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(54) Benævnelse: **FORBEDREDE BINDEMIDDELSAMMENSÆTNINGER OG ANVENDELSER DERAF**

(56) Fremdragne publikationer:
EP-A1- 2 223 941
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WO-A1-2012/152731
WO-A1-2013/030390
WO-A1-2016/009062

DESCRIPTION

[0001] The present invention relates to new improved binder compositions, more specifically curable binder compositions for use in manufacturing products from a collection of non or loosely assembled matter. For example, these binder compositions may be employed to fabricate fiber products which may be made from woven or nonwoven fibers. In one illustrative embodiment, the binder compositions are used to bind glass fibers to make fiberglass. In another illustrative embodiment, the binder compositions are used to bind mineral wool fibers, such as glass wool or stone wool in a matted layer, such as an insulating product. In a further embodiment, the binders are used to fabricate, for example, wood fiber board, particle board or oriented strand board (OSB), which has desirable physical properties (e.g., mechanical strength). Further, the binders may be used to assemble sheets of cellulosic material, such as sheets of wood to manufacture plywood. The invention further extends to a process for using said binder compositions to bound loosely assembled matter, and to a composite product made from loosely assembled matter bound by a binder of the invention.

[0002] Several formaldehyde-free binder compositions have been developed in recent times. One such curable binder composition involves sustainable materials and is based on condensation products of a nitrogenous compound, such as ammonium salt of inorganic acids or of polycarboxylic acids or an amine, preferably a polyamine, with reducing sugars as thermosets. These chemistries show several advantages as compared to prior formaldehyde based chemistries.

[0003] WO2013/030390 discloses an aqueous binder composition comprising a carbohydrate component (a) and an amine component (b), wherein the carbohydrate component (a) comprises one or more pentoses in a total amount of 3 to 70 mass%, based on the mass of total carbohydrate. It then also discloses a method of producing such binder composition and a method of use of such binder composition in the manufacturing of a product.

[0004] WO2016/009062 discloses aqueous curable binder compositions comprising a carbohydrate component and a nitrogen containing component and a matric polymer, wherein the nitrogen containing component is an ammonium salt of an inorganic acid. There is further disclosed the use of cellulose hydrolysate sugars as sugar component in said curable binder composition, in order to improve dry and/or wet strength of an assembly of matter comprising mineral fibers, synthetic or natural fibers, cellulosic particles or sheet material, bonded together by said curable binder composition and/or reaction product resulting from the condensation and/or curing of the carbohydrate component and inorganic ammonia salt of said curable binder composition.

[0005] WO2012/152731 relates to liquid, curable, thermosetting, aqueous formaldehyde-free, binder compositions comprising a primary or secondary polyetheramine and a carbohydrate. The documents points to different suitable polyetheramines. The carbohydrate may be a hydrolysate of sugars, starches, cellulose, or lignocellulosic material. The carbohydrate may comprise a monosaccharide or a disaccharide or a combination thereof. There is further described a process for fabricating a collection of matter bonded by the said binder composition.

[0006] The present invention seeks to provide an improved curable binder composition suitable for bonding an assembly of matter, including mineral fibers, synthetic fibers and natural fibers, particulate matter such as sand or natural or synthetic particulate material, cellulosic particle or sheet material, showing improved mechanical properties. An objective is to provide an improved binder composition based on renewable and/or sustainable resources. Further, the invention seeks to provide binder compositions that rapidly cure into strong binders.

[0007] According to another aspect, the present invention seeks to provide a composite product comprising an assembly of matter bonded by a binder resulting from the curing of above-mentioned binder composition.

[0008] According to yet another aspect, the present invention seeks to provide a process for the preparation of a composite product as defined here above. The process should be cost-effective and suitable for large volume production.

[0009] The present invention now provides a curable binder composition, a product and a process for making same, as per the attached claims.

[0010] It has now been found that curable binder compositions comprising cellulose hydrolysate sugars and a salt of an inorganic acid with ammonia shows particularly good mechanical properties upon curing and is particularly suitable for bonding an assembly of matter as mentioned above. Upon curing, such binder composition produces a highly cross-linked resin which confers improved bond strength to the assembly of matter in accordance with the invention These polymers may be analysed by techniques generally known in the art, including determination of molecular weight, and other known techniques.

[0011] The composite product of the invention comprises an assembly of matter comprising mineral fibers, synthetic fibers or natural fibers, cellulosic fibers, cellulosic particles or sheet material, natural or synthetic particulate material, bonded together by a binder obtained by subjecting to curing conditions a curable binder composition as above described. The said binder composition may also comprise some reaction product resulting from the cross-linking between the saccharides of the cellulose hydrolysate and the inorganic ammonium salt crosslinker.

[0012] The invention composite product may be prepared by applying invention binder composition on fibrous or particulate matter and subjecting the obtained product to curing conditions.

[0013] It has been found that when an aqueous curable binder composition as defined above is applied on a glass fiber veil, it shows high bond strength upon curing, particularly after weathering. The loss of bond strength after weathering is significantly reduced as compared to prior art thermoset binders.

[0014] Without being bound by theory, it is believed that the combination of mono and oligosaccharides as obtained after cellulose hydrolysis together with an inorganic ammonium salt is particularly suited as a curable binder composition which confers to a composite product containing it, high or even improved dry bond strength and significantly improved wet bond strength, upon curing.

[0015] The binder compositions of the invention and binders produced therefrom are essentially formaldehyde-free (that is comprising less than about 1 ppm formaldehyde based on the weight of the composition) and do not liberate substantial formaldehyde.

[0016] The invention compositions may obviously further comprise coupling agents, dyes, antifungal agents, antibacterial agents, hydrophobes and other additives known in the art for such binder applications, as may be appropriate. Silicon-containing coupling agents are typically present in such binders, generally in the range from about 0.1 to about 1 % by weight based on the weight of the solids in the binder composition. These additives are obviously selected such as not to antagonise the adhesive properties of the binder nor the mechanical and other desired properties of the final product comprising such binder composition or binder produced therefrom, and advantageously comply with stringent environmental and health related requirements.

[0017] According to the present invention, the term "binder composition" is not particularly restricted and generally includes any composition which is capable of binding loosely assembled matter, either as such or upon curing. The binder composition is preferably an aqueous non-cured composition comprising the starting materials for forming a thermoset binder resin and possibly reaction product resulting from the reaction or partial reaction of at least part of the relevant starting materials, and possibly additives. The binder composition may, however, also be solid, the condensation occurring under the effect of heat. Solid binder compositions may be preferred in some particular applications in which water is difficult to evaporate in the course of the curing process; or in applications in which the presence of water may have a deleterious effect on the particles or fibers to be bonded.

[0018] As used herein, the term "aqueous" is not particularly limited and generally relates to a solution and/or dispersion which is based on water as a solvent. Said term further includes compositions or mixtures which contain water and one or more additional solvents. An "aqueous binder composition" of the invention may be a solution or partial solution of one or more of said binder components or may be a dispersion, such as an emulsion or suspension.

[0019] The term "binder composition" as used herein means all ingredients applied to the matter to be bound and/or present on the matter to be bound, notably prior to curing, (other than the matter and any moisture contained within the matter) including cellulose hydrolysate sugars, any inorganic ammonium salt crosslinker and any additives, and possibly solvents (including water).

[0020] The term "binder" is used herein to designate a thermoset binder resin obtained from the "binder composition".

[0021] The term "cured" means that the components of the binder composition have been subjected to conditions that lead to chemical change, such as covalent bonding, hydrogen bonding and chemical crosslinking, which may increase the cured product's durability and solvent resistance, and result in thermoset material.

[0022] The term "dry weight of the binder composition" as used herein means the weight of all components of the binder composition other than any water that is present (whether in the form of liquid water or in the form of water of crystallization).

[0023] The term "crosslinker" as used herein comprises compounds that are capable of reacting with the carbohydrate components of the cellulose hydrolysate to form ramifications or reticulations of the said carbohydrate components.

[0024] The terms "inorganic ammonium salt" as used herein means salts of inorganic acid with ammonia. Examples are ammonium sulphate and ammonium phosphate, more specifically diammonium phosphate.

[0025] The term "cellulose hydrolysate sugars" as used herein means the carbohydrate composition obtainable by hydrolysis of cellulosic material. Cellulosic material contains cellulose and hemicellulose. Cellulose is a linear polysaccharide composed of 6-carbon saccharide units that constitutes the chief part of the cell walls of plants, occurs naturally in such fibrous products as cotton and kapok, and is the raw material of many manufactured goods (e.g. paper). Hemicellulose is a polysaccharide composed of 5-carbon saccharide units and is present along with cellulose in plant cell walls. While cellulose is strong and resistant to hydrolysis, hemicellulose is much less stable and easier to hydrolysate. It is understood that the hydrolysate sugar composition varies as a function of the feedstock, on the balance between cellulose and hemicellulose and of the hydrolysis process, including acid hydrolysis and enzymatic hydrolysis, and process conditions. Such hydrolysates comprise essentially reducing sugars. Thus the hydrolysate sugar composition comprises monosaccharides, dextrose and xylose, disaccharides, and polysaccharides. The concentration of each of these components in the composition may depend on the feedstock used for hydrolysis purposes, the hydrolysis process and the process conditions. Examples of carbohydrates present are glucose, fructose, sucrose, arabinose, galactose, mannose, xylose, arabinan, galactan, glucan, mannan and xylan.

[0026] Advantageously, the cellulose feedstock for hydrolysis may be selected from sugar cane bagasse, cotton fibers, plant material, wood, paper waste, or mixtures thereof. Among other sources, non-recyclable household waste may be used as a source of cellulosic material.

The saccharide composition of the hydrolysate will obviously depend on the nature of the source or waste used and the hydrolysis process and process conditions applied. The cellulose hydrolysis sugars may make up 10 to 100 wt % of the carbohydrate component of the invention binder composition (based on dry weight), preferably 50 to 100 wt %, or 60 to 100 wt %, more preferably 70 to 100 wt %, or 80 to 100 wt %, most preferred between 90 and 100 wt % or even between 95 and 100 wt %.

[0027] The carbohydrate component of the invention binder composition may comprise 1 to 95 wt % glucose and 0.5 to 15 wt % xylose, preferably 1 to 10 wt% xylose, the remainder being fructose, mannose, galactose and/or polysaccharide fraction, such as glucan and/or xylan for instance. Other polysaccharides that may be present are arabinan, galactan, and/or mannan. In said carbohydrate component, the polysaccharide content may vary between 1 and 90 wt%, preferably between 3 and 20 wt% or between 3 and 15 wt% or between 3 and 10 wt%. It will be understood that, depending on feedstock and processing, the polysaccharide fraction is a blend of polysaccharides of different polymerization degrees, varying from 2 to 20, preferably 2 to 15, with an average polymerization degree comprised between 3 and 7, preferably between 3 and 5; which means that polysaccharides of lower polymerization degree show the higher concentrations.

[0028] Preferably, the carbohydrate component comprises 1 to 90 wt glucose and/or glucan, 0.5 to 15 wt % xylose, preferably 1 to 10 wt% xylose, the remainder being fructose, mannose, galactose, glucan, xylan, arabinan, galactan and/or mannan.

[0029] The solid content of the invention aqueous binder composition may range from 5 to 95 w%, advantageously from 8 to 90 w%, preferably from 10 to 85 w%, based on the weight of the total aqueous binder composition. More specifically, when used as a binder for mineral wool insulation, the solid content of the aqueous binder composition may be in the range from 5 to 25 w%, preferably from 8 to 20 w%, more preferably from 10 to 20 w% or even 12 to 18 w%, based on the weight of the total aqueous binder composition. When used as a binder in wood boards, such as plywood, particle boards, fiber boards, the solid content of the aqueous binder composition may range from 50 to 95 w%, preferably 50 to 90 w%, more preferably 55 to 85 w% or even 60 to 80 w%, based upon the weight of the total aqueous binder composition.

[0030] The components of the invention binder compositions may be transported separately and combined shortly before use in the relevant manufacturing plant. It is also possible to transport the binder composition as such, possibly in a prereacted stage.

[0031] The binders of the invention may be used to bond a collection of non or loosely assembled matter. The collection of matter includes any collection of matter which comprises fibers selected from mineral fibers, including but not limited to slag wool fibers, stone wool fibers, glass fibers, aramid fibers, ceramic fibers, metal fibers, carbon fibers, polyimide fibers, polyester fibers, rayon fibers, and cellulosic fibers. Further examples of collection of matter include particulates such as sand, coal, cellulosic particles, wood shavings, saw dust, wood pulp, ground wood, wood chips, wood strands, wood layers; other natural fibers, such as jute, flax, hemp, straw, wood veneers, facings and other particulate materials, woven or non-woven fiber materials. According to a specific embodiment of the invention, the collection of matter is selected from wood particles and mineral fibers.

[0032] In one illustrative embodiment, the binder composition of the invention may be used to make insulation products, comprising mineral fibers. In such an application, the fibers are bonded together such that they become organized in a fiber mat which may then be processed into an insulation product, for instance based on glass wool or stone wool. In such an application, the fibers are generally present in an amount ranging from 70 to 99% by weight.

[0033] The invention binder composition may also be used to manufacture a non-woven fiber veil, e.g. glass fiber veil, which may then find application in battery separators, as substrate for roofing products such as roofing membranes or shingles, or other membranes.

[0034] According to another embodiment of the invention, the binder may be used to bond cellulosic particles, such as cellulosic fibers, wood shavings, wood layers or sheets, wood pulp and other materials commonly used to manufacture composite wood boards, including fiber boards, particle boards, oriented strand boards, plywood etc. Such wood boards show nominal thicknesses ranging from 6 to 30 mm and a modulus of Elasticity of at least about 1000 N/mm^2, bending strength of at least about 5 N/mm^2 and/or an internal bond strength of at least 0.10 N/mm^2. In such applications, the binder content in the final wood board may range from about 5 to 30 % wt with respect to the total weight of the wood board notably from 9 to 20%.

[0035] The binder of the invention may further be used to bond cellulosic fibers in a fiber mat used to make filters, such as oil filters.

[0036] According to the invention, the aqueous binder composition may be applied in a manner known per se onto the fiber or particulate or sheet material. The binder composition may preferably be applied by spray application. Other techniques include roll application or mixing and/or tumbling the collection of matter with the binder composition. As water evaporates the aqueous binder composition forms a gel that bonds the particulate material together when arranged into a desirable assembly as detailed further herein below. When curing, the reactive binder components are caused to react to form essentially water insoluble macromolecular binder resin. Curing thus imparts increased adhesion, durability and water resistance as compared to uncured binder. Curing may be effected at temperatures between ambient (from about 10 to 25 °C) and up to 280 °C.

[0037] The obtained product may then be further processed in suitable process steps to make intermediate or final products, including but not limited to insulation products or wood boards. More specifically, a process for the manufacturing of an assembly of fibers or cellulosic particles or sheets may comprise (i) the provision of (a) a cellulose hydrolysate, (ii) the provision of appropriate amounts of (b) an inorganic ammonium salt, (iii) the successive or simultaneous application of (a) and (b), possibly as an aqueous composition comprising (a) and (b) and possibly (a) cross-linked by (b), onto fibrous or cellulosic particulate or sheet material to produce resinated material, and (v) subjecting the resulting resinated material to curing conditions and allowing for evaporation of excess water.

[0038] Curing may be effected at a temperature ranging from 90 - 200 °C, preferably higher than 140 °C, more preferably lower than 190 °C, typically between 160 and 180 °C. In the manufacture of wood boards, curing is performed while the material is subjected to pressing.

[0039] The invention will be explained in more details in the examples below with reference to the attached Figures, in which:

Figure 1 shows tensile strength of invention sample 1 compared to standard glucose based binder compositions;

Figure 2 shows tensile strength data for invention samples 2, 3 and 4 compared to standard glucose based binder compositions;

Figure 3 shows tensile strength data for invention sample 5 compared to glucose based binder compositions; and.

Figure 4 shows tensile strength data for invention sample 12 compared to standard glucose based binder compositions

Example 1

[0040] An invention binder composition comprising cellulose hydrolysate and ammonium sulphate in a ratio of 85 parts total sugars for 15 parts ammonium sulphate was prepared. The cellulose hydrolysate has been obtained by enzymatic digestion of cellulosic material contained in household waste and shows the following composition (in parts by weight):

Sample	% Glucose	% Xylose	% Oligomers	Total
1	8	0.8	0.5	9.3
2	5.6	0.8	0.5	6.9
3	9.2	1.7	0.9	11.8
4	10.1	2.3	1.8	14.2
5	36.2	6.3	4.3	46.8
12	4.4	0.2	0.2	4.8

[0041] For comparison purposes, a binder composition comprising dextrose and ammonium sulphate in the same ratio was prepared.

[0042] Commercial Urea formaldehyde impregnated (A4 size) glass fiber veils were placed into a muffle furnace oven for 30 minutes at 600°C in order to burnout the PF binder, and were then allowed to cool for 30 minutes. The obtained veil samples were weighted.

[0043] Approx. 400 g binder solution (2% solids) samples were poured into dip trays, and the obtained veil samples carefully fully immersed into the relevant binder solutions. The impregnated veils were cured at 190°C for indicated periods of time varying from 0 to 600 seconds. Binder content was then measured and tensile strength determined as follows.

[0044] The tensile strength of the relevant cured binder impregnated veils was determined by means of mechanical testing instrument (M350-10CT). For each test a cured binder impregnated A4 veil was cut into 8 equal strips. Each strip was tested separately using a 50 Kg load cell (DBBMTCL-50 kg) at an automated test speed of 10 mm/min controlled by winTest Analysis software. Glass veil tensile plates were attached to the testometric machine in order to ensure a 100 mm gap between plates. Samples were placed vertically in the grippers; and the force was tarred to zero. Various parameters such as maximum load at peak, stress at peak and modulus at peak were evaluated by the software, and data presented as an average of 8 samples with standard deviation. The average maximum load at peak or stress at peak defined as the tensile strength.

[0045] The figures show development of strength as cure evolves. As can be seen in the figures for relevant samples, the cellulose hydrolysate based binder compositions confer similar or improved strength as compared to glucose based binders comprising the same amount of total sugar.

[0046] It has further been found that the dry bond strength is significantly improved for invention binder compositions as compared to standard glucose based binder compositions, both compositions having the same amount of total sugar.

REFERENCES CITED IN THE DESCRIPTION

Cited references

Patent documents cited in the description

- WO2013030390A [0003]
- WO2016009062A [0004]
- WO2012152731A [0005]

Patentkrav

1. Hærdbar bindemiddelsammensætning omfattende en kulhydratkomponent og et salt af en uorganisk syre med ammoniak, hvor kulhydratkomponenten består mindst delvist af cellulosehydrolysatsukre omfattende monosaccharider, inklusiv dextrose og xylose, disaccharider og polysaccharider.

2. Den hærdbare bindemiddelsammensætning ifølge krav 1, hvor cellulose-hydrolysatsukrene udgør 10 til 100 vægt-% af sukkerkomponenten.

3. Den hærdbare bindemiddelsammensætning ifølge krav 1 eller 2, hvor nævnte sammensætning er vandig og omfatter et faststofindhold på 5 til 95 vægt-%, fortrinsvis fra 8 til 90 vægt-%, mere fortrinsvis fra 10 til 85 vægt-%, baseret på vægten af den samlede vandige bindemiddelsammensætning, mere specifikt, i området fra 5 til 25 vægt-%, fortrinsvis fra 8 til 20 vægt-%, mere fortrinsvis fra 10 til 20 vægt-% eller endda 12 til 18 vægt-%, baseret på vægten af den samlede vandige bindemiddelsammensætning, eller i området fra 50 til 95 vægt-%, fortrinsvis 50 til 90 vægt-%, mere fortrinsvis 55 til 85 vægt-% eller endda 60 til 80 vægt-%, baseret på vægten af den samlede vandige bindemiddel-sammensætning.

4. Den hærdbare bindemiddelsammensætning ifølge et hvilket som helst af de foregående krav, hvor kulhydratkomponenten omfatter 1 til 95 vægt-% glucose og 0,5 til 15 vægt-% xylose, fortrinsvis 1 til 10 vægt-% xylose, hvor den restende del er fructose, mannose, galactose og/eller en polysaccharidfraktion.

5. Den hærdbare bindemiddelsammensætning ifølge krav 4, hvor polysaccharid-fraktionen omfatter arabinan, galactan og/eller mannan.

6. Den hærdbare bindemiddelsammensætning ifølge krav 5, hvor polysaccharid-indholdet varierer mellem 1 og 90 vægt-%, fortrinsvis mellem 3 og 20 vægt-% eller mellem 3 og 15 vægt-% eller mellem 3 og 10 vægt-%.

7. Den hærdbare bindemiddelsammensætning ifølge et hvilket som helst af kravene 4 til 6, hvor polysaccharidfraktionen er en blanding af polysaccharider med forskellige polymeriseringsgrader, som varierer fra 2 til 20, fortrinsvis 2 til 15, med en gennemsnitlig polymeriseringsgrad omfattet mellem 3 og 7, fortrinsvis mellem 3 og 5.

8. Den hærdbare bindemiddelsammensætning ifølge et hvilket som helst af de foregående krav yderligere omfattende koblingsmidler, farvestoffer, anti-svampemidler, anti-bakteriemidler, hydrofober og andre tilsætningsstoffer kendt inden for teknikken.

9. Den hærdbare bindemiddelsammensætning ifølge krav 8, hvor den omfatter et silicium-holdigt koblingsmiddel, fortrinsvis i området fra ca. 0,1 til ca. 1 vægt-% baseret på vægten af faststofferne i bindemiddelsammensætningen.

10. Materialeanordning omfattende mineralske fibre, syntetiske fibre eller naturlige fibre, celluloseholdig partikel eller plademateriale, forbundet med hinanden via en hærdbar bindemiddelsammensætning ifølge et hvilket som helst af kravene 1 til 9 og/eller reaktionsprodukt, som stammer fra kondenseringen af kulhydrat-komponenten og uorganisk ammoniaksalt af nævnte hærdbare bindemiddel-sammensætning ifølge et hvilket som helst af kravene 1 til 9, eller med et bindemiddel opnået ved at udsætte en vandig hærdbar bindemiddel-sammensætning ifølge et hvilket som helst af kravene 1 til 9 for hærdningsbetingelser.

11. Materialeanordning ifølge krav 10, hvilken er

a. et isoleringsprodukt, omfattende mineralske fibre i en mængde i området fra 70 til 99 vægt-%, for eksempel baseret på glasuld eller stenuld, klæbet sammen således at de bliver arrangeret i en fibermåtte, som skal bearbejders til et isoleringsprodukt, eller

b. et ikke-vævet fiberslør, f.eks. glasfiberslør, til anvendelse i batteriseparatorer, som substrat til tagbeklædningsprodukter såsom tagbeklædningsmembraner eller tagspåner, eller andre membraner, eller

c. forbundne partikler, såsom sandpartikler eller celluloseholdige partikler, såsom celluloseholdige fibre, træspåner, trælag eller -plader, træmasse og andre materialer, som sædvanligvis anvendes til fremstilling af komposit-træplader, inklusiv fibreplader, spånplader, OSB- (oriented strand board) plader eller krydsfiner, hvis bindemiddelindhold er i området fra ca. 5 til 30 vægt-% i forhold den samlede vægt af anordningen, især fra 9 til 20 vægt-%.

12. Fremgangsmåde til fremstilling af materialeanordningen ifølge et hvilket som helst af kravene 10 eller 11 omfattende (i) tilvejebringelsen af (a) en kulhydrat-komponent bestående mindst delvist af cellulosehydrolysatsukre, (ii) tilvejebringelsen af passende mængder af (b) et uorganisk ammoniumsalt, (iii) den successive eller samtidige påføring af (a) og (b), muligvis som en vandig sammensætning omfattende (a) og (b) og muligvis (a) tværbundet af (b), på partikelformet, fiberholdigt eller celluloseholdigt partikel- eller pladematerialе for at fremstille resin-belagt materiale, og (v) at udsætte det resulterende resin-belagte materiale for hærdningsbetingelser og muliggøre fordampning af overskydende vand.

13. Fremgangsmåden ifølge krav 12, hvor hærdning udføres ved en temperatur i området fra 90 - 200 °C, fortrinsvis højere end 140 °C, mere fortrinsvis lavere end 190 °C, typisk mellem 160 og 180 °C.

14. Anvendelse af cellulosehydrolysatsukre som sukkerkomponent i en hærdbar bindemiddelsammensætning omfattende en kulhydratkomponent og et salt af en uorganisk syre med ammoniak, for at forbedre tør- og/eller vådstyrke af en materialeanordning omfattende mineralske fibre, syntetiske eller naturlige fibre, celluloseholdige partikler eller pladematerialе, er forbundet med hinanden via nævnte hærdbare bindemiddelsammensætning og/eller reaktionsprodukt, som stammer fra kondenseringen og/eller hærdningen af kulhydratkomponenten og det uorganiske ammoniaksalt af nævnte hærdbare bindemiddelsammensætning, hvor cellulosehydrolysatsukrene omfatter monosaccharider, inklusiv dextrose og xylose, disaccharider og polysaccharider.

DRAWINGS

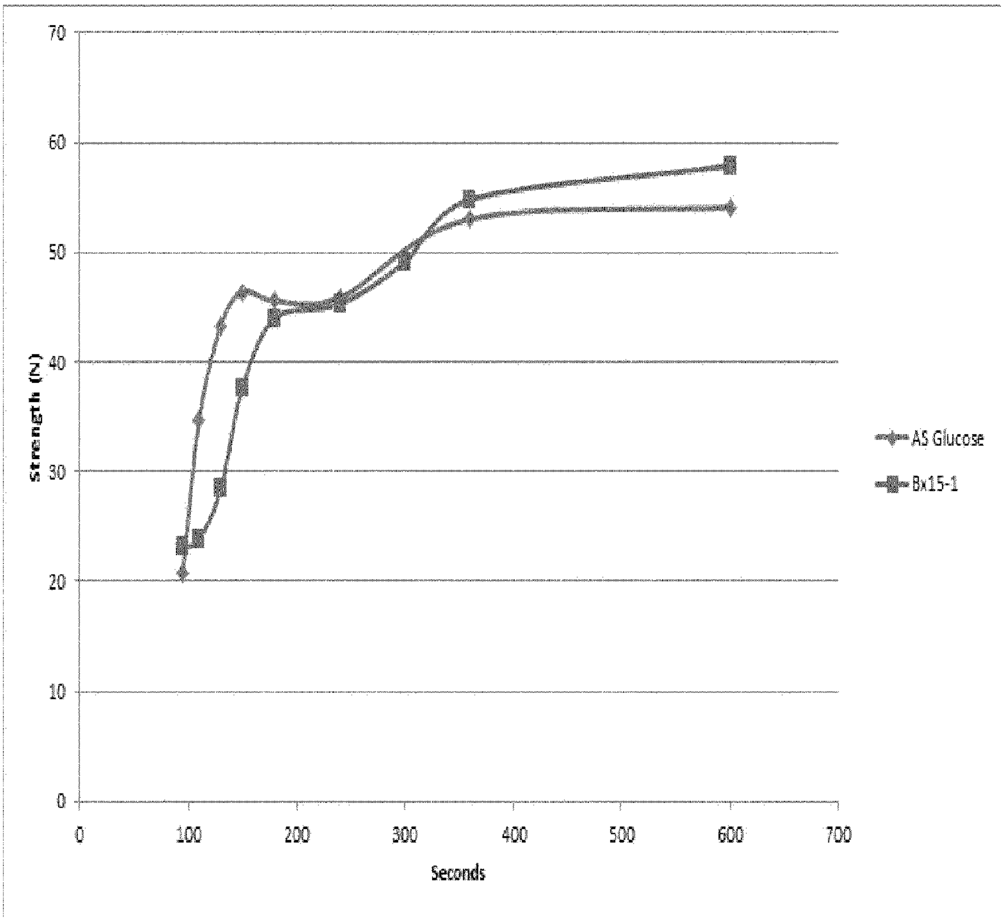
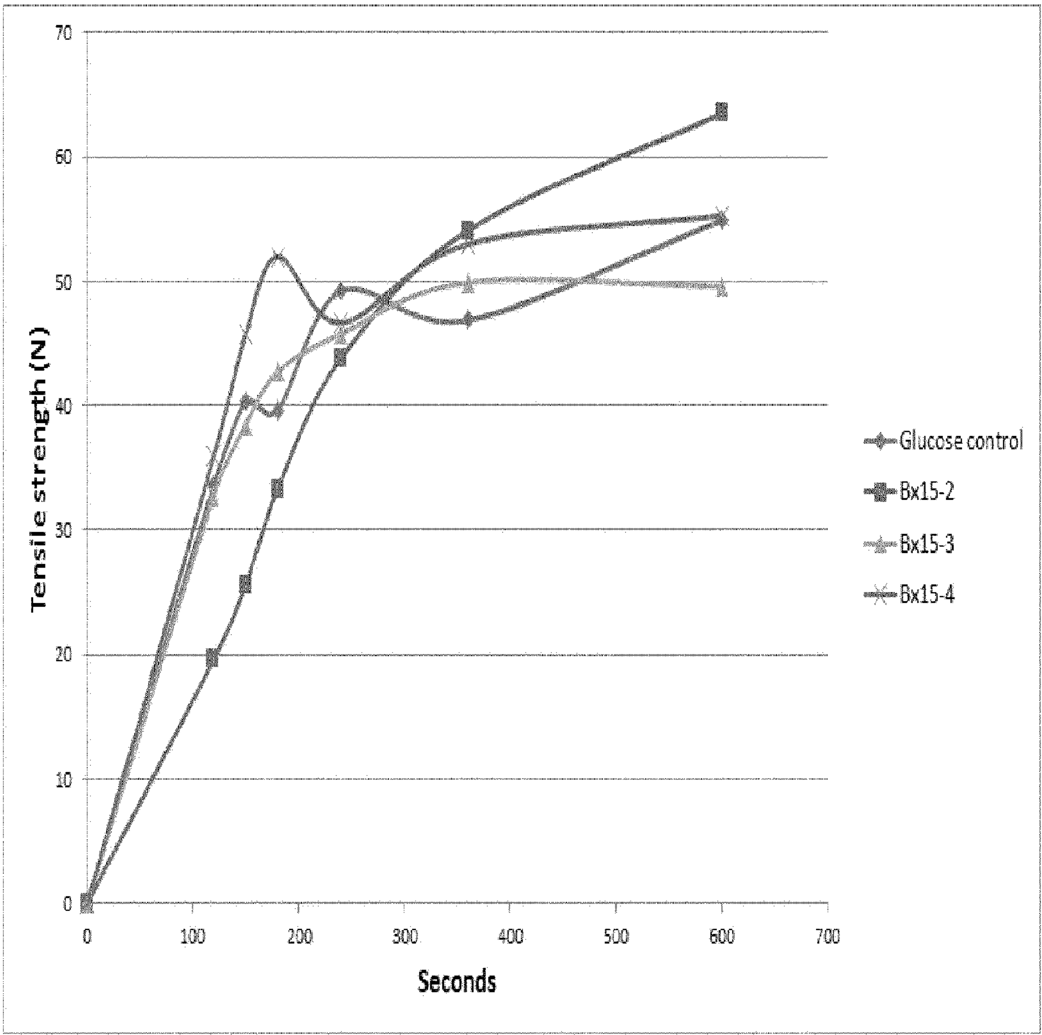


Fig. 1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Tensile strength (N)
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Seconds
Glucose control
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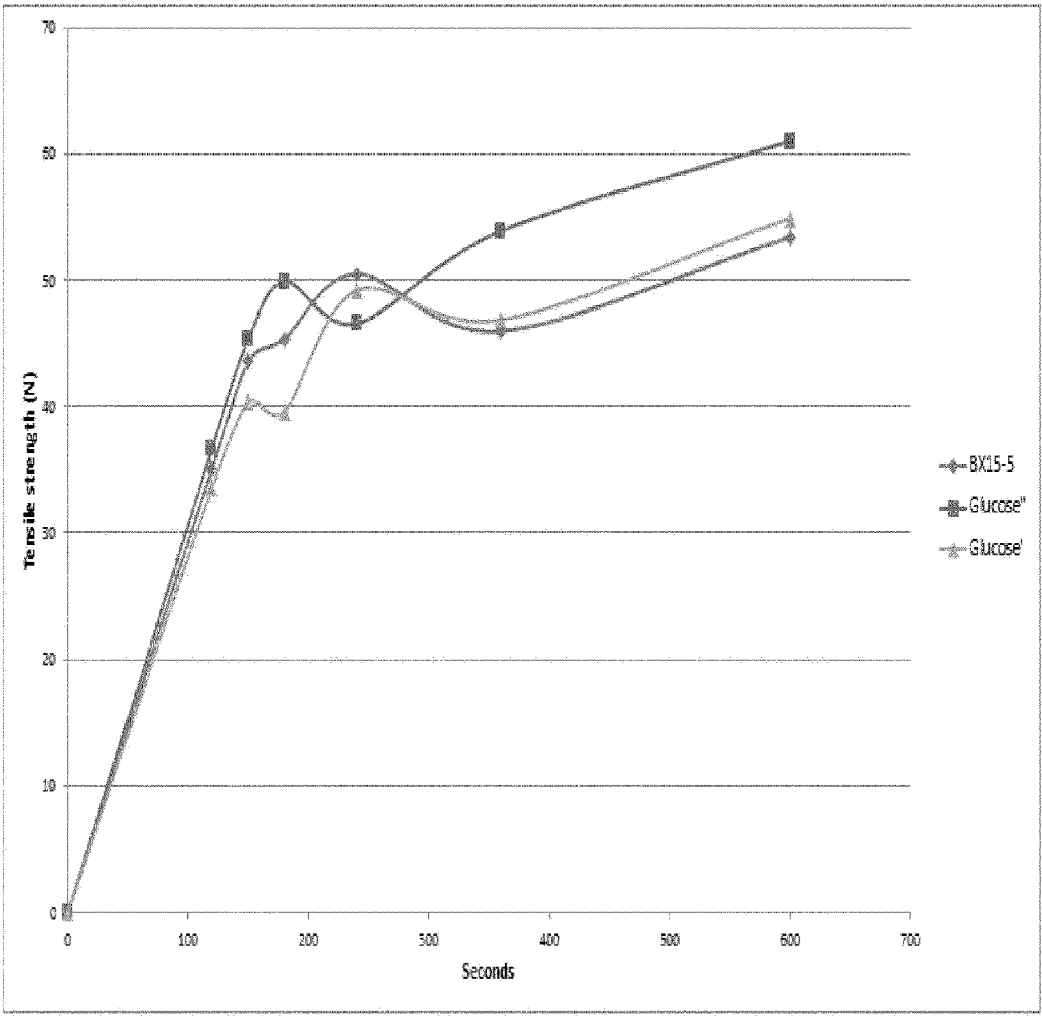
Bx15-3
Bx15-4

Fig. 2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Tensile strength (N)
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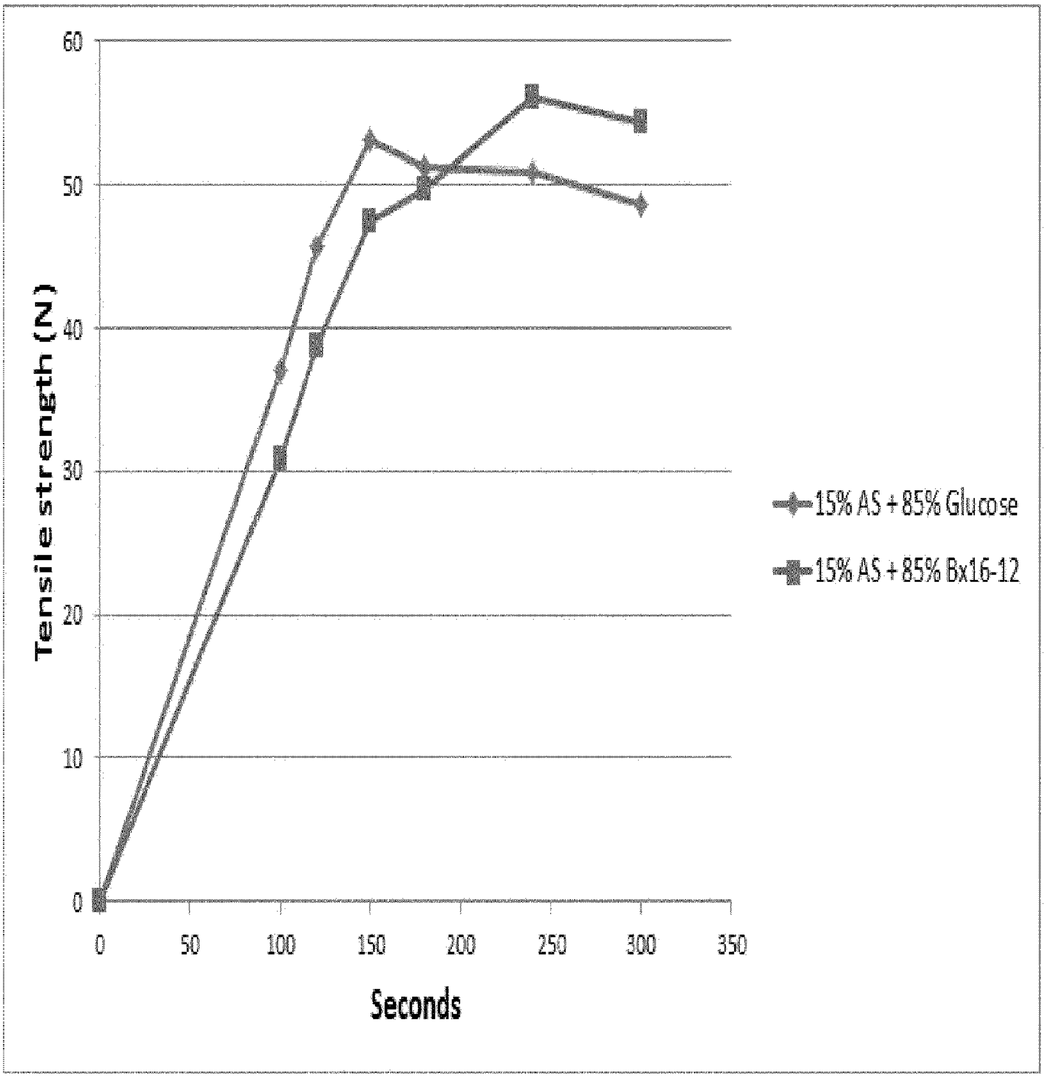
Glucose''
Glucose'

Fig. 3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Tensile strength (N)
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100
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Seconds
15% AS + 85% Glucose
15% AS + 85% Bx16-12

Fig. 4