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(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.



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;

- 10 introducing to the fiber stock at least one at least one fatty alcohol and at least one polysaccharide; 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 at least one at least one fatty alcohol and at least

- 15 one polysaccharide, 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 at least one at least one fatty alcohol and at least one polysaccharide; and in addition

- 20 optionally alkylene ketene dimer for improving grease and oil resistance of a moulded fiber based article.

In a fourth aspect the present invention provides a composition comprising at least one at least one fatty alcohol and cationic alpha-glucan, anionic alpha-glucan or a complex of

- 25 cationic alpha-glucan and anionic alpha-glucan, and optionally alkyl ketene dimer and/or pigment material.

It has now been surprisingly found that moulded, such as thermoformed, fiber based articles comprising at least one at least one fatty alcohol and at least one polysaccharide, such as alpha-glucan, has increased oil resistance. It was surprisingly found that the at least one at

- 30 least one fatty alcohol and at least one polysaccharide act as oil barrier in the fiber based article. It is also believed that the at least one at least one fatty alcohol and at least one polysaccharide act also as a grease barrier in the fiber based article.

Without bounding to any theory it is believed that the at least one fatty alcohol improves formation and/or retention of the polysaccharide, such as alpha-glucan, to fiber in production of fiber based article and, thus, improving the oil resistance and grease resistance.

5 It has been found that the at least one at least one fatty alcohol and at least one polysaccharide 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 at least one at least one fatty alcohol and at least one polysaccharide. It is also believed that grease resistance is obtained.

10 It has been also surprisingly found that moulded, such as thermoformed, fiber based articles comprising at least one fatty alcohol and at least one polysaccharide, such as 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.

15 Without bounding to any theory, it is believed that the moulded fiber based articles comprising the at least one fatty alcohol and at least one polysaccharide, such as alpha-glucan, and optionally alkyl ketene dimer (AKD), will trap grease and oil components and act as grease and oil barrier.

The fiber based articles of the present invention are at least partly biodegradable and compostable, preferably mostly biodegradable and compostable, more preferably almost
20 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 and low-cost 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 composition comprising at least
25 one fatty alcohol and at least one polysaccharide, 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
30 based article, the method comprising

providing a fibre stock comprising cellulosic fibers;
introducing to the fiber stock at least one fatty alcohol and at least one polysaccharide; and
moulding the fiber stock.

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

In one embodiment the at least one fatty alcohol and the at least one polysaccharide are introduced to the fiber stock as a mixture or a composition.

In one embodiment the at least one fatty alcohol and the at least one polysaccharide are introduced to the fiber stock simultaneously but separately.

10 In one embodiment the at least one fatty alcohol and the at least one polysaccharide are introduced to the fiber stock sequentially.

In one embodiment the at least one fatty alcohol is introduced to the fiber stock prior introducing the at least one polysaccharide to the fiber stock.

15 In one embodiment the at least one polysaccharide is introduced to the fiber stock prior introducing the at least one fatty alcohol to the fiber stock.

In one embodiment the at least one fatty alcohol, at least one polysaccharide and the AKD are introduced as a mixture or a composition to the fiber stock.

The at least one fatty alcohol, the at least one polysaccharide and the AKD can be introduced to the fiber stock in any combination or order.

20 In one embodiment the at least one fatty alcohol, the at least one polysaccharide and the AKD are introduced to the fiber stock simultaneously but separately.

In one embodiment the at least one fatty alcohol, the at least one polysaccharide and the AKD are introduced to the fiber stock sequentially.

25 In one embodiment the at least one fatty alcohol is introduced to the fiber stock prior introducing the at least one polysaccharide and the AKD to the fiber stock.

In one embodiment the at least one polysaccharide is introduced to the fiber stock prior introducing the at least one fatty alcohol and the AKD to the fiber stock.

In one embodiment the at least one polysaccharide is introduced to the fiber stock prior introducing the AKD to the fiber stock followed by introducing the at least one fatty alcohol to the fiber stock.

5 In one embodiment the at least one fatty alcohol is introduced to the fiber stock prior introducing the AKD to the fiber stock followed by introducing the at least one polysaccharide to the fiber stock.

In one embodiment the fatty alcohol has carbon chain length of C4-C26, preferably C6-C22, more preferably C16-C22, such as C16-C18 or C18-C22.

10 In one embodiment the fatty alcohol is a mixture of at least two fatty alcohols, preferably a mixture of two fatty alcohols. In one embodiment the fatty alcohols in the mixture have same carbon chain length. In one embodiment the fatty alcohols in the mixture have different carbon chain lengths. The fatty alcohols in the mixture can be in any suitable ratio. In one embodiment the mixture is of two fatty alcohols having carbon chain length of C16-C18 and C18-C22.

15 In one embodiment the at least two fatty alcohols are introduced to the fiber stock simultaneously but separately. In one embodiment the at least two fatty alcohols are introduced to the fiber stock sequentially.

20 In one embodiment the polysaccharide comprises starch, microfibrillated cellulose (MFC), nanofibrillated cellulose NFC), carboxymethyl cellulose (CMC), alpha-glucan or a mixture thereof.

In one embodiment the polysaccharide is alpha-glucan. In one embodiment the alpha-glucan is liner alpha-glucan. In one embodiment the alpha-glucan is 1,3-alpha-glucan.

In one embodiment the alpha-glucan comprises

- (i) cationic alpha-glucan
- 25 (ii) anionic alpha-glucan
- (iii) complex of cationic alpha-glucan and 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
- 5 (xi) other than 1,3-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
- 10 (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
- 15 (xxi) a mixture of at least two of the aforementioned alpha-glucans.

In one embodiment the alpha-glucan is cationic alpha-glucan, anionic alpha-glucan, a complex of cationic alpha-glucan and anionic alpha-glucan or a mixture thereof.

In one embodiment cationic alpha-glucan and anionic alpha-glucan are introduced to the fiber stock simultaneously but separately.

- 20 In one embodiment cationic alpha-glucan and anionic alpha-glucan are introduced as a mixture to the fiber stock.

In one embodiment cationic alpha-glucan and anionic alpha-glucan are introduced to the fiber stock sequentially. In one embodiment cationic alpha-glucan is introduced to the fiber stock prior or after introducing anionic alpha-glucan to the fiber stock.

- 25 In one embodiment AKD is introduced to the fiber stock followed by introducing cationic alpha-glucan to the fiber stock, followed by introducing anionic alpha-glucan to the fiber stock and followed by introducing fatty alcohol to the fiber stock.

In one embodiment dry amount of the at least one fatty alcohol is 0.1-50 kg, preferably 1-10 kg, more preferably 1.5-8 kg per ton of dry fiber stock.

In one embodiment dry amount of the at least one polysaccharide is 0.1 -100 kg, preferably 10-90 kg, more preferably 10-60 kg per ton of dry fiber stock.

- 5 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 further preferably 1.5-4.5 kg per ton of dry fiber stock.

10 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 the at least one fatty alcohol and the at least one polysaccharide. In one embodiment the pigment material and the at least one fatty alcohol and the at least one polysaccharide are introduced as a mixture to the fiber stock.

15 In one embodiment the pigment material is introduced to the fiber stock before addition of the at least one fatty alcohol and the at least one polysaccharide. In one embodiment the pigment material is introduced to the fiber stock after addition of the at least one fatty alcohol and the at least one polysaccharide.

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

20 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 the at least one fatty alcohol and the at least one polysaccharide 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.

25 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 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 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.

- 5 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 %.

- 10 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

- 15 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.

- 20 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.

- 25 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.

- 5 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
- 10 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.

- 15 In one embodiment temperature of mould(s) in heat pressing, hot pressing, hot press drying, heat compression, hot compression, 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
- 20 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, hot
- 25 pressing, hot press drying, heat compression moulding, hot compression moulding, 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 the at least one fatty alcohol and at least one polysaccharide is vacuum forming coated on a vacuum forming coated fiber stock that is

substantially free, preferably free of the at least one fatty alcohol and at least one polysaccharide, followed by moulding the fiber stocks.

In one embodiment the fiber stock comprising the at least one fatty alcohol and at least one polysaccharide is vacuum forming coated on 2-10 vacuum forming coated fiber stocks stock
5 that are substantially free, preferably free of the at least one fatty alcohol and at least one polysaccharide, 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
10 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
15 at least one fatty alcohol and at least one polysaccharide, and not 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.

20 In one embodiment amount of the composition 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
25 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.

5 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.

10 In one embodiment amount of the 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.

15 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.

20 In a third aspect the present invention provides use of at least one fatty alcohol and at least one polysaccharide, and in addition optionally alkyl ketene dimer for improving grease and oil resistance of a moulded fiber based article.

25 In one embodiment the alkyl ketene dimer is used in addition to the at least one fatty alcohol and the at least one polysaccharide for improving grease and oil resistance of a moulded fiber based article

30 In one embodiment pigment material is used in addition to the at least one fatty alcohol and the at least one polysaccharide and optional alkyl ketene dimer for improving grease and oil resistance of a moulded fiber based article.

In one embodiment sizing chemical, fixative, retention aid, drainage aid, wet strength agent, dry strength agent or a mixture thereof is used in addition to the at least one fatty alcohol and the at least one polysaccharide, optional alkyl ketene dimer and optional pigment material for improving grease and oil resistance of a moulded fiber based article.

- 5 In a fourth aspect the present invention provides a composition comprising at least one fatty alcohol and cationic alpha-glucan, anionic alpha-glucan or a complex of cationic alpha-glucan and anionic alpha-glucan, and optionally alkyl ketene dimer.

In one embodiment the composition comprises alkyl ketene dimer.

- 10 In one embodiment weight ratio of the at least one fatty alcohol to the cationic alpha-glucan, anionic alpha-glucan or a complex of cationic alpha-glucan and anionic alpha-glucan or any combination thereof is from 1:3 to 1:180, preferably from 1:4 to 1:80, more preferably from 1:6 to 1:50, based on dry weights.

In one embodiment the composition comprises at least one fatty alcohol and alpha-glucan comprising

- 15 (i) cationic alpha-glucan
(ii) anionic alpha-glucan
(iii) complex of cationic alpha-glucan and anionic alpha-glucan
(iv) amphoteric alpha glucan
(v) complex of amphoteric alpha-glucan and cationic alpha-glucan
20 (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
25 (xi) other than 1,3-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
- 5 (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.

EXAMPLES

Example 1, according to the present invention

- 10 The chemicals are introduced to the fiber stock in the order and amounts as shown in Table 1. Amount of the fatty alcohol is 2 kg/ton. The amounts of the chemicals are amounts of active chemical based on dry weight of the fiber stock. Consistency of the fiber stock was adjusted to 0.2-0.3 %. In the Table 1, AKD denotes alkyl ketene dimer, CAG denotes cationic alpha-glucan and AG denotes anionic alpha-glucan. After each introduction of a
- 15 chemical to the fiber stock the fiber stock is mixed for 5-10 minutes.

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

- After introducing the chemicals according to example 1 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
- 20 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
- 25 – 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 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 with very short and light wet press is continued until dryness of wet moulded 3D article is 33 % on average. Wet moulded 3D article is then transferred on to heated counter
5 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.

10 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

15 Table 1 shows results of the oil resistance tests and Cobb tests of moulded fiber based article. Oil penetration time at 50 °C was improved when cationic alpha-glucan was used with AKD. Oil penetration time at 50 °C was further improved when a complex of cationic and anionic alpha-glucan was used with AKD. Even better oil penetration time was obtained when fatty alcohol was used with AKD and a complex of cationic and anionic alpha-glucan.

20 **Table 1.**

	Grammage		Bendtsen air permeability	Cobb 5min	Oil penetration time at 50°C
(kg/t of dry product)	[g/m ²]	S.D.	[ml/min]	[g/m ²]	[h]
AKD (2)	441	3		42	0,3
AKD (2)+CAG (40)	439	7	60	48	0,6
AKD (2)+CAG (40)+AG (20)	449	16	43	42	7,0
AKD(2)+CAG (40)+AG (20)+ fatty alcohol	460	8		40	12,0

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.

- 5 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 at least one fatty alcohol and at least one polysaccharide; and
5 moulding the fiber stock.
2. The method according to claim 1, wherein the method further comprises introducing alkyl ketene dimer (AKD) to the fiber stock.
3. The method according to claim 1 or 2, wherein the polysaccharide comprises starch, microfibrillated cellulose (MFC), nanofibrillated cellulose (NFC), carboxymethyl cellulose
10 (CMC), alpha-glucan or a mixture thereof.
4. The method according to any of claims 1-3, wherein the polysaccharide is alpha-glucan, preferably cationic alpha-glucan, anionic alpha-glucan, a complex of cationic alpha-glucan and anionic alpha-glucan or a mixture thereof.
5. The method according to any of claims 1-4, wherein the fatty alcohol has carbon chain
15 length of C4-C26, preferably C6-C22, more preferably C16-C22.
6. The method according to any of claims 1-5, wherein the at least one fatty alcohol, the at least one polysaccharide and optional alkyl ketene dimer are introduced sequentially to the fiber stock.
7. The method according to any of claims 1-6, wherein dry amount of the at least one
20 fatty alcohol is 0.1-50 kg, preferably 1-10 kg, more preferably 1.5-8 kg per ton of dry fiber stock.
8. The method according to any of claims 1-7, wherein dry amount of the at least one polysaccharide is 1-100 kg, preferably 10-90 kg, preferably 10-60 kg per ton of dry fiber stock.
- 25 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.

5 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 forming coating, vacuum moulding, extrusion forming, extrusion moulding, compression molding, thermoforming, dry moulding,
10 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,
15 retention aid, drainage aid, wet strength agent, dry 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 at least one fatty alcohol and at least one polysaccharide, and optionally alkyl ketene dimer, or
20 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 safe trays, clamshell boxes, other food
25 boxes, soup cups, fresh meat and poultry trays, plates or cup lids.

19. Use of at least one fatty alcohol and at least one polysaccharide, and in addition optionally alkylene ketene dimer for improving grease and oil resistance of a moulded fiber based article.

20. A composition comprising at least one fatty alcohol and cationic alpha-glucan, anionic alpha-glucan or a complex of cationic alpha-glucan and anionic alpha-glucan, and optionally alkyl ketene dimer.

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2024/050257

A. CLASSIFICATION OF SUBJECT MATTER					
INV.	D21H11/18	D21H17/24	D21H17/28	D21H19/54	D21H27/10
	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					
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☒ Further documents are listed in the continuation of Box C.					
☒ See patent family annex.					
* Special categories of cited documents :					
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"E" earlier application or patent but published on or after the international filing date			"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		
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"O" document referring to an oral disclosure, use, exhibition or other means			"&" document member of the same patent family		
"P" document published prior to the international filing date but later than the priority date claimed					
Date of the actual completion of the international search			Date of mailing of the international search report		
26 July 2024			05/08/2024		
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016			Authorized officer Karlsson, Lennart		

INTERNATIONAL SEARCH REPORT

International application No

PCT/FI2024/050257

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A	WO 2022/144681 A1 (STORA ENSO OYJ [FI]) 7 July 2022 (2022-07-07) the whole document -----	1 - 20

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Information on patent family members

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