method according to claim 10 wherein the coating material is selected from the group consisting of shellac, paint, and polymer material.

12. A method according to claims 10 and 11 wherein said coating material is applied in liquid state and allowed to harden or dry on surface of the wood substrate.
13. A resin-containing wood substrate wherein at least a part of the resin is hardened which hardening is obtained by the method according to any one of the claims 1-12.