(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 895 863 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
23.04.2025 Bulletin 2025/17

(21) Application number: **20203710.7**

(22) Date of filing: **23.10.2020**

(51) International Patent Classification (IPC):
B27K 3/00 $^{(2006.01)}$ ***B27K 3/02*** $^{(2006.01)}$
B27K 3/10 $^{(2006.01)}$ ***B27K 3/18*** $^{(2006.01)}$
B27K 3/26 $^{(2006.01)}$

(52) Cooperative Patent Classification (CPC):
B27K 3/005; B27K 3/0278; B27K 3/10; B27K 3/18; B27K 3/26

(54) WOOD TREATMENT

HOLZBEHANDLUNG

TRAITEMENT DU BOIS

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **16.04.2020 EP 20169815**

(43) Date of publication of application:
20.10.2021 Bulletin 2021/42

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Description

Field

[0001] The present disclosure relates to the treatment of wood. In particular, the present disclosure relates to modifying the properties of a piece of wood by impregnation.

Background

[0002] Impregnating a piece of wood allows depositing substances in the piece of wood that change the (natural) properties of the piece. For example, impregnating a piece of wood may be directed at reducing the susceptibility of the piece to shrinking/swelling, increasing its strength, increasing its resistance to decay, fire, etc.

[0003] For example, EP 2 937 193 A1 teaches a process for treating wood. The process consists of a first impregnation cycle in which a salt solution comprising a metal salt is used and a second impregnation cycle in which a salt solution comprising another salt is used.

[0004] Other methods for treating wood are known from JP 6 368939B2, CN111002413A, and DD231028A1.

Summary

[0005] The present invention is directed at a method of treating wood according to claim 1.

[0006] In this regard, the terms "wood" and "piece of wood" as used throughout the description and claims are to be construed broadly and shall include natural wood and wood pieces, but also derivative wood products, i.e., any structure comprising wood cells. A wood cell may have a cell wall comprising cellulose, hemicellulose and lignin. Notably, wood pieces may come in various forms (veneers, panels, boards, beams, etc.). The method comprises providing a mixture comprising a cement and a carrier liquid, pressure impregnating a piece of wood with the mixture and activating hydration of the cement.

[0007] In this regard, the term "mixture", as used throughout the description and the claims, particularly refers to a heterogeneous mixture of a liquid and solid particles (dispersion, colloid, sol, suspension).

[0008] The solid particles may be sufficiently large for sedimentation such that providing the mixture may involve agitating the liquid to disperse the solid particles in the liquid. Moreover, mixing the liquid and the solid particles at a certain speed and/or for a certain duration may be required to avoid or break up particle clogging. For example, the particles may have a size that is smaller than a size of the cells or pores of the piece of wood, but particle agglomerates may have a size that is larger than the size of cells or pores and thus necessitate breaking-up the agglomerates.

[0009] The cement may comprise particles of different substances. The mass fractions of the substances that form the cement may be fixed or within given ranges and different substances may occur at different mass fractions (and particle sizes). The cement may comprise Portland cement clinker. In addition to Portland cement clinker, the cement may comprise slag, silica fume, pozzolana, fly ash, burnt shale or limestone. The cement may also comprise latent hydraulic substances such as blast furnace slag in combination with calcium oxide or calcium hydroxide. The cement may also be trass cement or alumina cement.

[0010] In other words, various different cement types may be used including (notation according to EN 197-1) Portland (CEM 1), Portland-slag (CEM II/A-S, CEM II/B-S), Portland-silica fume (CEM II/A-D), Portland-pozzolana (CEM II/A-P, CEM II/B-P, CEM II/A-Q, CEM II/B-Q), Portland-fly ash (CEM II/A-V, CEM II/B-V, CEM II/A-W, CEM II/B-W), Portland-burnt shale (CEM II/A-T, CEM II/B-T), Portland-limestone (CEM II/A-L, CEM II/B-L, CEM II/A-LL, CEM II/B-LL, Portland-composite (CEM II/A-M, CEM II/B-M), Blastfurnace (CEM III/A, CEM III/B, CEM III/C), Pozzolanic (CEM IV) and Composite (CEM V).

[0011] The term "carrier liquid", as used throughout the description and the claims, particularly refers to a liquid that may be used to transport the particles into the cells or pores of (or cracks within) the piece of wood, without activating hydration.

[0012] For example, the carrier liquid may be a non-aqueous carrier liquid (that does not activate hydration). The carrier liquid may be provided with organic or inorganic additives that reduce the susceptibility of the piece to shrinking/swelling and/or increase its resistance to decay and/or its fire resistance. The carrier liquid may be recycled. For example, the cement particles may be filtered from the carrier liquid or a loss in cement particle concentration (in the mixture) may be compensated by adding cement particles to the mixture.

[0013] Moreover, the mixture may be used for several impregnation cycles. In this regard, sedimentation may be prevented by agitating the mixture, or the cement particles and the carrier liquid may be mixed between consecutive cycles. Mixing may be scheduled at certain intervals or at need. For example, the mixture may be monitored for sedimentation and mixing may be scheduled (or started right away) if it is detected that sedimentation occurs or that a degree of sedimentation reaches or approaches a threshold.

[0014] The term "pressure impregnation", as used throughout the description and the claims, particularly refers to increasing a pressure at which the mixture is forced into the cell walls, cell lumen or pores (or cracks).

[0015] For instance, the piece of wood may be placed in a pressure chamber which is evacuated (and may be floated with the mixture after an evacuation period). Once the pressure in the chamber is increased, the mixture in which the piece of wood may be immersed, may be soaked/forced into the cell walls, cell lumen or pores (or cracks). This evacuation-floating-procedure might be repeated several times before hydration. Moreover, the formulation "activating hydration", as used throughout the description and the claims, particularly refers to providing for conditions under which hydration occurs or under which hydration is accelerated.

[0016] For example, activating hydration may involve adding a substance required for hydration to take place (such as, for instance, water) or removing a substance that inhibits (or slows down) hydration. Activating hydration may also involve changing a condition which affects the hydration such as changing a temperature (e.g., heating) of the mixture.

[0017] The carrier liquid may be a non-aqueous carrier liquid.

[0018] In this regard, the term "non-aqueous", as used throughout the description and the claims, particularly refers to a solution in which the solvent is a liquid, different from water.

[0019] Activating hydration of the cement may comprise immersing the impregnated piece of wood into an aqueous liquid or water.

[0020] In this regard, the formulation "immersing the impregnated piece of wood into an aqueous liquid or water", as used throughout the description and the claims, shall encompass immersing the impregnated piece of wood into any fluid that contains water or any aqueous solution. The term "aqueous solution" shall extend to any solution in which the solvent is water. Moreover, the formulation "immersing the impregnated piece of wood into an aqueous liquid or water", as used throughout the description and the claims, shall also encompass immersing the impregnated piece of wood into a bath that contains only (or substantially only) water.

[0021] The method may further comprise replacing a liquid in which the impregnated piece of wood is immersed with aqueous liquid or water.

[0022] For example, the liquid in which the impregnated piece of wood is immersed may be (substantially) a solution comprising water and the carrier liquid, or a mixture comprising water, the carrier liquid and mineral hydrates. This liquid may be replaced with water to accelerate hydration.

[0023] The method may further comprise removing the non-aqueous carrier liquid from the liquid in which the impregnated piece of wood is immersed.

[0024] For example, the liquid in which the impregnated piece of wood is immersed may be subject to liquid-liquid phase separation allowing for the (full or partial) removal of the non-aqueous carrier liquid.

[0025] Providing the mixture may comprise adding cement particles with an average particle size of less than 100 micrometer (μm), preferably of less than 50μm and even more preferably of less than 10μm to the carrier liquid and agitating the mixture.

[0026] In this regard, the term "particle size", as used throughout the description and the claims, may refer to a diameter (for spherical particles), or to a volume-based particle size which equals a diameter of a sphere that has the same volume as the particle.

[0027] The cement particles may be Portland cement particles or particles of another cement type described above.

[0028] The carrier liquid may comprise alcohol and/or ether. In particular, the carrier liquid may be an alcohol.

[0029] The alcohol may be a glycol selected from the group consisting of monoethylene glycol, diethylene glycol, triethylene glycol, oligomere ethylene glycol, and polyethylene glycol.

[0030] A mass ratio of glycol and cement (glycol/cement) may be between 0.4 and 1.2, preferably between 0.6 and 1.0 (e.g., 0.8).

[0031] The carrier liquid may comprise an alkoxylate. The alkoxylate may be an alkoxylate of a Zerewitinoff-active compound, e.g., an alcohol, a fatty alcohol, a phenol, a diol, a triol, a tetrol, ..., a monosaccharide, an oligosaccharide, ammonia, a primary or secondary amine, a diamine, ..., which has reacted (block-wise or statistical) with, for example, ethylene oxide, propylene oxide, butylene oxide (or mixtures thereof).

[0032] The alkoxylate may be selected from the group consisting of an ethoxylate, a propoxylate and a butoxylate. The ethoxylate may be an ethoxylate of a Zerewitinoff-active compound (alcohols, fatty alcohols, phenols, diols, triols, tetrols, ..., monosaccharides, oligosaccharides, ammonia, primary or secondary amines, diamines, ...). The propoxylate may be a propoxylate of a Zerewitinoff-active compound (alcohols, fatty alcohols, phenols, diols, triols, tetrols, ..., monosaccharides, oligosaccharides, ammonia, primary or secondary amines, diamines, ...). The butoxylate may be a butoxylate of a Zerewitinoff-active compound (alcohols, fatty alcohols, phenols, diols, triols, tetrols, ..., monosaccharides, oligosaccharides, ammonia, primary or secondary amines, diamines, ...).

[0033] The OH groups of the alcohol or alkoxylate can be fully or partially transformed (e.g., blocked or functionalized). The functionalization may be etherification or esterification (e.g., poly(ethylene glycol) methacrylate). Etherification may involve the terminal OH group(s) of an alkoxylate being blocked. Esterification may involve transesterification, a reaction with acid anhydrides, acid halides, etc. The acid component of the ester may be an alkane carboxylic acid (e.g., formic acid, acetic acid, ...), an unsaturated acid (e.g. acrylic acid, methacrylic acid, unsaturated fatty acids, ...) etc. The OH groups of a diol or a polyol may be completely esterified (e.g,, poly(ethylene glycol) monomethacrylate).

[0034] The carrier liquid may comprise an acrylic ester or a methacrylic acid ester of a Zerewitinoff-active compound.

[0035] The carrier liquid may comprise an oligo-tetrahydrofuran or poly-tetrahydrofuran (or its acrylic ester or methacrylic acid ester).

[0036] The impregnated piece of wood comprises cells which are at least partially filled with inorganic hydrates. The impregnated piece of wood may further comprise at least one substantially flat surface area.

[0037] For example, the impregnated piece of wood may comprise two substantially flat surface areas that are perpendicular. The shape of the impregnated piece of wood may be a cuboid.

[0038] The inorganic hydrates comprise calcium silicate hydrates.

[0039] The calcium silicate hydrates are formed by cement hydration.

[0040] The hydrates may serve as flame retardants. Notably, other substances which, when exposed to heat, release water may also be used as flame retardants.

[0041] The piece of wood may be a piece of hardwood.

[0042] The present disclosure further relates to a system for treating wood which comprises a first container for a cement, a second container for a carrier liquid, a mixer, a first feeder for feeding the cement to the mixer, a second feeder for feeding the carrier liquid to the mixer and a pressure chamber for pressure impregnating a piece of wood.

[0043] The system for treating wood may further comprise means for activating setting and hardening of the cement.

[0044] The system for treating wood may further comprise a separator for separating the carrier liquid from an aqueous liquid or water.

[0045] The separated carrier liquid may be fed to the mixer for reuse.

[0046] More generally, the system may be used for carrying-out a method in which wood is impregnated with a substance and a reaction of said substance (with another substance) is initiated after said impregnation. Thus, the reaction does not occur during (and does hence not interfere with) said impregnation.

Brief Description of Drawings

[0047] The foregoing aspects and many of the attendant advantages will become more readily appreciated as the same becomes better understood by reference to the following description of embodiments, when taken in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts throughout the various views, unless otherwise specified.

Fig. 1 schematically illustrates a system for treating wood.

Fig. 2 schematically illustrates a cross-sectional view of a treated piece of wood.

Fig. 3 shows a flow chart of a method of treating wood.

Fig. 4 to Fig. 6 illustrate the properties of a piece of wood treated in accordance with the method.

Fig. 7 and Fig. 8 show a comparison of properties of pieces of wood treated in accordance with the method and pieces of wood treated in accordance with other methods.

[0048] Notably, the drawings are not drawn to scale and unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described herein.

Description of Embodiments

[0049] System 10 schematically illustrated in Fig. 1 comprises container 12 for a cement 14 and container 16 for carrier liquid 18. Containers 12 and 16 are connected by feeders 20 and 22 to mixer 24. Cement 14 may be a Portland cement with a particle size of 5μm. Such cement is sold by Dyckerhoff GmbH of Wiesbaden, Germany under the trade name Mikrodur. Carrier liquid 18 may be glycol or polyethylene glycol dimethacrylate (PEGDMA). Cement 14 and carrier liquid 18 may be mixed at 12,000 rpm for 5 minutes to provide mixture 26.

[0050] System 10 further comprises pressure chamber 28. Before feeding mixture 26 into pressure chamber 28, wood pieces 30 may be exposed to an absolute pressure of about 0.1 bar or less (vacuum) for 30-60 minutes. Once mixture 26 is fed into pressure chamber 28, wood pieces 30 may soak up mixture 26. The pressure in pressure chamber 28 may be increased to 12-15 bar to force mixture 26 into wood pieces 30. The pressure in pressure chamber 28 may then be decreased to about 0.1 bar for 30-60 minutes. Notably, mixer 24 and pressure chamber 28 need not be two separate entities but can be realized as a pressure chamber 28 with an integrated disperser.

[0051] After pressure impregnating wood pieces 30, hydration of the cement 14 may be activated by immersing impregnated wood pieces 30 into water 32. Wood pieces 30 may remain in water tank 34 for a period (of time) long enough for the cement 14 to set and harden (e.g., 48 hours) and the liquid in water tank 34 may be exchanged with water 32 several times during that period. Alternatively, or in addition, carrier liquid 18 and superfluous/set cement 14 may be removed from water tank 34 or the carrier liquid may be withdrawn from water tank 34 by separator 34a.

[0052] After the cement 14 has set and (sufficiently) hardened, wood pieces 30 may be dried. As schematically illustrated in Fig. 2, the cement 14 may set and harden in cells 36 of wood piece 30 and form inorganic material 38. The walls of the cells 36 may comprise lignin. Inorganic material 38 comprises inorganic hydrates such as calcium silicate hydrates Moreover, inorganic material 38 in cells 36 may comprise flame retardants which may have been added to the cement 14 or which may result from the reactions of ingredients in the cement 14 and water 32.

[0053] A cementitious mineralization process as described above may be used in relation to peeled wood veneers. In particular, the process may be used to introduce a (non-toxic) flame-retardant into veneers which may then be used to produce laminated veneer lumber.

[0054] For instance, veneers (e.g., peeled beech, Fagus sylvatica L.) may be impregnated in a vacuum-pressure process using an ethylene glycol-Portland cement suspension. The veneers may be subsequently manufactured into laminated veneer lumber specimens. The ethylene glycol may be used as a carrier liquid which prevents the hydraulic Portland cement from prematurely hydrating before and/or during the (cyclic) vacuum-pressure impregnation process. To enable the cement particles to penetrate the wood pores, a fine cement (e.g., a cement with a maximum aggregate size of d95 = 8 μm) may be used and mixed (e.g., for 3 minutes at 12000 rpm) with the Ethylene glycol carrier liquid.

[0055] The veneers may be impregnated with the cement-glycol suspension. For example, the veneers may be kept under vacuum (e.g., for about 45 minutes at an absolute pressure of about 0.3 MPa or less) before flooding the impregnation vessel (e.g., pressure chamber 28) with the cement-glycol suspension. Thereafter, the pressure may be increased (e.g., to an absolute pressure of about 15 MPa which may be applied for about three hours). The increase may be followed by a final vacuum cycle (e.g., 45 minutes at an absolute pressure of about 0.3 MPa).

[0056] After impregnating the veneers, the hydration reaction (and curing process) of the hydraulic fine cement particles in the wood pores may be initiated by storing the veneers in water (e.g., for 48 hours). Due to an osmotic process, the Ethylene glycol may be replaced by water. The necessary cement hydration time may be evaluated by a calorimetric determination of the reaction time.

[0057] Fig. 3 shows a flow chart of the steps for treating wood pieces 30. At step 40, mixture 26 comprising cement 14 and carrier liquid 18 is provided. As shown in Fig. 1, mixture 26 may be provided by mixing cement 14 and carrier liquid 18 in mixer 24. At step 42, wood pieces 30 are pressure impregnated with mixture 26. As described in relation to Fig. 1, wood pieces 30 in pressure chamber 28 may be exposed to an increased pressure (above the normal pressure) after exposing wood pieces 30 to a vacuum for a certain period (of time). Moreover, wood pieces 30 may be exposed to a vacuum for a certain period (of time) after having increased the pressure (above normal pressure). At step 44, hydration of the cement 14 is activated. As described in relation to Fig. 1, wood pieces 30 may be immersed into water 32 and carrier liquid 18 in cells 36 may be exchanged with water 32 by osmosis.

[0058] In the following, different mixtures are compared regarding their effects on the thermal properties and the fire resistance of beech veneers (*Fagus sylvatica L.*). The mixtures comprise Portland fine cement mixed with glycol (mass ratio of glycol and cement W/B=0.8), Portland fine cement and calcium oxalate monohydrate (COM) (ratio: 80/20) mixed with glycol (W/B=1.2), or aluminium hydroxide (ATH) mixed with glycol (W/B=1.2). The effects were investigated based on a thermogravimetric analysis (TGA). Furthermore, the reaction to fire was tested based on a single-flame source test (European Standard EN ISO 11925-2, 2010: Prüfungen zum Brandverhalten - Entzündbarkeit von Produkten bei direkter Flammeneinwirkung - Teil 2: Einzelflammentest).

[0059] Before further treatment, the peeled beech wood veneers of size 250×90×2 mm^3 (no defects like knots and cracks) were stored at 65 % relative humidity (RH) and 20°C. For the mixtures, Portland fine cement with a maximum aggregate size of $d_{95} = 8\ \mu m$ (available from Dyckerhoff under the trade name "Microdur"), ethylene glycol (100%), calcium oxalate-monohydrate $CaC_2O_4 \cdot H_2O$ (99.5%), and aluminium hydroxide d_{50} = 13-17 μm $AL(OH)_3$ (99.5%) were used.

- Portland cement

[0060] The Portland fine cement was mixed with glycol (W/B= 0.8) and then dispersed for 3 minutes at 12000 rpm. The glycol served as a carrier fluid and prevented the cement from premature hydration. The veneers were kept for 30 minutes at an absolute pressure of 0.3 MPa. After the cement glycol suspension had been infused into the vacuum chamber, an absolute pressure of 15 MPa was applied to the veneers for three hours during which the veneers were immersed in the suspension. Thereafter, an absolute pressure of 0.3 MPa was applied for 30 minutes.

- Portland cement and calcium oxalate monohydrate

[0061] The Portland fine cement was mixed with COM powder (80/20) and then dispersed for 3 minutes at 12000 rpm using glycol (W/B= 1.2). The impregnation process was the same as described in the preceding paragraph.

- Aluminum hydroxide (not according to the invention)

[0062] ATH powder was dispersed with glycol (W/B = 1.2) and the suspension was used to impregnate veneers as described above. After the impregnation, all veneers were stored in water for 48 hours and then oven-dried at 60°C. While being stored in water, a liquid exchange occurred, and the glycol was replaced by water which initiated cement hydration. The impregnation process and the preparation of the chemicals and specimens is summarized in the following table.

Process/Batch	Control	Cement	Cement/Oxalate	AL(OH)3
Conditioning (relative humidity % and temperature °C) °C/%	20/65	20/60	20/60	20/65
Materials		Cement/ Glycol	Cement/Oxalate/ Glycol	AL(OH)3/ Glycol
Ratio		80/100	(80/20)/83	100/83
Mixing at 12000 rpm in minutes		3	3	3
Pressure applied for 30 minutes in MPa		0.3	0.3	0.3
Pressure applied for 3 hours MPa		15	15	15
Pressure applied for 30 minutes in MPa		0.3	0.3	0.3
Time of Storage in H_2O in hours		48	48	48
Drying temperature in °C		60	60	60
Sample conditioning		20/65	20/65	20/65

[0063] For each mixture, twelve samples were prepared (from three impregnated veneers). The mass and dimensions were measured after conditioning at 20°C/65% and oven drying until the weight remained constant. The difference in weight between the control and the prepared veneers has been determined and the weight percentage gain (WPG) of the oven dried materials has been calculated as follows.

$$WPG(\%) = \frac{Treated\,Veneer\,Weight}{Control\,Veneer\,Weight} - 1$$

[0064] For each sample the dimensions were measured to determine the gross density.

[0065] For twelve samples, a single flame source test was performed (according to European Standard EN ISO 11925-2, 2010: Prüfungen zum Brandverhalten - Entzündbarkeit von Produkten bei direkter Flammeneinwirkung - Teil 2: Einzelflammentest).

[0066] Three specimens with a diameter of four millimetres each were punched out of every impregnated veneer. One at the top, one at the middle, and one at the bottom. A thermogravimetric analysis TGA was used with a heating rate of 10 K/min and a nitrogen atmosphere with a gas flow of 25 ml/min. Before starting the TGA process which involved a temperature increase up to 600°C (at a given heating rate), the specimens were conditioned at 103 °C for 15 minutes.

[0067] A weight percentage gain (WPG) determination of the impregnated specimens revealed that cement led to the highest mass gain, when compared to the other inorganic materials.

[0068] Fig. 4 shows boxplots of the single-flame source test. Therein, whiskers mark the range between minimum (Min) and maximum (Max). The lower (Q25) and upper (Q75) quartiles are shown by a box. The median ($\tilde{x}$) is given by a horizontal line and the arithmetic mean ($\bar{x}$) is given by a square. A symmetric boxplot with a relatively small distance between $\tilde{x}$ and $\bar{x}$ indicates a normal distribution.

[0069] A mean rank comparison test between the impregnants and untreated wood (Fig. 5) shows a significant decrease of flammability for cement and cement-oxalate impregnants.

[0070] The single flame source test indicates a strong reduction of the flammability compared to the control specimens. The median time until the flame reaches the 150 mm mark is 42 seconds for the control specimens, while it is 49.5 seconds for the cement/oxalate impregnation. $AL(OH)_3$ treatment leads to a time of 45 seconds. The highest value was achieved with the cement impregnation (56 seconds).

[0071] The flammability-reducing potential of impregnated wood using inorganic solids is illustrated in Fig. 8 which depicts weight loss per temperature (%/°C) versus process temperature. Although an increased weight loss can be observed, impregnating inorganic solids increases the temperature peak at the point of maximum weight loss.

Specimens	Temp. peak in °C	Char in %
Control	353,06	20,42
Beech cement	365,04	23,01
Beech cement oxalate	364,20	22,74
Beech aluminum hydroxide	364,55	17,64

Reference Signs List

[0072]

10	system
12	container
14	cement
16	container
18	carrier liquid
20	feeder
22	feeder
24	mixer
26	mixture
28	pressure chamber
30	piece of wood
32	water
34	water tank
34a	separator
36	cell
38	inorganic material
40	step
42	step
44	step

Claims

1. A method of treating wood, comprising:

providing (40) a mixture (26) comprising a mineral binder and a carrier liquid (18), the mineral binder being comprised of solid particles of substances that chemically react with water, thereby forming mineral hydrates;
pressure impregnating (42) a piece (30) of wood with the mixture (26); and
activating hydration of the mineral binder;
characterized in that
the mineral binder is cement (14); and
the mineral hydrates comprise calcium silicate hydrates.

2. The method of treating wood according to claim 1, wherein the carrier liquid (18) is a non-aqueous carrier liquid and activating hydration of the mineral binder comprises immersing the impregnated piece (30) of wood into an aqueous liquid or water (32).

3. The method of treating wood according to claim 2, further comprising:

replacing a liquid in which the impregnated piece (30) of wood is immersed, with aqueous liquid or water (32); or removing the non-aqueous carrier liquid (18) from the liquid in which the impregnated piece (30) of wood is immersed.

4. The method of treating wood according to any one of claims 1 to 3, wherein providing the mixture (26) comprises adding mineral binder particles with an average particle size of less than 100 µm and preferably of less than 50 µm to the carrier liquid (18) and agitating the mixture (26).

5. The method of treating wood according to any one of claims 1 to 4, wherein the carrier liquid (18) comprises alcohol and/or ether.

6. The method of claim 5, wherein the alcohol is a glycol selected from the group consisting of monoethylene glycol, diethylene glycol, triethylene glycol, oligomere ethylene glycol, and polyethylene glycol.

7. The method of treating wood according to any one of claims 1 to 4, wherein the carrier liquid (18) comprises an alkoxylate selected from the group consisting of an ethoxylate, a propoxylate and a butoxylate.

8. The method of treating wood according to any one of claims 1 to 4, wherein the carrier liquid (18) comprises an acrylic ester or a methacrylic acid ester of a Zerewitinoff-active compound.

9. The method of treating wood according to any one of claims 1 to 4, wherein the carrier liquid (18) comprises an oligo-tetrahydrofuran or poly-tetrahydrofuran.

Patentansprüche

1. Verfahren zum Behandeln von Holz, das Folgendes umfasst:

   Bereitstellen (40) einer Mischung (26), die ein mineralisches Bindemittel und eine Trägerflüssigkeit (18) umfasst, wobei das mineralische Bindemittel aus festen Partikeln von Substanzen besteht, die chemisch mit Wasser reagieren, wodurch mineralische Hydrate gebildet werden;
   Druckimprägnieren (42) eines Holzstücks (30) mit der Mischung (26); und
   Aktivieren einer Hydration des mineralischen Bindemittels;
   dadurch gekennzeichnet, dass
   das mineralische Bindemittel Zement (14) ist; und
   die mineralischen Hydrate Kalziumsilikathydrate umfassen.

2. Verfahren zum Behandeln von Holz nach Anspruch 1, wobei die Trägerflüssigkeit (18) eine nichtwässrige Trägerflüssigkeit ist und Aktivieren der Hydration des mineralischen Bindemittels Eintauchen des imprägnierten Holzstücks (30) in eine wässrige Flüssigkeit oder Wasser (32) umfasst.

3. Verfahren zum Behandeln von Holz nach Anspruch 2, das weiter Folgendes umfasst:

   Ersetzen einer Flüssigkeit, in die das imprägnierte Holzstück (30) eingetaucht wird, durch eine wässrige Flüssigkeit oder Wasser (32); oder
   Entfernen der nichtwässrigen Trägerflüssigkeit (18) aus der Flüssigkeit, in die das imprägnierte Holzstück (30) eingetaucht wird.

4. Verfahren zum Behandeln von Holz nach einem der Ansprüche 1 bis 3, wobei Bereitstellen der Mischung (26) Zugeben von mineralischen Bindemittelpartikeln mit einer mittleren Partikelgröße von weniger als 100 µm und vorzugsweise von weniger als 50 µm zu der Trägerflüssigkeit (18) und Rühren der Mischung (26) umfasst.

5. Verfahren zum Behandeln von Holz nach einem der Ansprüche 1 bis 4, wobei die Trägerflüssigkeit (18) Alkohol und/oder Äther umfasst.

6. Verfahren nach Anspruch 5, wobei der Alkohol ein Glykol ist, ausgewählt aus der Gruppe bestehend aus Monoethylenglykol, Diethylenglykol, Triethylenglykol, oligomerem Ethylenglykol und Polyethylenglykol.

7. Verfahren zum Behandeln von Holz nach einem der Ansprüche 1 bis 4, wobei die Trägerflüssigkeit (18) ein Alkoxylat umfasst, ausgewählt aus der Gruppe bestehend aus einem Ethoxylat, einem Propoxylat und einem Butoxylat.

8. Verfahren zum Behandeln von Holz nach einem der Ansprüche 1 bis 4, wobei die Trägerflüssigkeit (18) einen Acrylsäureester oder einen Methacrylsäureester einer Zerewitinoff-aktiven Verbindung umfasst.

9. Verfahren zum Behandeln von Holz nach einem der Ansprüche 1 bis 4, wobei die Trägerflüssigkeit (18) ein Oligo-Tetrahydrofuran oder Poly-Tetrahydrofuran umfasst.

Revendications

1. Procédé de traitement du bois, comprenant :

   la fourniture (40) d'un mélange (26) comprenant un liant minéral et un liquide porteur (18), le liant minéral étant composé de particules solides de substances qui réagissent chimiquement avec de l'eau, ce qui permet de former des hydrates minéraux ;
   l'imprégnation sous pression (42) d'un morceau (30) de bois avec le mélange (26) ; et
   l'activation de l'hydratation du liant minéral ;
   caractérisé en ce que
   le liant minéral est du ciment (14) ; et
   les hydrates minéraux comprennent des hydrates de silicate de calcium.

2. Procédé de traitement du bois selon la revendication 1, dans lequel le liquide porteur (18) est un liquide porteur non aqueux et l'activation de l'hydratation du liant minéral comprend l'immersion de la pièce de bois imprégnée (30) dans un liquide aqueux ou de l'eau (32).

3. Procédé de traitement du bois selon la revendication 2, comprenant en outre :

   le remplacement d'un liquide dans lequel est immergée la pièce de bois imprégnée (30), par un liquide aqueux ou de l'eau (32) ; ou
   l'élimination du liquide porteur non aqueux (18) du liquide dans lequel est immergée la pièce de bois imprégnée (30).

4. Procédé de traitement du bois selon l'une quelconque des revendications 1 à 3, dans lequel la fourniture du mélange (26) comprend l'ajout de particules de liant minéral ayant une taille de particule moyenne inférieure à 100 μm et, de préférence, inférieure à 50 μm au liquide porteur (18) et l'agitation du mélange (26).

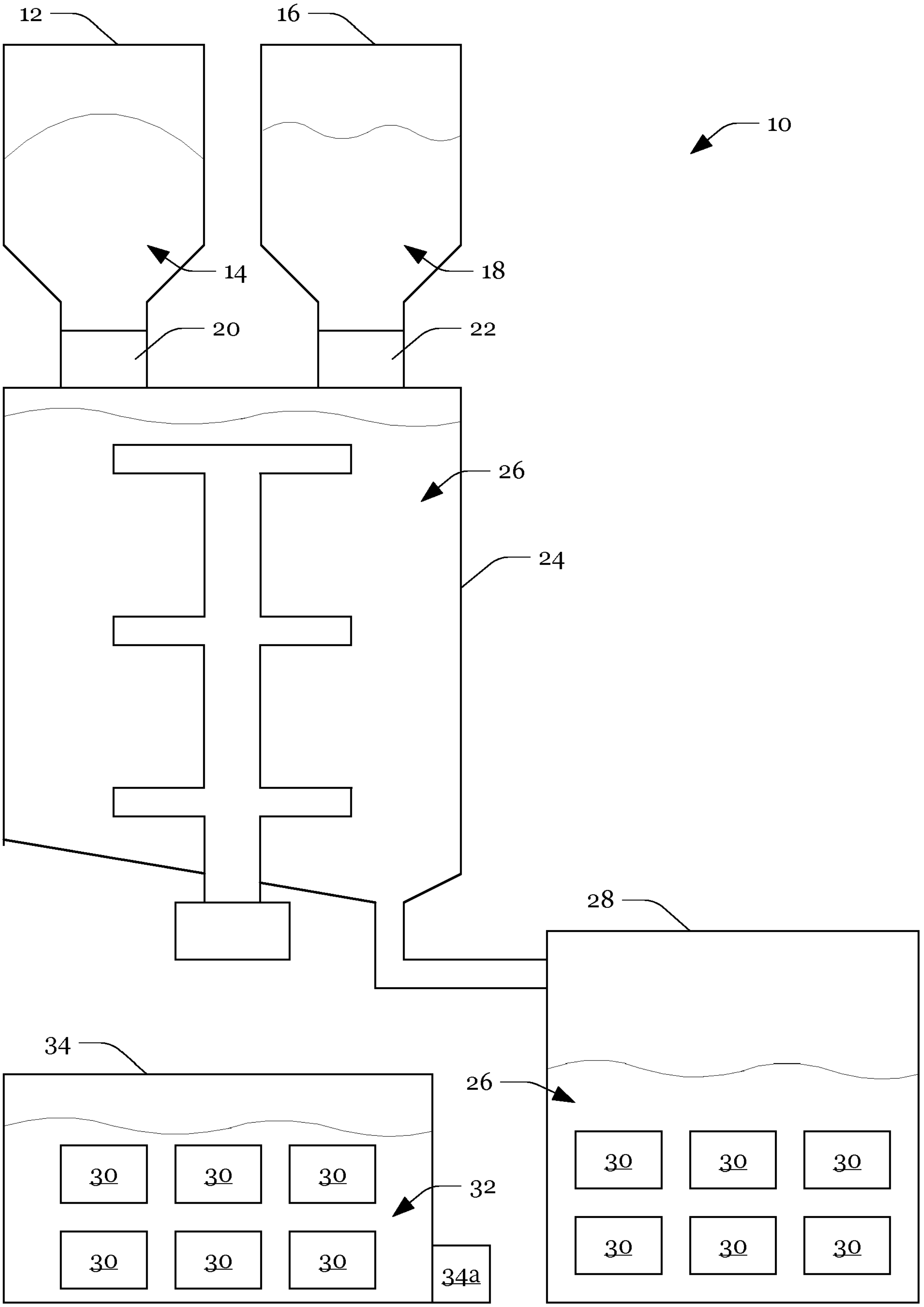
5. Procédé de traitement du bois selon l'une quelconque des revendications 1 à 4, dans lequel le liquide porteur (18) comprend de l'alcool et/ou de l'éther.

6. Procédé selon la revendication 5, dans lequel l'alcool est un glycol choisi dans le groupe consistant en le mono-éthylène glycol, le diéthylène glycol, le triéthylène glycol, l'oligomère d'éthylène glycol et le polyéthylène glycol.

7. Procédé de traitement du bois selon l'une quelconque des revendications 1 à 4, dans lequel le liquide porteur (18) comprend
   un alcoxylate choisi dans le groupe consistant en un éthoxylate, un propoxylate et un butoxylate.

8. Procédé de traitement du bois selon l'une quelconque des revendications 1 à 4, dans lequel le liquide porteur (18) comprend un ester acrylique ou un ester d'acide méthacrylique d'un composé actif Zerewitinoff.

9. Procédé de traitement du bois selon l'une quelconque des revendications 1 à 4, dans lequel le liquide porteur (18) comprend un oligo-tétrahydrofurane ou un poly-tétrahydrofurane.


12
16
10
14
18
20
22
26
24
28
34
26
30
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30
30
30
30
32
30
30
30
30
30
30
34a

Fig. 1

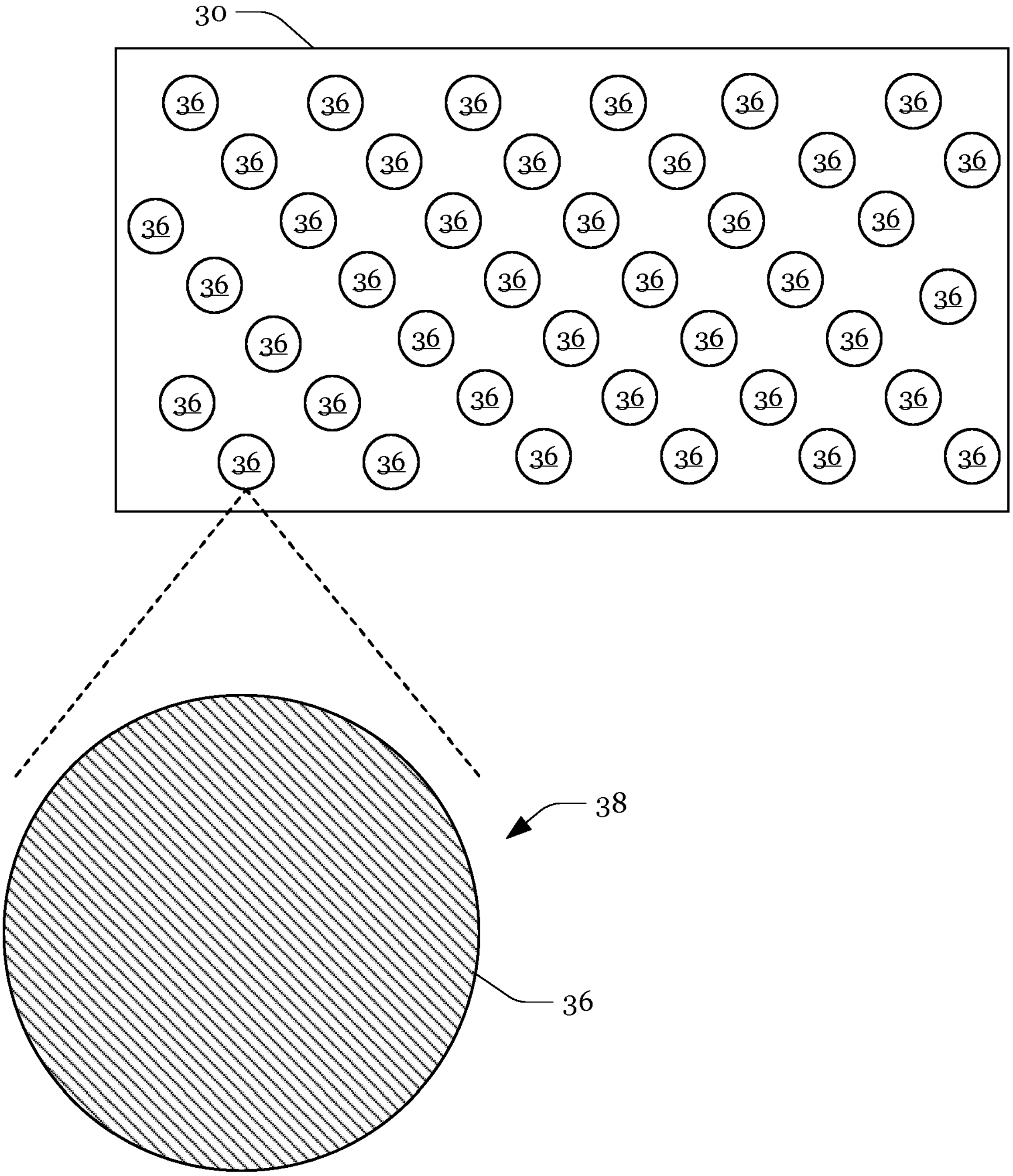

Fig. 2

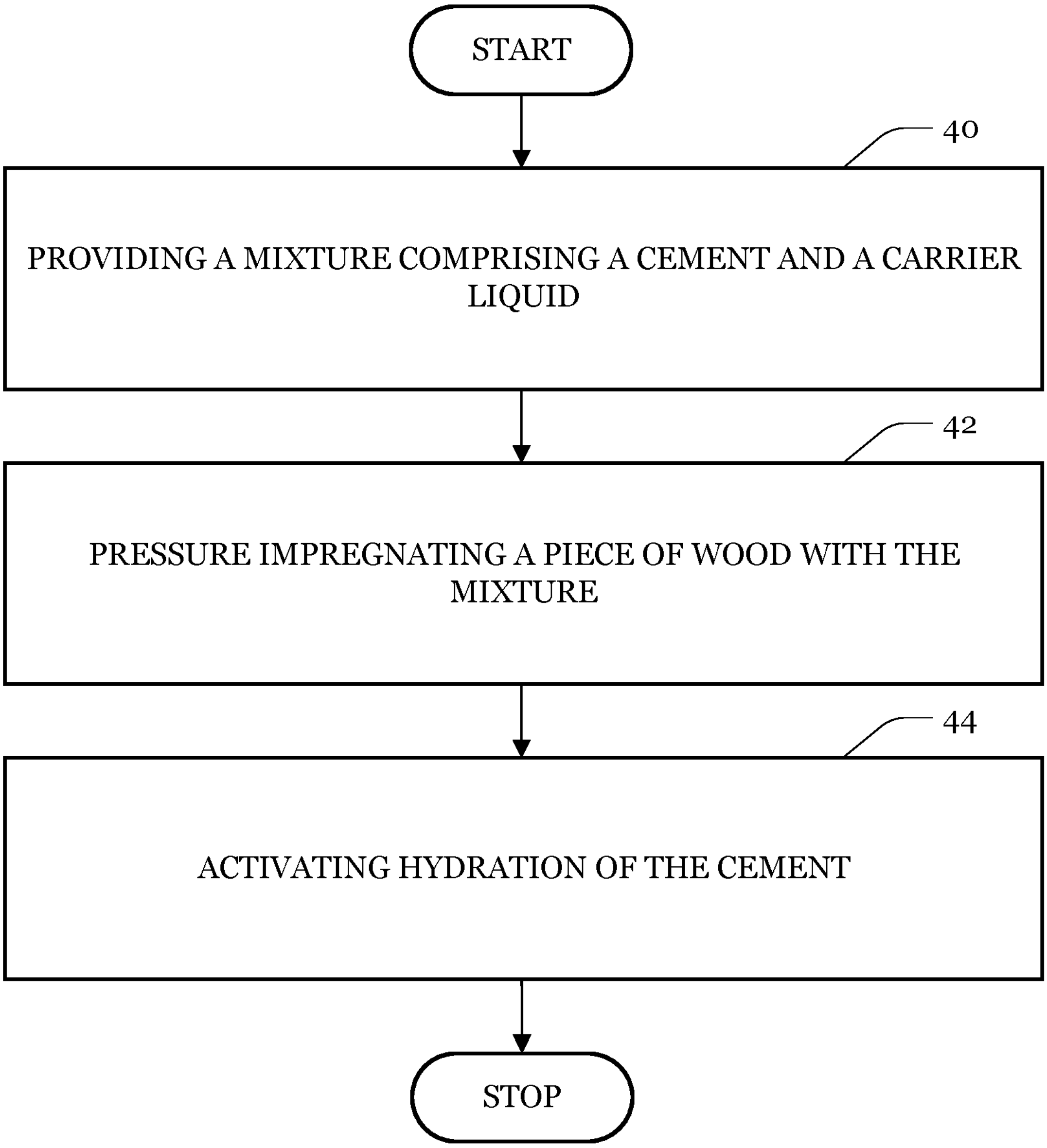
START
40
PROVIDING A MIXTURE COMPRISING A CEMENT AND A CARRIER LIQUID
42
PRESSURE IMPREGNATING A PIECE OF WOOD WITH THE MIXTURE
44
ACTIVATING HYDRATION OF THE CEMENT
STOP

Fig. 3

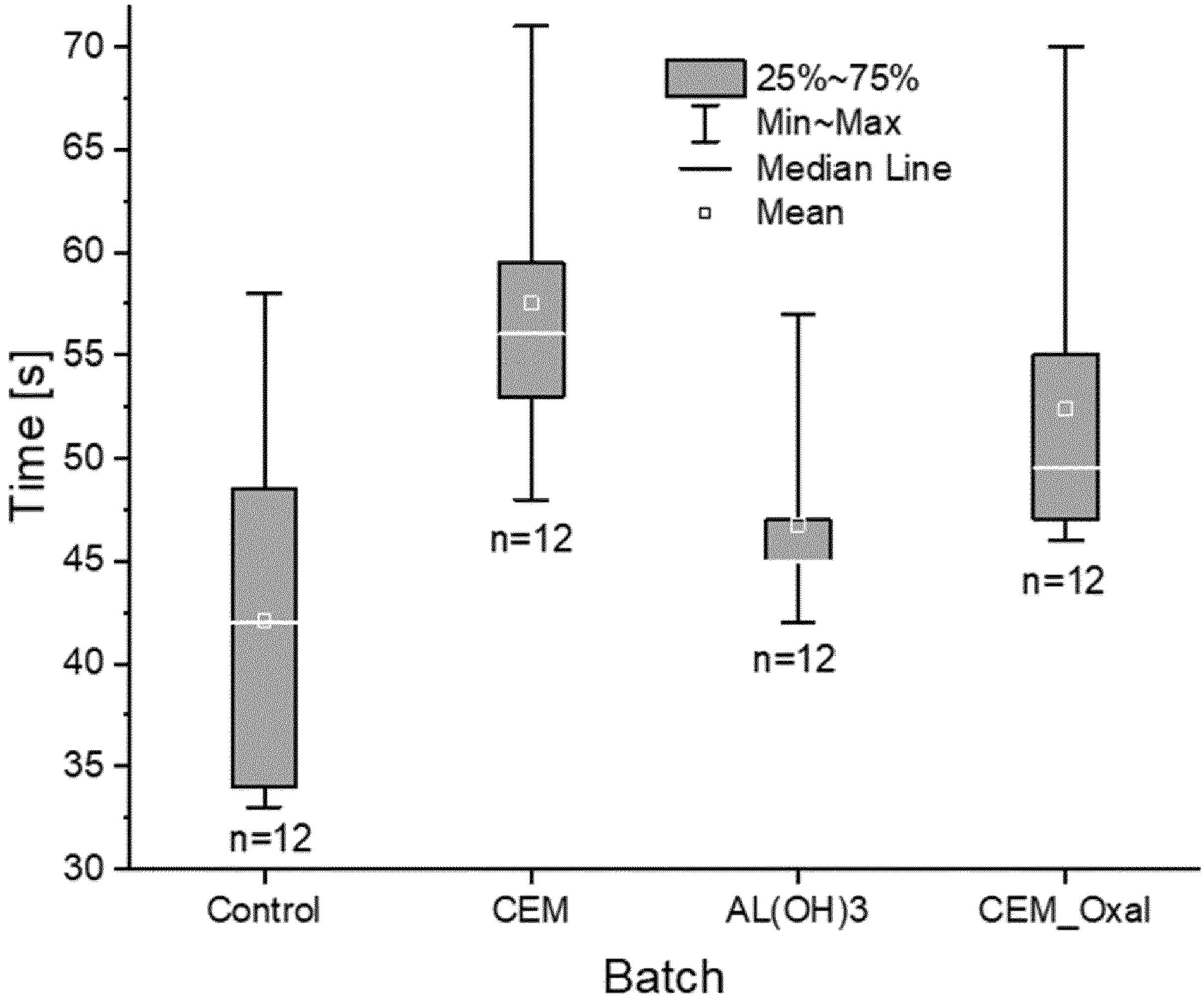
Time [s]
70
65
60
55
50
45
40
35
30
25%~75%
Min~Max
Median Line
Mean
n=12
n=12
n=12
n=12
Control
CEM
AL(OH)3
CEM_Oxal
Batch

Fig. 4

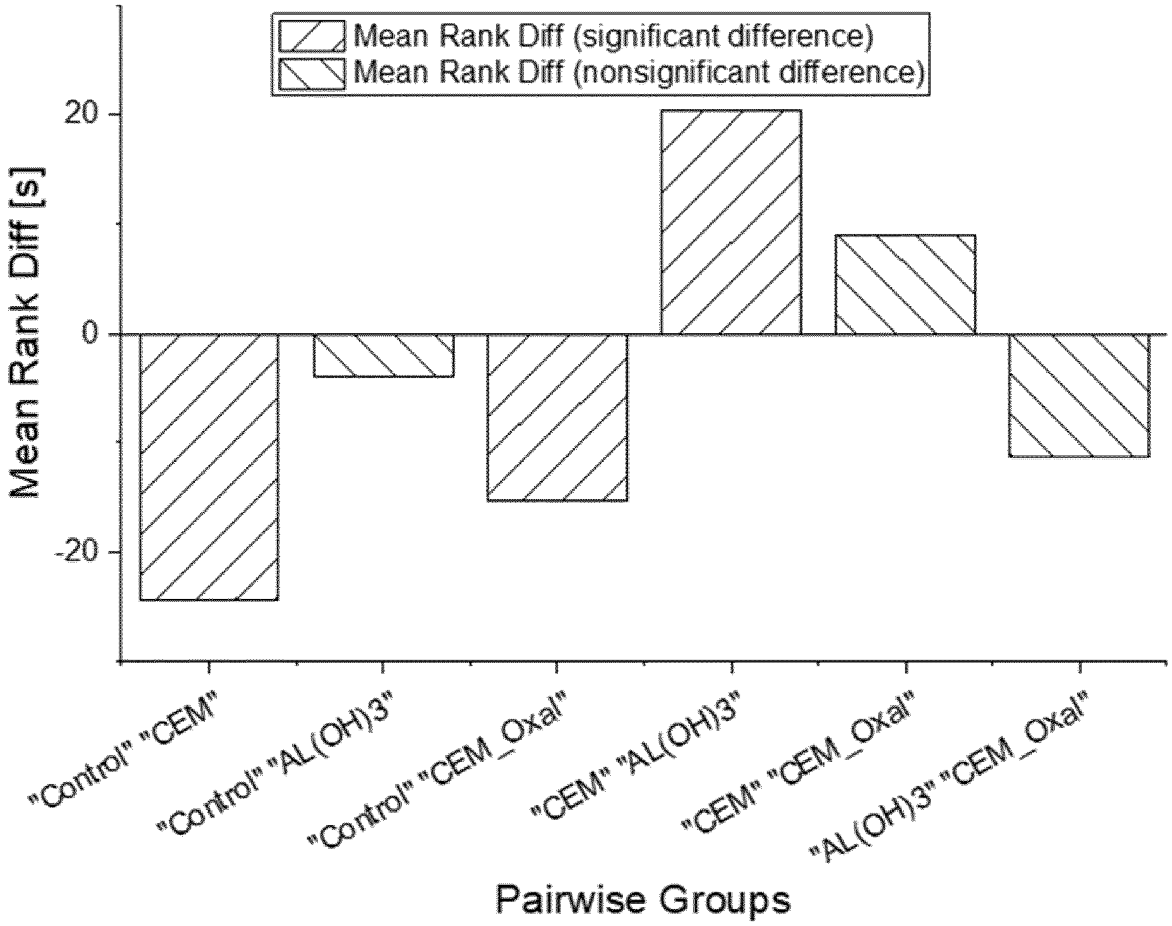
Mean Rank Diff (significant difference)
Mean Rank Diff (nonsignificant difference)
Mean Rank Diff [s]
20
0
-20
"Control" "CEM"
"Control" "AL(OH)3"
"Control" "CEM_Oxal"
"CEM" "AL(OH)3"
"CEM" "CEM_Oxal"
"AL(OH)3" "CEM_Oxal"
Pairwise Groups

Fig. 5

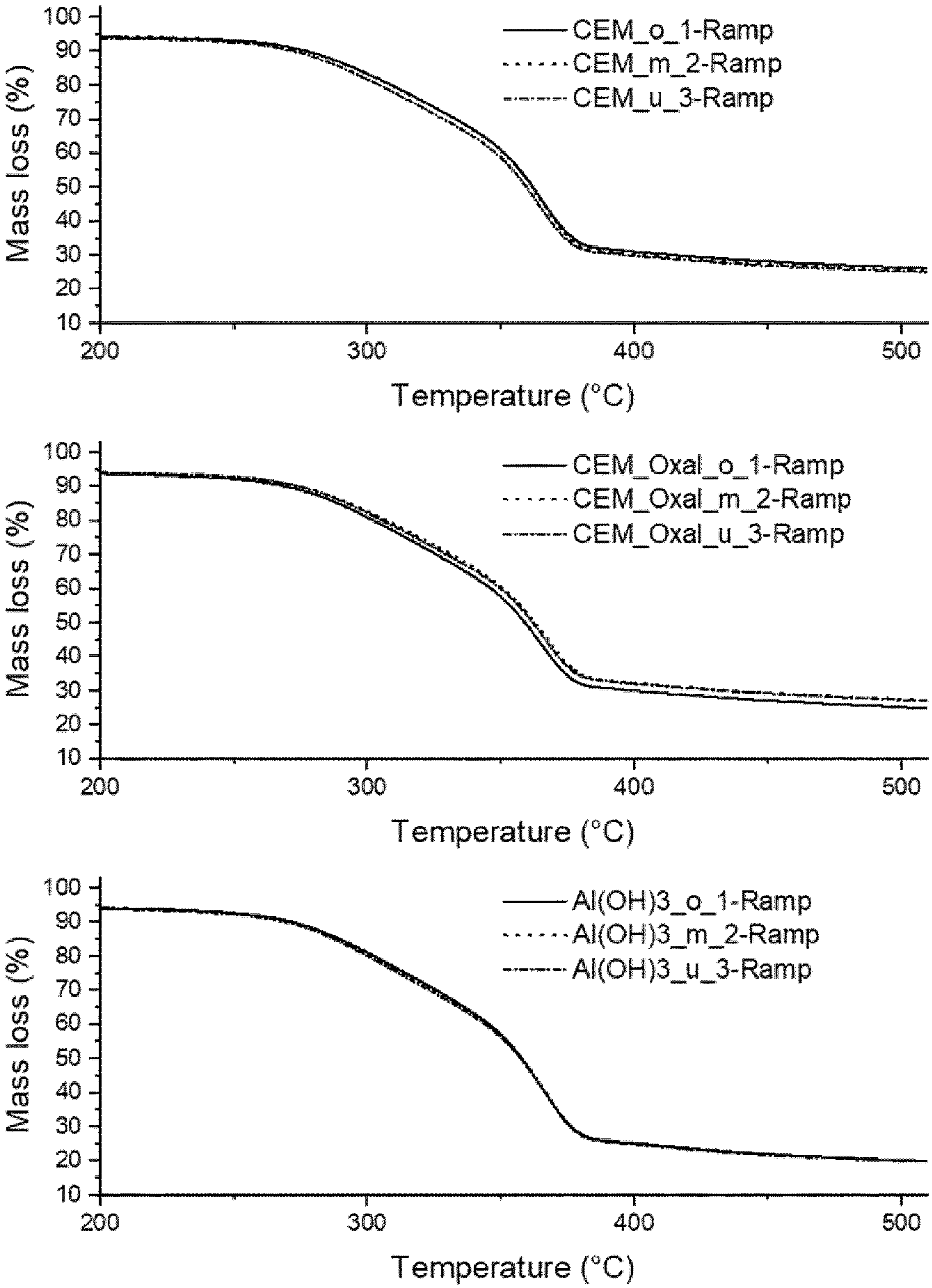
Mass loss (%)
100
90
80
70
60
50
40
30
20
10
200
300
400
500
Temperature (°C)
CEM_o_1-Ramp
CEM_m_2-Ramp
CEM_u_3-Ramp
CEM_Oxal_o_1-Ramp
CEM_Oxal_m_2-Ramp
CEM_Oxal_u_3-Ramp
Al(OH)3_o_1-Ramp
Al(OH)3_m_2-Ramp
Al(OH)3_u_3-Ramp

Fig. 6

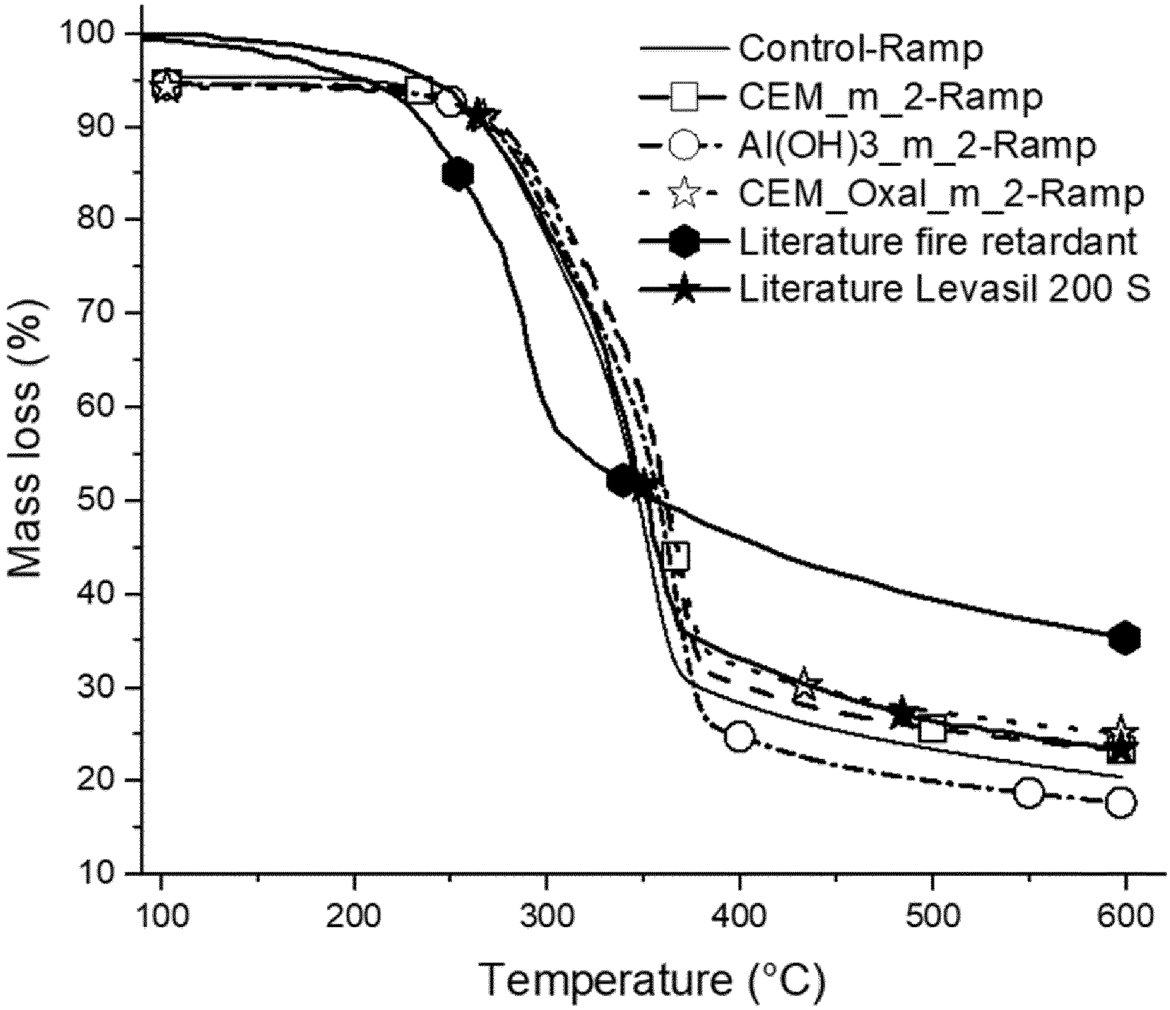
Control-Ramp
CEM_m_2-Ramp
Al(OH)3_m_2-Ramp
CEM_Oxal_m_2-Ramp
Literature fire retardant
Literature Levasil 200 S
Mass loss (%)
100
90
80
70
60
50
40
30
20
10
100
200
300
400
500
600
Temperature (°C)

Fig. 7

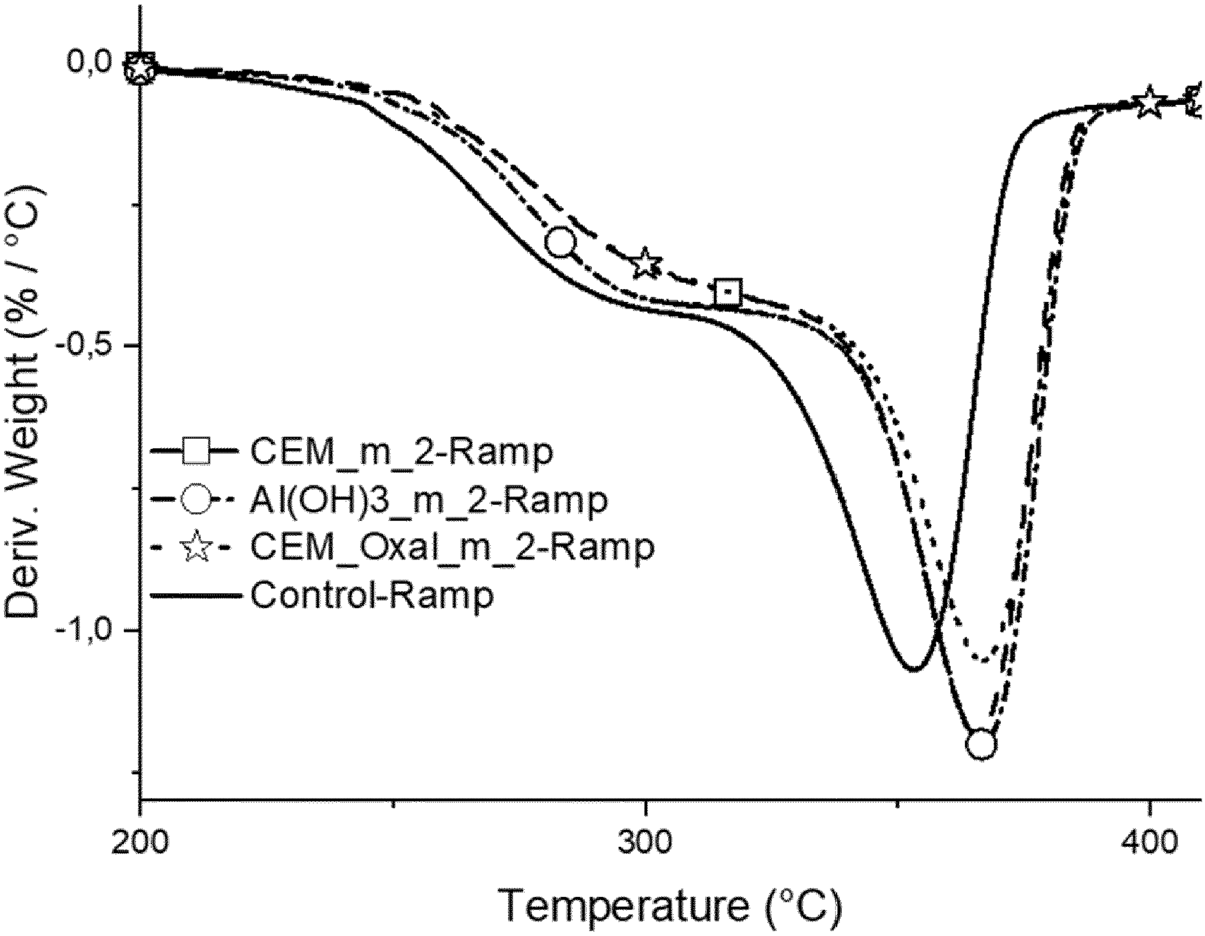
0,0
-0,5
-1,0
Deriv. Weight (% / °C)
200
300
400
Temperature (°C)
CEM_m_2-Ramp
Al(OH)3_m_2-Ramp
CEM_Oxal_m_2-Ramp
Control-Ramp

Fig. 8

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- EP 2937193 A1 **[0003]**
- JP 6368939 B **[0004]**
- CN 111002413 A **[0004]**
- DD 231028 A1 **[0004]**