(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
02 January 2025 (02.01.2025)

WIPO | PCT

(10) International Publication Number
WO 2025/003555 A1

(51) International Patent Classification:
D21H 17/24 (2006.01) *D21H 19/54* (2006.01)
D21H 17/17 (2006.01) *D21H 21/16* (2006.01)
D21H 17/28 (2006.01) *D21J 3/00* (2006.01)

(21) International Application Number:
PCT/FI2024/050258

(22) International Filing Date:
23 May 2024 (23.05.2024)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
20235771 30 June 2023 (30.06.2023) FI

(71) Applicant: **KEMIRA OYJ** [FI/FI]; Energiakatu 4, 00180 Helsinki (FI).

(72) Inventors: **LAINE, Jaana**; c/o Kemira Oyj, P.O. Box 44, 02271 Espoo (FI). **KVIST, Markus**; c/o Kemira Oyj, P.O. Box 44, 02271 Espoo (FI). **OJANEN, Mari**; c/o Kemira Oyj, P.O. Box 44, 02271 Espoo (FI). **ROBERTSÉN, Leif**; c/o Kemira Oyj, P.O. Box 44, 02271 Espoo (FI). **PUTTONEN, Sami**; c/o Kemira Oyj, P.O.Box 330, 00101 Helsinki (FI). **VALDESUEIRO, David**; c/o IFF, Willem Einthovenstraat 4, 2342 BG Oegstgeest (NL).

(74) Agent: **ESPATENT OY**; Kaivokatu 10 D, 00100 Helsinki (FI).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *of inventorship (Rule 4.17(iv))*

Published:
— *with international search report (Art. 21(3))*
— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

(54) Title: A METHOD FOR PRODUCING A FIBER BASED ARTICLE

(57) Abstract: There is provided a method for producing a moulded fiber based article. There is also provided a moulded fiber based article.

WO 2025/003555 A1

A METHOD FOR PRODUCING A FIBER BASED ARTICLE

TECHNICAL FIELD

The present disclosure generally relates to a method for producing a fiber based article. The disclosure relates particularly, though not exclusively, to a method for producing a fiber based article by moulding a fiber stock.

BACKGROUND

This section illustrates useful background information without admission of any technique described herein representative of the state of the art.

Pollution caused by single use plastic containers and packaging materials is epidemic, scarring the global landscape and threatening delicate ecosystems and the life forms that inhabit them. Single use containers migrate along waterways to the oceans in the form of Styrofoam and expanded polystyrene (EPS) packaging, to-go containers, bottles, thin film bags and photo-degraded plastic pellets. Sustainable solutions for reducing plastic pollution are gaining momentum. However, continuing adoption requires that these solutions not only be good for the environment, but also competitive with plastics from both a performance and a cost standpoint.

By way of brief background, molded paper pulp (molded fiber) has been used since the 1930's to make containers, trays and other packages, but experienced a decline in the 1970s after the introduction of fossil based plastic foam packaging. Paper pulp can be produced from old newsprint, corrugated boxes and other plant fibers. Today, molded pulp packaging is widely used for electronics, household goods, automotive parts and medical products, and as an edge/corner protector or pallet tray for shipping electronic and other fragile components.

Cellulose fiber-based packaging products are biodegradable, compostable and, unlike fossil based plastics, do not migrate into the ocean. However, presently known fiber technologies are not well suited for use with meat and poultry, prepared food, produce, microwavable food, or as lids for beverage containers such as hot coffee. In particular, selectively integrating one or more oil, water, vapor, and/or oxygen barriers into the slurry, and/or selectively applying one or more of the barrier layers to all or a portion of the surface of the finished packaging product, can be cumbersome, time consuming, and expensive.

Depending on molded pulp application, oil, grease, water, water vapor, oxygen and/or other gas or liquid barrier properties are needed in different container types. Use of suitable slurry chemicals can improve process efficiency, mechanical properties, barrier properties and/or surface coatability and therefore, make production of molded pulp products more competitive against products made from planar board.

SUMMARY

In a first aspect the present invention provides a method for producing a moulded fiber based article, the method comprising
providing a fibre stock comprising cellulosic fibers;
introducing to the fiber stock
(i) cationic alpha-glucan; or
(ii) complex of cationic alpha-glucan and anionic alpha-glucan; and
moulding the fiber stock.

In a second aspect the present invention provides a moulded fiber based article, wherein the moulded fiber based article comprises
(i) cationic alpha-glucan, or
(ii) complex of cationic alpha-glucan and anionic alpha-glucan, and
optionally alkyl ketene dimer, or
wherein the moulded fiber based article is produced with the method according to the present invention.

In a third aspect the present invention provides a use of cationic alpha-glucan or complex of cationic alpha-glucan and anionic alpha-glucan, and in addition optionally alkylene ketene dimer for improving grease and oil resistance of a moulded fiber based article.

It has now been surprisingly found that moulded, such as thermoformed, fiber based articles comprising cationic alpha-glucan or complex of cationic alpha-glucan and anionic alpha-glucan has increased oil resistance. It was surprisingly found that the cationic alpha-glucan or complex of cationic alpha-glucan and anionic alpha-glucan acts as oil barrier in the fiber based article. It is also believed that the cationic alpha-glucan or complex of cationic alpha-glucan and anionic alpha-glucan acts also as a grease barrier in the fiber based article.

It has been found that the cationic alpha-glucan or complex of cationic alpha-glucan and anionic alpha-glucan gives oil resistance, i.e. penetration time and/or uptake of a moulded fiber based article compared to a moulded fiber based article without the cationic alpha-

glucan or complex of cationic alpha-glucan and anionic alpha-glucan. It is also believed that grease resistance is obtained.

It has been also surprisingly found that moulded, such as thermoformed, fiber based articles comprising cationic alpha-glucan or complex of cationic alpha-glucan and anionic alpha-glucan, and alkyl ketene dimer (AKD) has even further increased oil resistance. Without bounding to any theory it is also believed that grease resistance is increased.

Without bounding to any theory, it is believed that the moulded fiber based articles comprising the cationic alpha-glucan or complex of cationic alpha-glucan and anionic alpha-glucan, and optionally alkyl ketene dimer (AKD), will clog structure of the fiber based article so that grease and oil components cannot substantially penetrate the structure.

The fiber based articles of the present invention are at least partly biodegradable and compostable, preferably mostly biodegradable and compostable, more preferably almost totally biodegradable and compostable, most preferably biodegradable and compostable.

It has been also surprisingly found that moulded fiber based articles having oil and grease resistance can be produced with a simple method. It has been found that moulded fiber based articles having oil and grease resistance can be produced by introducing to a fiber stock comprising cellulosic fibers the cationic alpha-glucan or complex of cationic alpha-glucan and anionic alpha-glucan, and optionally introducing AKD to the fiber stock.

The appended claims define the scope of protection.

DETAILED DESCRIPTION

In a first aspect the present invention provides a method for producing a moulded fiber based article, the method comprising

providing a fibre stock comprising cellulosic fibers;

introducing to the fiber stock

(i) cationic alpha-glucan; or

(ii) complex of cationic alpha-glucan and anionic alpha-glucan; and

moulding the fiber stock.

In one embodiment the method further comprises introducing alkyl ketene dimer (AKD) to the fiber stock.

In one embodiment the cationic alpha-glucan of option (i) is cationic 1,3-alpha-glucan. In one embodiment the cationic alpha-glucan is linear cationic alpha-glucan.

In one embodiment to the fiber stock is introduced alpha-glucan comprising

(i) cationic alpha-glucan

(ii) complex of cationic alpha-glucan and anionic alpha-glucan

(iii) anionic alpha-glucan

(iv) amphoteric alpha glucan

(v) complex of amphoteric alpha-glucan and cationic alpha-glucan

(vi) complex of amphoteric alpha glucan and anionic alpha-glucan

(vii) complex of net cationic and net anionic amphoteric alpha-glucans

(viii) interpenetrating polymer network of cationic alpha-glucan

(ix) interpenetrating polymer network of anionic alpha-glucan

(x) interpenetrating polymer network of cationic and anionic alpha-glucan

(xi) other than1,3-alpha-glucans such as dextran, pullulan, glycogen or a mixture thereof

(xii) crosslinked cationic alpha-glucan

(xiii) crosslinked anionic alpha-glucan

(xiv) crosslinked amphoteric alpha-glucan

(xv) cationic alpha-glucan copolymer

(xvi) anionic alpha-glucan copolymer

(xvii) amphoteric alpha-glucan copolymer

(xviii) grafted alpha-glucan

(xix) graft copolymer of alpha-glucan

(xx) nonionic alpha-glucan of any of the aforementioned or a mixture thereof, or

(xxi) a mixture of at least two of the aforementioned alpha-glucans.

In one embodiment the cationic alpha-glucan of option (i) and AKD are introduced as a mixture to the fiber stock, or the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) and AKD are introduced as a mixture to the fiber stock.

The cationic alpha-glucan of option (i) and AKD can be introduced to the fiber stock in any order. The complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) and AKD can be introduced to the fiber stock in any order.

In one embodiment the cationic alpha-glucan of option (i) and AKD are introduced separately but simultaneously to the fiber stock, or the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) and AKD are introduced separately but simultaneously to the fiber stock.

In one embodiment the cationic alpha-glucan of option (i) and AKD are introduced sequentially to the fiber stock, or the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) and AKD are introduced sequentially to the fiber stock.

In one embodiment the cationic alpha-glucan of option (i) is introduced to the fiber stock prior introducing AKD to the fiber stock.

In one embodiment the cationic alpha-glucan of option (i) is introduced to the fiber stock after introducing AKD to the fiber stock.

In one embodiment the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) is introduced to the fiber stock prior introducing AKD to the fiber stock.

In one embodiment the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) is introduced to the fiber stock after introducing AKD to the fiber stock.

In one embodiment cationic alpha-glucan and anionic alpha-glucan of option (ii) are introduced as a mixture to the fiber stock.

In one embodiment cationic alpha-glucan and anionic alpha-glucan of option (ii) are introduced separately but simultaneously to the fiber stock.

In one embodiment cationic alpha-glucan and anionic alpha-glucan of option (ii) are introduced sequentially to the fiber stock. The cationic alpha-glucan can be introduced to the fiber stock prior or after introducing of the anionic alpha-glucan to the fiber stock.

In one embodiment AKD is introduced to the fiber stock prior, after or between introducing the cationic alpha-glucan and anionic alpha-glucan of option (ii) to the fiber stock.

The cationic alpha-glucan of option (i) can be introduced to the fiber stock in high amounts. The complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) can be introduced to the fiber stock in high amounts.

In one embodiment dry amount of the cationic alpha-glucan of option (i) is 25-75 kg, such as 25-40 kg, 45-55 kg or 60-75 kg per ton of dry fiber stock.

In one embodiment dry amount of the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) is 25-75, such as, 25-40 kg, 45-55 kg or 60-75 kg per ton of dry fiber stock.

In one embodiment dry amount of the alkyl ketene dimer is 0.1-40 kg preferably 1-10 kg, more preferably 1.5-8 kg, even more preferably 1.5-6 kg, yet even preferably 1.5-4.5 kg per ton of dry fiber stock.

In one embodiment pigment material is introduced to the fiber stock. In one embodiment the pigment material is introduced to the fiber stock at the same time as cationic alpha-glucan of option (i) or the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) are introduced sequentially to the fiber stock.

In one embodiment the pigment material is introduced to the fiber stock before addition of the cationic alpha-glucan of option (i) or the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) In one embodiment the pigment material is introduced to the fiber stock after addition of cationic alpha-glucan of option (i) or the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii).

In one embodiment the pigment material and cationic alpha-glucan of option (i) or the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) are introduced as a mixture to the fiber stock.

In one embodiment the pigment material comprises talc, kaolin clay, calcium carbonate, titanium dioxide or a mixture thereof.

In one embodiment sizing chemical, fixative, retention aid, drainage aid, wet strength agent, dry strength agent or a mixture thereof is introduced to the fiber stock, preferably before introducing cationic alpha-glucan of option (i) or the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) and optional alkyl ketene dimer to the fiber stock.

In one embodiment the sizing chemical comprises alkenyl succinic anhydride (ASA), rosin or a mixture thereof.

In one embodiment ASA, rosin or a mixture thereof is introduced in an amount of 0.1 – 4%, preferably 0.5-1.5% based on dry weight of the fiber stock.

In one embodiment the retention aid comprises cationic polyacryl amide (CPAM), cationic starch, polyamidoamine-epichlorohydrin (PAE), polyvinyl alcohol (PVA), polyvinylamine (PVAm), poly ethylenimine (PEI) or a mixture thereof.

In one embodiment the fixative, drainage aid or a mixture thereof comprises aluminium sulphate (ALS), polyaluminium chloride (PAC), poly(diallyldimethylammonium chloride) (PDACMAC), cationic polyacrylamide (CPAM), polyethylenimine (PEI), polyamine (PA), polyvinylalcohol (PVA), polyvinylamine (PVAm), silica sol or a mixture thereof.

In one embodiment the wet strength agent comprises polyamide-epichlorohydrin (PAE), glyoxalated polyacrylamide (GPAM), starch or a mixture thereof. In one embodiment the wet strength agent is added after addition of a sizing agent but before addition of the composition to the fiber stock.

In one embodiment the dry strength agent comprises cationic starch, polyamidoamine-epichlorohydrin (PAE), polyamine, polyvinyl alcohol (PVA) or a mixture thereof.

In one embodiment consistency of the fiber stock comprising cellulosic fibers is 0.1 %-10 %, preferably 0.1 %-5 %, more preferably 0.2 %-1.0 %.

The moulding, i.e. moulding step or moulding process, can be any suitable method known in the art.

In one embodiment the moulding comprises wet forming, wet moulding, vacuum forming, vacuum forming coating, vacuum moulding, extrusion forming, extrusion moulding, compression molding, thermoforming, dry moulding, hot pressing, hot press drying, hot moulding, heat pressing, heat moulding, thermomoulding or a combination thereof

In one embodiment the moulding is thermoforming, preferably heat pressing, hot pressing, hot press drying, thermomoulding, compression moulding or a combination thereof.

In one embodiment the moulding is a combination of vacuum forming, wet moulding and moulding using both heat and mechanical pressure, such as thermoforming, compression moulding, hot press drying or thermoforming drying.

In one embodiment the fiber stock is moulded to a sheet.

In one embodiment the fiber stock is formed to a sheet, preferably thermoformed to a sheet.

In the context of the present application by term “sheet” is meant an article having smaller thickness than length and width.

In the context of the present application by term “two-dimensional, 2D, article” is meant a 2D-article originally been made to planar shape and has a smaller thickness than length and width. The 2D-article can be folded or bended to a three-dimensional, 3D, article.

In the context of the present application by term “three-dimensional, 3D, article” is meant an article having three dimensions.

In the context of the present application a sheet is not considered to be a three-dimensional, 3D, article.

In one embodiment the sheet is formed to a three-dimensional, 3D, article.

In one embodiment the fiber stock is moulded to a three-dimensional, 3D, article.

In one embodiment the fiber stock with or without foam is vacuum formed, extrusion formed, injection formed, blow formed, wet pressed and/or drained by help of vacuum, unrestrained and/or restrained dried, compacted in one or more directions, polymer impregnated, polymer laminated, polymer coated or a combination thereof, to a two-dimensional, 2D, sheet having thickness of 0.1 mm - 10 mm, preferably 0.3 mm – 2 mm. In one embodiment the 2D sheet is further thermoformed (i.e. dry moulded, i.e. dry formed) to a three-dimensional, 3D, article having preferably length and width of 5 cm – 50 cm, depth of 2 cm -20 cm and wall thickness of 0.1 mm – 2 mm.

In one embodiment the fiber stock is wet moulded and the wet moulded fiber stock is moulded to a three-dimensional, 3D, article.

In one embodiment temperature of mould(s) in heat pressing, hot pressing, hot press drying, thermoforming or thermomoulding is 100 °C - 400 °C, preferably 130 °C - 220 °C.

In one embodiment mechanical pressure applied on fiber stock or two- or three-dimensional fiber based article in heat pressing, hot pressing, hot press drying, heat compression, hot compression, thermoforming or thermomoulding is 0.1 bar – 1000 bar, preferably 1-250 bar and pressure can alternate during heat pressing, hot pressing, hot press drying, heat compression, hot compression, thermoforming or thermomoulding depending on manufacturing technology, equipment and moulded fiber product application.

In one embodiment the moulding is thermoforming, heat pressing, thermomoulding, wet or dry moulding and/or wet or dry forming to form densifying or a combination thereof, to a three dimensional article.

In one embodiment the fiber stock comprising (i) the cationic alpha-glucan; or (ii) the complex of cationic alpha-glucan and anionic alpha-glucan is vacuum forming coated on a vacuum forming coated fiber stock that is substantially free, preferably free of (i) the cationic alpha-glucan; or (ii) the complex of cationic alpha-glucan and anionic alpha-glucan, followed by moulding the fiber stocks.

In one embodiment the fiber stock comprising (i) the cationic alpha-glucan; or (ii) the complex of cationic alpha-glucan and anionic alpha-glucan is vacuum forming coated on 2-10 vacuum forming coated fiber stock that are substantially free, preferably free of (i) the cationic alpha-glucan; or (ii) the complex of cationic alpha-glucan and anionic alpha-glucan, followed by moulding the fiber stocks.

In one embodiment the fiber stock comprising cellulosic fibers comprises natural fibers, synthetic fibers or a mixture thereof. Preferably the fibers are plant origin comprising recycled, chemical and/or mechanical hardwood and softwood pulps, sugar cane (such as bagasse), bamboo, marley, wheat, maize, corn, oats, barley, rice, rye, tomato, sorghum, rape seed, palm oil plants, flax, hemp, ramie, cotton, kenaf, jute, banana, cannabis, peat, moss or a mixture thereof.

In a second aspect the present invention provides a moulded fiber based article, wherein the moulded fiber based article comprises

(i) cationic alpha-glucan, or

(ii) complex of cationic alpha-glucan and anionic alpha-glucan, and

optionally alkyl ketene dimer, or

wherein the moulded fiber based article is produced with the method according to the present invention.

In one embodiment the moulded fiber based article comprises alkyl ketene dimer.

In one embodiment amount of the cationic-alpha glucan of option (i) in the moulded fiber based article is 0.5 wt.%-10 wt.%, preferably 2 wt.%-8 wt.%, more preferably 4 wt.%-8 wt.%, even more preferably 5 wt.%-7 wt.%, based on the dry weight of the moulded fiber based article.

In one embodiment amount of the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) in the moulded fiber based article is 0.5 wt.%-10 wt.%, preferably 2 wt.%-8 wt.%, more preferably 4 wt.%-8 wt.%, even more preferably 5 wt.%-7 wt.%, based on the dry weight of the moulded fiber based article.

In one embodiment amount of the alkyl ketene dimer is 0.1- 8 wt.%, preferably 0.1- 4 wt.%, more preferably 0.1-1 wt.%, even more preferably 0.15-0.4 wt.%, based on dry weight of the moulded fiber based article.

In one embodiment the moulded fiber based article comprises pigment material.

In one embodiment the moulded fiber based article is thermoformed fiber based article, preferably hot pressed, hot pressed dried, heat pressed, heat compression moulded, hot compression moulded fiber based article or thermomoulded fiber based article.

In one embodiment amount of the fiber in the moulded fiber based article is 50 wt.%-99 wt.%, preferably 80 wt.%-97 wt.%, more preferably 90 wt.%-97 wt.%, based on dry weight of the moulded fiber based article.

In one embodiment amount of the pigment material in the moulded fiber based article is 0.01 wt.%-10 wt.%, preferably 0.5 wt.%-5 wt.%, based on dry weight of the moulded fiber based article.

In one embodiment the moulded fiber based article comprises a sizing chemical, fixative, retention aid, drainage aid, wet strength agent, dry strength agent or a mixture thereof.

In one embodiment amount of the a sizing chemical, fixative, retention aid, drainage aid, wet strength agent, dry strength agent or a mixture thereof in the moulded fiber based article is 0.01 wt.%-5 wt.%, preferably 0.1 wt.%-2.0 wt.%, based on dry weight of the moulded fiber based article.

In one embodiment the moulded fiber based article comprises food packages, food service items, drink packages, drink service items, goods packages, goods service items, preferably food service and packaging items such as oven proof trays, microwave proof trays, clamshell boxes, other food boxes, soup cups, fresh meat and poultry trays, plates or cup lids.

In one embodiment the moulded fiber based article is produced with the method according to the present invention.

In a third aspect the present invention provides a use of cationic alpha-glucan or complex of cationic alpha-glucan and anionic alpha-glucan, and in addition optionally alkylene ketene dimer for improving grease and oil resistance of a moulded fiber based article.

In one embodiment the alkyl ketene dimer is used in addition to the cationic alpha-glucan or complex of cationic alpha-glucan and anionic alpha-glucan for improving grease and oil resistance of a moulded fiber based article.

In one embodiment pigment material is used in addition to the cationic alpha-glucan or the complex of cationic alpha-glucan and anionic alpha-glucan and optional alkyl ketene dimer for improving grease and oil resistance of a moulded fiber based article.

In one embodiment a sizing chemical, fixative, retention aid, drainage aid, wet strength agent, dry strength agent or a mixture thereof is used in addition to the cationic alpha-glucan or the complex of cationic alpha-glucan and anionic alpha-glucan, optional alkyl ketene dimer and optional pigment material for improving grease and oil resistance of a moulded fiber based article.

EXAMPLES

Example 1, option (i) according to the present invention

Alkyl ketene dimer (AKD) 2 kg of active chemical per ton of dry end product, or AKD 2 kg of active component per ton of dry end product and cationic alpha-glucan (CAG) 40 kg per ton of dry fiber are introduced to the fiber stock in order as shown in Table 1. Consistency of the fiber stock was adjusted to 0.2-0.3 %. After each introduction of a chemical to the fiber stock the fiber stock is mixed for 10 minutes.

Example 2, option (ii) according to the present invention

The chemicals are introduced to the fiber stock in the order as shown in Table 2. Consistency of the fiber stock was adjusted to 0.2-0.3 %. In the Table 2, AKD denotes alkyl ketene dimer (AKD), CAG denotes cationic alpha-glucan and AG denotes anionic alpha-glucan. The amount of the AKD was 2 kg of active chemical per ton of dry end product. Amount of the CAG was 40 kg per ton of dry fiber. The amount of AG was 20 kg per ton of dry fiber. After each introduction of a chemical to the fiber stock the fiber stock is mixed for 10 minutes.

Preparation of two-dimensional, 2D, article/sheet according to the present invention

After introducing the chemicals according to Example 1 or Example 2 to the fiber stock the fiber stock is vacuum formed to dryness of 20 – 30 % using dynamic drainage analyzer under 200 - 650 mBar vacuum against planar round shaped 10 cm in diameter, forming wire with 200 - 400 micron openings. Wet 2D article/sheet with grammage of 200 – 800 g/m2 as dry is hot press dried and thermoformed to 0.2 – 1.2 mm thickness between 130-200 °C metal plates until dryness of 94 - 99% is reached.

The 2D fiber moulded article may be hot pressed and/or thermoformed to a density of 0.5 g/cm3-1.5 g/cm3, preferably 1.0 – 1.2 g/cm3 and thickness of 0.1 – 1.2 mm, preferably 0.3 – 0.8 mm.

Preparation of three-dimensional, 3D, article according to the present invention

After introducing the chemicals to the fiber stock according to the Example 1 or Example 2 a 3D shaped forming wire with suction mould is dipped into the fiber stock and fiber stock material is drawn/formed against the 3D wire with 200 - 500 micron openings under up to 900 mBar vacuum. Formed 3D article is lifted up from the fiber stock and vacuum suction assisted drainage is continued until dryness of wet moulded 3D article is 33 % on average. Wet moulded 3D article is then transferred on to heated counter mould (130-200 °C) and hot press dried and thermoformed to 0.2 – 1.2 mm thickness and final dryness of 90 - 96%.

The 3D article may be hot press dried and thermoformed to a wall thickness of 0.2 mm-1.2 mm, such as 0.5 mm- 0.8 mm, length of 5 cm-50 cm, width of 5 cm-50 cm and depth of 2 cm-20 cm.

Oil resistance test

Oil test was performed using the test method based on standard ASTM F119-82:2015.

Cobb test

Cobb test was performed using the test method based on standard ISO 535.

Results of the oil resistance test and Cobb test

Table 1 shows results of the oil resistance tests and Cobb tests of moulded fiber based article produced according to the option (i). As shown in the Table 1, oil penetration time at 50 °C and Cobb were improved when cationic alpha-glucan was used with AKD.

Table 1.

	Grammage	Thickness	Density	Bendtsen air permeability	Cobb 5min	Oil penetration time at 50° C
	[g/m2]	[um]	[g/cm3]	[ml/min]	[g/m2]	[h]
AKD	441	519	0.85		42	0.3
AKD+CAG (40)	439	507	0.87	60	48	0.6

Table 2 shows results of the oil resistance tests and Cobb tests of moulded fiber based article produced according to the option (ii). As shown in the Table 2, oil penetration time at 50 °C was improved when cationic alpha-glucan was used with AKD. The oil penetration time was further improved when a complex of cationic and anionic alpha-glucan was used with AKD.

Table 2.

	Grammage	Thickness	Density	Bendtsen air permeability	Cobb 5min	Oil penetration time at 50° C
	[g/m2]	[um]	[g/cm3]	[ml/min]	[g/m2]	[h]
AKD	441	519	0.85		42	0.3
AKD+CAG (40)	439	507	0.87	60	48	0.6
AKD+CAG (40)+AG (20)	449	546	0.82	43	42	7.0

The foregoing description has provided by way of non-limiting examples of particular implementations and embodiments a full and informative description of the best mode presently contemplated by the inventors for carrying out the invention. It is however clear to

a person skilled in the art that the invention is not restricted to details of the embodiments presented in the foregoing, but that it can be implemented in other embodiments using equivalent means or in different combinations of embodiments without deviating from the characteristics of the invention.

Furthermore, some of the features of the afore-disclosed example embodiments may be used to advantage without the corresponding use of other features. As such, the foregoing description shall be considered as merely illustrative of the principles of the present invention, and not in limitation thereof. Hence, the scope of the invention is only restricted by the appended patent claims.

CLAIMS

1. A method for producing a moulded fiber based article, the method comprising
providing a fibre stock comprising cellulosic fibers;
introducing to the fiber stock
(i) cationic alpha-glucan; or
(ii) complex of cationic alpha-glucan and anionic alpha-glucan; and
moulding the fiber stock.

2. The method according to claim 1, wherein in option (i) the cationic alpha-glucan is cationic 1,3-alpha-glucan.

3. The method according to claim 1 or 2, wherein the method further comprises introducing alkyl ketene dimer (AKD) to the fiber stock.

4. The method according to any of claims 1-3, wherein the cationic alpha-glucan of option (i) and AKD are introduced as a mixture to the fiber stock, or the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) and AKD are introduced as a mixture to the fiber stock.

5. The method according to any of claims 1-3, wherein the cationic alpha-glucan of option (i) and AKD are introduced separately but simultaneously to the fiber stock, or the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) and AKD are introduced separately but simultaneously to the fiber stock.

6. The method according to any of claims 1-3, wherein the cationic alpha-glucan of option (i) and AKD are introduced sequentially to the fiber stock, or the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) and AKD are introduced sequentially to the fiber stock.

7. The method according to any of claims 1-6, wherein dry amount of the cationic alpha-glucan of option (i) is 25-75 kg, such as 25-40 kg, 45-55 kg or 60-75 kg per ton of dry fiber stock.

8. The method according to any of claims 1-7, wherein dry amount of the complex of cationic alpha-glucan and anionic alpha-glucan of option (ii) 25-75 kg, such as 25-40 kg, 45-55 kg or 60-75 kg per ton of dry fiber stock.

9. The method according to any of claims 1-8, wherein dry amount of the alkyl ketene dimer is 0.1-40 kg, preferably 1-10 kg, more preferably 1.5-8 kg, even more preferably 1.5-6 kg, yet even further preferably 1.5-4.5 kg per ton of dry fiber stock.

10. The method according to any of claims 1-9, wherein the fiber stock is formed to a sheet.

11. The method according to claim 11, wherein the sheet is formed to a three-dimensional, 3D, article.

12. The method according to any of claims 1-11, wherein the fiber stock is moulded to a three-dimensional, 3D, article.

13. The method according to any of claims 1-12, wherein the fiber stock is wet moulded and the wet moulded fiber stock is moulded to a three-dimensional, 3D, article

14. The method according to any of claims 1-13, wherein the moulding comprises wet forming, wet moulding, vacuum forming, vacuum moulding, extrusion forming, extrusion moulding, thermoforming, dry moulding, hot pressing, hot press drying, hot moulding, heat pressing, heat moulding, thermomoulding or a combination thereof.

15. The method according to any one of claims 1-14, wherein pigment material is introduced to the fiber stock.

16. The method according to any of claims 1-15, wherein sizing chemical, fixative, drainage aid, wet strength agent or a mixture thereof is introduced to the fiber stock

17. A moulded fiber based article, wherein the moulded fiber based article comprises

(i) cationic alpha-glucan, or

(ii) complex of cationic alpha-glucan and anionic alpha-glucan, and

optionally alkyl ketene dimer, or

wherein the moulded fiber based article is produced with the method according to any of claims 1-16.

18. The moulded fiber based article according to claim 17, wherein the moulded fiber based article comprises food packages, food service items drink packages, goods packages, preferably oven proof trays, microwave proof trays, clamshell boxes, other food boxes, soup cups, fresh meat and poultry trays, plates or cup lids.

19. Use of cationic alpha-glucan or complex of cationic alpha-glucan and anionic alpha-glucan, and in addition optionally alkylene ketene dimer for improving grease and oil resistance of a moulded fiber based article.

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2024/050258

A. CLASSIFICATION OF SUBJECT MATTER

INV. D21H17/24 D21H17/17 D21H17/28 D21H19/54 D21H21/16
D21J3/00
ADD.

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)

D21H D21J

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2023/118645 A1 (KEMIRA OYJ [FI]) 29 June 2023 (2023-06-29) page 16, lines 22-27; claims 1-28	1-19
X	WO 2018/140392 A1 (DU PONT [US]) 2 August 2018 (2018-08-02) claims 1-18; examples 9-18	1-19
X	WO 2023/287684 A1 (NUTRITION & BIOSCIENCES USA 4 INC [US]) 19 January 2023 (2023-01-19) claims 1-20; example 5	1-19
A	WO 2017/074859 A1 (DU PONT [US]) 4 May 2017 (2017-05-04) the whole document	1-19

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 July 2024	05/08/2024

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Karlsson, Lennart

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2024/050258

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2022/144681 A1 (STORA ENSO OYJ [FI]) 7 July 2022 (2022-07-07) the whole document - - - - -	1-19
A	ADIBI AZIN ET AL: "Sustainable barrier paper coating based on alpha-1,3 glucan and natural rubber latex", CARBOHYDRATE POLYMERS, vol. 282, 1 April 2022 (2022-04-01), page 119121, XP093036147, GB ISSN: 0144-8617, DOI: 10.1016/j.carbpol.2022.119121 the whole document - - - - -	1-19

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/FI2024/050258

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2023118645 A1	29-06-2023	AU 2022418339 A1	06-06-2024
		CA 3240792 A1	29-06-2023
		CN 118369479 A	19-07-2024
		WO 2023118645 A1	29-06-2023
WO 2018140392 A1	02-08-2018	AU 2018212543 A1	11-07-2019
		CN 110198958 A	03-09-2019
		EP 3574021 A1	04-12-2019
		JP 2020508952 A	26-03-2020
		KR 20190111060 A	01-10-2019
		US 2019330802 A1	31-10-2019
		WO 2018140392 A1	02-08-2018
WO 2023287684 A1	19-01-2023	CN 117616054 A	27-02-2024
		EP 4370560 A1	22-05-2024
		JP 2024525685 A	12-07-2024
		WO 2023287684 A1	19-01-2023
WO 2017074859 A1	04-05-2017	AU 2016347044 A1	22-03-2018
		CA 2997563 A1	04-05-2017
		CN 108350661 A	31-07-2018
		EP 3368717 A1	05-09-2018
		ES 2939179 T3	19-04-2023
		JP 7365117 B2	19-10-2023
		JP 2019500480 A	10-01-2019
		KR 20180072709 A	29-06-2018
		RU 2018115392 A	28-11-2019
		US 2019153674 A1	23-05-2019
		US 2022228321 A1	21-07-2022
		WO 2017074859 A1	04-05-2017
WO 2022144681 A1	07-07-2022	EP 4271886 A1	08-11-2023
		SE 2051575 A1	01-07-2022
		WO 2022144681 A1	07-07-2022