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(54) **METHOD FOR PRODUCING MODIFIED WOOD AND DEVICE FOR CARRYING OUT SAID METHOD**

(57) The invention relates to the field of woodworking and can be used for producing modified wood from various kinds simultaneously with its protective impregnation. The method of obtaining modified wood includes simultaneous drying, impregnation by means of immersion of the semi-finished product into the impregnating compound and its exposure to an acoustic field. The immersion of the semi-finished product into the impregnating compound, and its subsequent removal and at least partial cooling shall be carried out in inert gas, whose molecular weight is greater than the molecular weight of oxygen. Prior to filling the area above the surface of the impregnating compound with inert gas, it shall be evacuated and the impregnating compound shall be heated up to a temperature of 140-230° C before the immersion of the semi-finished product.

The device for obtaining modified wood includes an impregnation and drying chamber (1) equipped with a lid, (2) filled with the impregnating compound, (3) in which the semi-finished product (4) is placed, to which acoustic energy source is connected (5). The impregnation and drying chamber is equipped with a heater (6) that ensures heating of the impregnating compound up to a temperature of 140-230° C. The lid (2) of the impregnation and drying chamber has a leak-proof design and equipped with at least one connecting pipe, (7) connected with evacuation system, as well as with inert gas filling system.

The technical result of the invention is that the invention ensures obtaining of high quality characteristics of the modified wood.

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Description

Technical field

[0001] This invention is related to the woodworking field and can be used to produce modified wood of various kinds with simultaneous protective impregnation.

Prior technical process

[0002] There is a wood drying method that includes a immersion of wood into a heated liquid medium, located in an impregnation and drying chamber and aging it in the chamber until the wood reaches the desired humidity value with its subsequent cooling (US Patent 4366627, 1999). Hot oil is used as the heated liquid medium and the aging is performed at a temperature above the water boiling temperature.

[0003] The disadvantages of this method are long duration of the process and impossibility to control the depth of impregnation of the treated wood, which is unacceptable for many applications of wood and does not allow the achievement of a high preservation effect.

[0004] Another method of obtaining modified wood includes the simultaneous drying, impregnation and compression of wood in hot impregnating compound and subjecting the semi-finished product to acoustic (ultrasound) field (Russian Federation Patent number 2391202, MPK V27K 3/08, published on 10.03.09).

[0005] The use of the method allows the reduction of the impregnation and drying time semi-finished product and improve the modified wood form stability: as a result of the acoustic field impact, the compressed wood acquires hydrophobic properties and its swelling in water does not exceed 12 %, which is sufficient to manufacture railway sleepers. This method is the closest to the stated technical solution and is selected as the prototype.

[0006] However, this method does not yield high-quality wood for artworks, since the color of the treated wood, along the cross section, becomes uneven and it is impossible to control the color of the wood.

[0007] A devicewood-drying device is known, which implements the method of wood drying (US Patent 4366627, 1999). The device combines an impregnation and drying chamber, filled with heated liquid medium in which the semi-finished product is placed.

[0008] The semi-finished product is aged in impregnation and drying chamber to achieve the desired humidity value of wood, and then cooled. Hot oil is used as the heated liquid medium and aging is performed at a temperature above the water boiling temperature. The device ensures drying of the wood and impregnation of the surface layer with oil.

[0009] The disadvantages of this device are long duration of the process and impossibility to control the depth of impregnation of the treated wood, which is unacceptable for many applications of wood and does not allow the achievement of a high preservation effect.

[0010] A device for obtaining the modified wood is known that implements the method of obtaining modified wood (Russian Federation patent № 2391202 MPK V27K 3/08, published on 10.03.09).

[0011] The device contains an impregnation and drying chamber with lid, filled with impregnating compound, in which the semi-finished product is placed, with an acoustic energy source, connected to the impregnation and drying chamber. The device ensures the simultaneous drying, impregnation and compression of the wood in the heated, impregnating compound, under the influence of acoustic (ultrasound) field.

[0012] The device allows the reduction of the impregnation and drying time of the semi-finished product and improve form stability of wood: as a result of impact of acoustic field the compressed wood acquires hydrophobic properties and its swelling in water does not exceed 12 %, which is sufficient for the manufacture of sleepers. This device is the closest to the claimed technical solution and is selected as the prototype.

[0013] However the device does not allow one to obtain high-quality wood for artworks because the color of the treated wood along the cross section becomes irregular and there is no possibility to control the hue (color) of the wood.

Disclosure of the Invention.

[0014] The task of the invention is the development of a method and a device for its implementation, which allow an improvement of the qualitative characteristics of the modified wood.

[0015] The set task is solved with the help of the features specified in paragraph 1 of the invention formula that are common with those of the prototype such as the method of obtaining the modified wood, including the simultaneous drying, impregnation by immersion into the impregnating compound and exposure of the semi-finished product to an acoustic field, as well as the invention's own distinctive features.

[0016] The essential features such as immersion of the semi-finished product into the impregnating compound, and its subsequent removal and at least a partial cooling shall be performed in an inert gas, whose molecular weight is greater than the molecular weight of the oxygen, and also, prior to filling the area above the surface of the impregnating compound with an inert gas, it shall be evacuated and the impregnating compound shall be heated to a temperature of 140-230 °C before the immersion of the semi-finished product.

[0017] Paragraphs 2 and 3 of the invention formula contain the peculiarities of placing of the semi-finished product, namely the process is conducted vertically along the wood fiber; the semi-finished product is partially immersed in the impregnating compound; also, the upper part or the end of the semi-finished product shall be located over the surface of the impregnating compound.

[0018] According to paragraph 4 of the invention for-

mula, wax-like substances are used as the impregnating compound.

[0019] Immersion of the semi-finished product into the impregnating compound, its subsequent removal, and at least partial cooling in inert gas, whose molecular weight is greater than the molecular weight of oxygen, with preliminary evacuation of the area over the surface of the impregnating compound, allows to reliably avoid contact of both the impregnating compound and the semi-finished product with atmospheric oxygen at all stages of the process, which eliminates an oxidation of the heated wood and the impregnating compound, charring and quality degradation of the finished material.

[0020] Heating the impregnation compound before immersion of the semi-finished product up to a temperature of 140-230° C, allows an implementation of its thermal modification simultaneously with the processes of drying, impregnation and compression of wood (dyeing of wood in natural shades without the use of chemical dyes), whose condition of such process for various kinds of wood is a thermal effect within the said temperature range while limiting the supply of oxygen. The degree of thermal modification and, accordingly, the color of the wood (from light to black shades) are set by adjusting the temperature within the specified range and the duration of the treatment.

[0021] The implementation of the method when the semi-finished product is performed vertically along the wood fiber, allows to ensure equal conditions of impregnation along the cross-section of the semi-finished product due to a uniform course of convection and diffusion processes as a result of compliance of the direction of the location of wood fibers with the direction of gravitation forces, which ensures the best quality of wood impregnation.

[0022] Partial immersion of the semi-finished product into the impregnating compound, while keeping the upper part (the end) of the semi-finished product over the surface of the impregnating compound allows to facilitate the release of moisture vapors from the wood of the semi-finished product via such end, whose surface is not coated with impregnating compound, which allows to ensure a more uniform moisture content and high quality of the finished material throughout the whole volume.

[0023] The use of wax-like substances as an impregnating compound allows ensuring a uniform impregnation, high quality and high environmental characteristics of the finished material due to their property of fluidity in the capillary structure of wood under the influence of the acoustic field. Also, wax-impregnated wood allows the treating of the surface to high purity.

[0024] The above-mentioned set of essential features allows obtaining of high quality characteristics of the modified wood.

[0025] The high-quality modified wood, manufactured from coniferous and broadleaf species having a through volumetric impregnation, various density and color, obtained by this method, is named "drevit".

[0026] The set task is solved with the help of features, specified in paragraph 5 of the invention formula that are common with those of the prototype such as the device for obtaining the modified wood, which includes an impregnation and drying chamber with a lid, filled with impregnating compound, in which the semi-finished product is placed, with acoustic energy source connected to the impregnation and drying chamber, as well as with the help of distinguishing and essential features, such as the following: the impregnation and drying chamber is equipped with a heater that ensures the heating up of the impregnating compound up to a temperature of 140-230 °C, and the lid of the impregnation and drying chamber has a leak-proof design and equipped with at least one connecting pipe, connected with the evacuation system, as well as with an inert gas filling system. According to paragraph 6 of the invention formula, the impregnation and drying chamber is designed with consideration of possibly placing the semi-finished product in it, in a vertical position along the maximum dimension of the semi-finished product, while the acoustic energy source shall be connected to the impregnation and drying chamber from the lower end side.

[0027] The peculiarity of the design of the impregnation and drying chamber's lid is reflected in paragraph 7 of the invention formula, namely the lid of the impregnation and drying chamber is designed as a hollow chamber, whose volume is at least equal to that of the impregnation and drying chamber.

[0028] According to paragraph 8 of the invention formula, the device is equipped with a mechanism (10) for a controlled load of the semi-finished product into the impregnation and drying chamber and its removal from the chamber.

[0029] The availability of the heater of the impregnation and drying chamber that ensures heating of the impregnating compound up to a temperature of 140-230° C, allows to maintain and control the temperature of the impregnating compound, which, in turn, allows to ensure the desired depth of the thermal modification of the semi-finished product wood, as well as to hue it with the desired shade of color.

[0030] The leak-proof design of the impregnation and drying chamber's lid allows to hermetically restrict the volume over the surface of the impregnating compound in the impregnation and drying chamber, and equipping the lid with at least one connecting pipe, connected to the evacuation system and an inert gas filling system, allows the removal of air and filling the volume with inert gas in order to avoid contact with air and oxidation of the heated semi-finished product and impregnating compound.

[0031] The design of the impregnation and drying chamber that allows the placement of the semi-finished product in a vertical position along the maximum dimension of the semi-finished product with connection of the acoustic energy source to the impregnation and drying chamber from its lower end, allow to ensure equal con-

ditions of impregnation along the cross-section of the semi-finished product due to uniform convection and diffusion processes as a result of compliance of the direction of the location of wood fibers with the direction of action of acoustic energy and gravitation forces, which ensures the best quality of wood impregnation.

[0032] The design of the lid of the impregnation and drying chamber as a hollow chamber with a volume at least equal to that of the impregnation and drying chamber allows the placement of the semi-finished product under the cover in an inert gas before its immersion and upon completion of the process excluding the contact of the semi-finished product with oxygen, charring and reduction of the finished material quality.

[0033] Equipping of the device with the mechanism for controlled load of the semi-finished product into the impregnation and drying chamber and its removal from the chamber allows the performance of partial and complete immersion of the semi-finished product for the set time, which ensures an implementation of modes of modified wood production and achievement of high quality characteristics.

[0034] The above mentioned set of essential features allows the obtaining of the high quality characteristics of modified wood.

[0035] The invention is illustrated by examples of implementation and the drawing. Example. The method is implemented as follows.

[0036] The semi-finished products are prepared from various kinds of wood, typically with a humidity of 20-60 %. The semi-finished products are placed in the area over the impregnation and drying chamber, which has been previously evacuated and filled with inert gas with a molecular weight greater than that of oxygen (for example, argon). The impregnation and drying chamber is filled with impregnating compound, which is heated up to a temperature of 140 to 230° C, depending on the desired degree of wood modification and the selected mode of impregnation. The semi-finished products are immersed partially or completely into the impregnating compound, preferably placed vertically along the fiber, and they shall be kept there for one or more stages within the time set for modification. Acoustic energy is supplied to the impregnation and drying chamber and modification process is implemented. The moisture, evaporated from the wood, is removed from the area over the impregnation and drying chamber. Upon completion of the process, the semi-finished product is removed from the impregnating compound, cooled in an inert gas to a temperature not exceeding 140° C, and afterwards, the semi-finished product is stored outside as finished material "drevit".

[0037] Additionally, the inert gas in the volume above the impregnation and drying chamber reliably isolates contact of both the impregnating compound and the semi-finished product with atmospheric oxygen at all stages of the process, which excludes oxidation of the heated wood and impregnating compound, charring and reduction of quality of the finished material. The wood's

thermal modification is carried out in the impregnating compound at a temperature of 140-230° C simultaneously with the processes of drying, impregnation and compression. Vertical immersion of the semi-finished products along the fiber, partial or stage-wise immersion of the semi-finished products into impregnating compound, ensures more uniform moisture removal and impregnation of the semi-finished products. Impregnation of the semi-finished products with wax-like substance ensures high environmental characteristics of the finished material.

[0038] Modified wood, "drevit", manufactured from various coniferous and broadleaf species has a uniform impregnation and color from light hues to shades of black (without the use of chemical dyes). It does not have cracks and inner stress. It is also distinguished by the high form stability that is a high quality indicator.

[0039] The density of the modified wood, "drevit", is increased by two times, the hardness of coniferous species is increased up to 150 %, and broadleaf species - up to 127 %.

[0040] For example, the modified wood, "drevit", is obtained by means of the suggested method, manufactured from birch (impregnation is bees wax, modification temperature is 220-230° C) has black and brown color, a density of 1.2 kg/m³ and a hardness of up to 45 N/m². By appearance, it corresponds to black fumed oak, being similar to more expensive kinds of wood.

[0041] The exact coupling sizes of parts made of wood "drevit" remain within the tolerances in the case of ambient air humidity deviation from 12 to 100 %.

[0042] The time of manufacturing of modified wood "drevit" from broadleaf species for semi-finished products with a thickness of 50-100 mm is 10 minutes at a temperature of 140° C (furthermore, the color is close to the original), it takes approximately up to 1.5 hours at a temperature of 220-230° C to obtain the "black oak" color.

[0043] The implementation of the claimed method with the help of the device is explained by the drawing, Fig.

[0044] The device for implementation of the method of obtaining modified wood "drevit" includes an impregnation and drying chamber (1) equipped with a lid, (2) filled with impregnating compound, (3) in which the semi-finished product (4) is placed, and an acoustic energy source, (5) connected to the impregnation and drying chamber (1). The impregnation and drying chamber (1) is equipped with a heater (6) that ensures heating of the impregnating compound up to a temperature of 140-230°C, and the lid (2) of the impregnation and drying chamber (1) with a leak-proof design and is equipped with at least one connecting pipe (7) connected to the evacuation system as well as to inert gas filling system (not shown in the drawing). The semi-finished product (4) is located in the impregnation and drying chamber (1) in vertical position along the maximum dimension (l) and the acoustic energy source (5) is connected to the impregnation and drying chamber (1) from the lower end (8). The lid (2) of the impregnation and drying chamber

(1) is designed as a hollow chamber (9). Under the lid (2) of the impregnation and drying chamber (1) there is a mechanism (10) for a controlled load and removal of the semi-finished product (4).

[0045] The device functions as follows:

The impregnation and drying chamber 1 is loaded with impregnating compound (3) and hermetically closed with a lid (2), in whose cavity (9) the semi-finished product (4) is fixed on the mechanism (10). The cavity (9) of the lid (2) via the nozzle (7) is evacuated and filled with inert gas (argon). The impregnating compound, (3) using the heater. (6) is heated up to a temperature ranging from 140 to 230° C. The semi-finished product (4) with the help of the mechanism (10) is immersed into the impregnating compound (3) and aged in accordance with the set mode of the process. The acoustic energy from the acoustic energy source (radiating element) (5) is supplied from the side of the lower end (8) of the impregnation and drying chamber (1) to the impregnating compound (3) and the process is carried out. Upon completion of the process, the semi-finished product (4) is removed by means of the mechanism (10) from the impregnating compound (3), being placed in the volume (9) of the lid (2), the semi-finished product (4) cooling is carried out in inert gas to a temperature that does not exceed 140°C (the position of the semi-finished product (4) in the volume (9) is shown by the dotted line). After cooling of the semi-finished product, (4) argon is removed from the volume (9) through the nozzle (7), the lid (2) is separated from the impregnation and drying chamber (1), the finished material - modified wood "drevit" is removed from the volume (9) of the lid (2) by means of the mechanism (10).

[0046] The modified wood "drevit", manufactured by means of the suggested invention has a uniform impregnation. It is colored from light hues to shades of black (without the use of chemical dyes), it has a density of 1.2 kg/m³ and no cracks and inner stress throughout the whole volume, as well as high form stability, which is a high quality indicator.

Industrial Applications

[0047] The suggested invention may be manufactured from available materials and components on standard equipment in industrial conditions. It may be widely used in the field of woodworking, construction, furniture manufacturing, decorative woodworking and artwork.

[0048] Though the present invention has been described by examples of its implementation and the drawing, the scope of the present invention is not limited to these examples but is defined only by the invention formula with consideration of possible equivalents.

Claims

1. The method of obtaining the modified wood that includes simultaneous drying, impregnation by means of immersion of the semi-finished product into the impregnating compound and its exposure to an acoustic field is distinguished by the fact that the immersion of the semi-finished product into the impregnating compound, its subsequent removal, and at least partial cooling shall be carried out in inert gas, whose molecular weight is greater than the molecular weight of oxygen. Prior to filling the area above the surface of the impregnating compound with inert gas, it shall be evacuated and the impregnating compound shall be heated up to a temperature of 140-230° C before the immersion of the semi-finished product.
2. The method, described in paragraph 1, is distinguished by the fact that the process is carried out with the semi-finished product placed in a vertical position along the wood fiber.
3. The method, described in paragraph 1, is distinguished by the fact that the semi-finished product is immersed into the impregnating compound partially. At that, the upper part, the end of the semi-finished product shall stay over the surface of the impregnating compound.
4. The method, described in paragraph 1, is distinguished by the fact that wax-like substances are used as the impregnating compound.
5. The device for obtaining the modified wood that includes an impregnation and drying chamber, equipped with a lid, filled with the impregnating compound, in which the semi-finished product is placed, to which an acoustic energy source is connected, is distinguished by the fact that the impregnation and drying chamber is equipped with a heater that ensures heating of the impregnating compound up to a temperature of 140-230° C, and the lid of the impregnation and drying chamber has a leak-proof design and equipped with at least one connecting pipe, connected with evacuation system, as well as with inert gas filling system.
6. According to paragraph 5, the device is distinguished by the fact that the impregnation and drying chamber is designed with consideration of the possibility to place the semi-finished product in a vertical position along the maximum dimension of the semi-finished product, and the acoustic energy source is connected to the impregnation and drying chamber from the lower end side.
7. According to paragraph 5, the device is distinguished

by the fact that the lid of the impregnation and drying chamber is designed as a hollow chamber, whose volume is at least equal to that of the impregnation and drying chamber.

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8. According to paragraph 5, the device is distinguished by the fact that it is equipped with a mechanism of a controlled load of the semi-finished product into the impregnation and drying chamber and its removal from the chamber.

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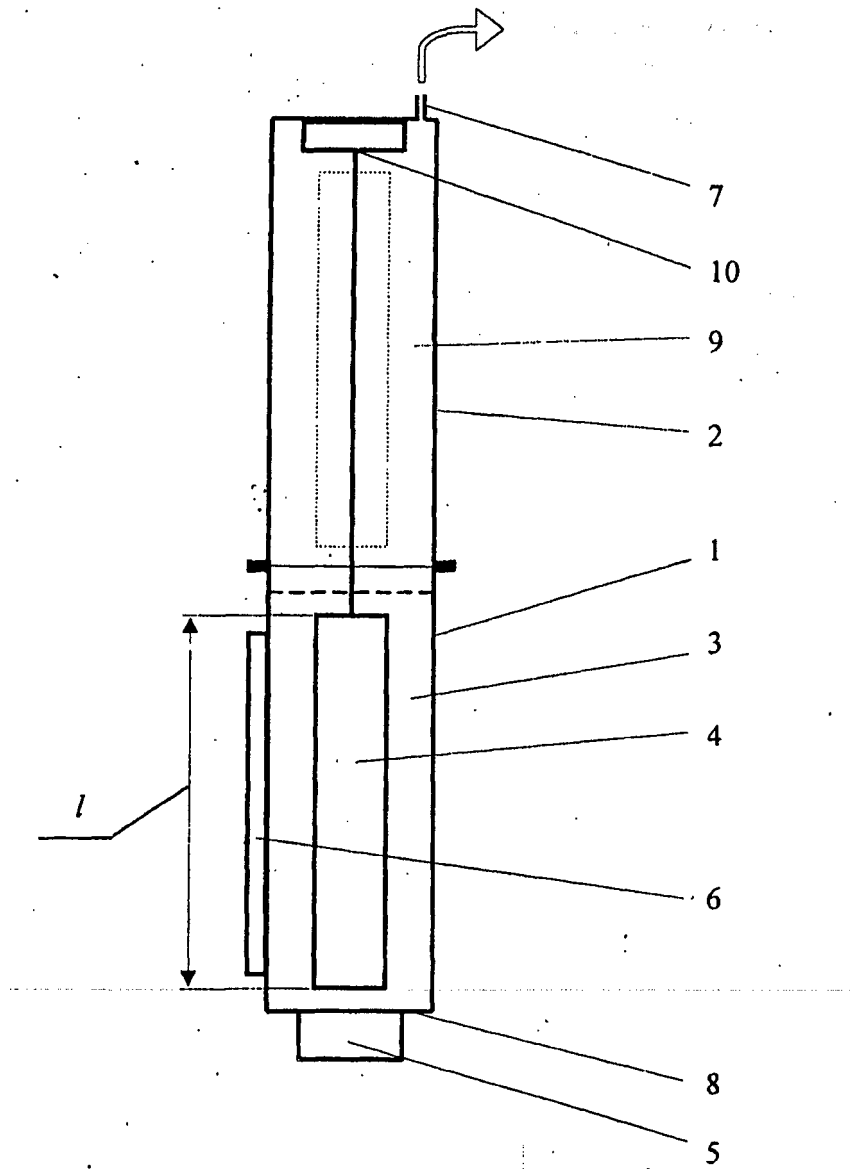


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 2012/000226

A. CLASSIFICATION OF SUBJECT MATTER		
B27K 3/08 (2006.01); F26B 7/00 (2006.01); B27K 5/04 (2006.01)		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
B27K 3/00, 3/02, 3/08, 3/10, 5/04, F26B 5/02, 5/04, 7/00, 9/06		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
PatSearch (RUPTO internal), Esp@cenet, PAJ, USPTO		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	RU 2391202 C1 (GOSUDARSTVENNOE OBRAZOVATELNOE UCHREZHDENIE VYSSHEGO OBRAZOVANIYA "VORONEZHSKAYA GOSUDARSTVENNAYA LESOTEKHNICHESKAYA AKADEMIYA") 10.06.2010	1-8
A	RU 2157314 C1 (BAZAROV SERGEI MIKHAILOVICH et al.) 10.10.2000	1-8
A	RU 50289 U1 (KOMARITSKY VLADIMIR VASILIEVICH et al.) 27.12.2005	1-8
A	WO 2008/085080 A1(PAMIR INTERPRAISES LIMITED et al.) 17.07.2008	1-8
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search		Date of mailing of the international search report
21 June 2012 (21.06.2012)		19 July 2012 (19.07.2012)
Name and mailing address of the ISA/		Authorized officer
Facsimile No.		Telephone No.

REFERENCES CITED IN THE DESCRIPTION

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- RU 2391202 [0004] [0010]