(54) **Title:** TREATED ARTICLE, METHODS OF MAKING THE TREATED ARTICLE, AND DISPERSION FOR USE IN MAKING THE TREATED ARTICLE

(57) **Abstract:** A treated article includes fibers, a sizing agent, and a retention aid. The sizing agent includes a wax or a component thereof having an acid value of from 10 mg to 220 mg, KOH/g as measured in accordance with USP 401. The retention aid includes a nitrogen-containing polymer independently selected from the group consisting of (i) a nitrogen-containing polymer of Formula I, (ii) a polyethyleneimine, (iii) a polyaminoamide, (iv) a copolymer formed from the reaction product of epichlorohydrin and dimethylamine, and (v) combinations thereof.

TREATED ARTICLE, METHODS OF MAKING THE TREATED ARTICLE, AND DISPERSION FOR USE IN MAKING THE TREATED ARTICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and all the advantages of United States Provisional Patent Application No. 63/212,776 filed on June 21, 2021 and United States Provisional Patent Application No. 63/121,500 filed on December 4, 2020, the disclosures of which are incorporated by reference in their entirety.

FIELD OF THE DISCLOSURE

[0002] The following disclosure relates to a treated article, methods of making the treated article, and a dispersion for use in making the treated article.

BACKGROUND OF THE DISCLOSURE

[0003] High performance treated articles (e.g. paper products) typically derive their performance from the inclusion of a fluoropolymer. Recent global trends towards the reduction of fluorine content in treated articles, especially articles used in the food industry, have resulted in articles that are considered more environmentally friendly. However, these environmentally friendly articles typically lack certain performance properties in comparison to their fluorine containing counterparts. Therefore, an opportunity remains to develop improved treated article, or a dispersion for making improved treated articles, having high performance.

SUMMARY OF THE DISCLOSURE AND ADVANTAGES

[0004] The present disclosure provides a treated article. The treated article includes fibers, a sizing agent, and a retention aid. The sizing agent includes a wax or a component thereof having an acid value of from 10 mg to 220 mg, KOH/g as measured in accordance with USP 401. The retention aid includes a nitrogen-containing polymer independently selected from the group consisting of (i) a nitrogen-containing polymer of Formula I, (ii) a polyethyleneimine, (iii) a polyaminoamide, (iv) a copolymer formed from the reaction product of epichlorohydrin and dimethylamine, and (v) combinations thereof.

[0005] The present disclosure also provides a dispersion for use in making the treated article. The dispersion includes a solvent, the sizing agent, and the retention aid.

[0006] The treated article is typically fluorine-free and has an excellent balance of performance properties. Specifically, the synergistic combination of the sizing agent and the retention aid

results in the treated article having excellent corn oil bleedthrough prevention/resistance and hot water repellency.

DETAILED DESCRIPTION

[0007] The present disclosure provides a dispersion for use in making a treated article. The dispersion includes three main components, a solvent, a sizing agent and a retention aid.

[0008] Referring first to the solvent, the solvent may include a variety of solvating liquids or may include a single liquid. The solvent generally includes at least water. Other liquids that may optionally be included in the solvent are liquids that are miscible with water. Specific examples of the water-miscible solvent include at least one solvent selected from the group of propylene glycol, dipropylene glycol, tripropylene glycol, propylene glycol monomethyl ether, propylene glycol monoethyl ether, dipropylene glyocol monomethyl ether, dipropylene glycol monoether ether, tripropylene glycol monomethyl ether, diacetone alcohol, and combinations thereof. Most typically, the solvent includes water or a combination of water and at least one water-miscible solvent selected from the group of propylene glycol, dipropylene glycol and tripropylene glycol.

[0009] The dispersion generally includes the solvent in an amount of at least 40 parts by weight, based on 100 parts by weight of the dispersion. Alternatively, the dispersion may include the solvent in an amount of from 40 to 90, from 50 to 90, from 60 to 90, from 70 to 90, from 80 to 90, from 50 to 80, 60 to 80, or about 70, parts by weight based on 100 parts by weight of the dispersion. For example, the solvent may include water (e.g. tap water) and dipropylene glycol, with the water present in an amount of from 50 to 75 parts by weight and the dipropylene glycol present in an amount of from 15 to 40 parts by weight, each based on 100 parts by weight of the dispersion.

[0010] Referring now to the sizing agent, the sizing agent includes a wax or component thereof. Persons having ordinary skill in the art understand that many waxes, particularly naturally occurring waxes, include a combination of individual components. For example, naturally occurring beeswax includes palmitate, palmitoleate, and oleate esters of long-chain (e.g. 30–32 carbons) aliphatic alcohols, with each individual component being a "component thereof" in relation to beeswax. For ease of reference, the term "wax or component thereof" will be collectively referred to as "wax" throughout the remaining description.

[0011] The wax of the sizing agent has an acid value of from 10 mg to 220 mg, KOH/g as measured in accordance with USP 401. Alternatively, the wax may have an acid value of from 10 to 200, 10 to 180, 10 to 160, 10 to 140, 10 to 120, 10 to 100, 10 to 80, 10 to 60, or 10 to 50, mg of

KOH/g. Alternatively still, the wax may have an acid value of from 20 to 100, 20 to 80, 20 to 60, 25 to 45, or 150 to 220 mg of KOH/g. For the purposes of this disclosure, any reference to the acid value of the wax is expressing an acid value that was measured in accordance with USP 401.

[0012] Although the wax is not limited to any particular wax, provided the wax has an acid value from 10 mg to 220 mg, KOH/g, typically the wax is selected from a group consisting of a stearate, beeswax (both synthetic and natural), candelilla wax, palmitate, behenate, and combinations thereof. For example, the wax of the sizing agent may be beeswax or a stearate, or both. Alternatively, the wax may be behenate or palmitate, or both.

[0013] The wax is generally present within the dispersion in an amount of from 10 to 50 parts by weight, based on 100 parts by weight of the dispersion. Alternatively, the wax may be present in an amount of from 10 to 45, 10 to 40, 10 to 35, 15 to 50, 20 to 50, or 25 to 50, parts by weight based on 100 parts by weight of the dispersion.

[0014] Those skilled in the art understand that the sizing agent including the wax is useful in the process of making the treated article because, as described in further detail below, the sizing agent is capable of being fixed, retained, anchored, incorporated, oriented, etc., within or by fibers within the treated article. As also described in further detail below, the sizing agent may be referred to as an internal sizing agent, an external sizing agent, or both, depending on the particular method that incorporates the dispersion within the process of making the treated article.

[0015] Referring now to the retention aid, the retention aid includes a nitrogen-containing polymer selected from the group consisting of: (i) a nitrogen-containing polymer of Formula I, (ii) a polyethyleneimine, (iii) a polyaminoamide, (iv) a copolymer formed from the reaction product of epichlorohydrin and dimethylamine, and (v) combinations thereof.

[0016] The nitrogen-containing polymer according to Formula I is shown below:

Formula I.

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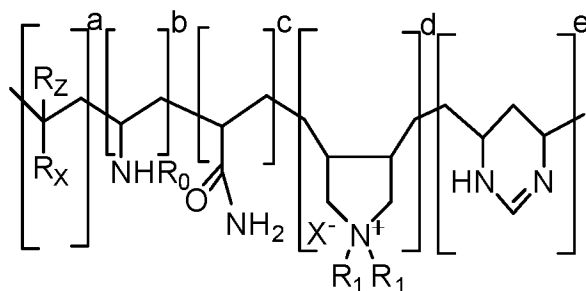
In Formula I, (a), (b), (c), (d), and (e) individually represent the molar percent of each repeating unit included in the nitrogen-containing polymer of Formula I. R_0 is independently selected from the group consisting of:
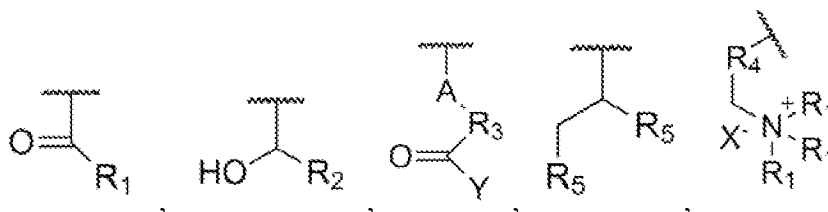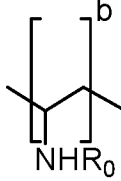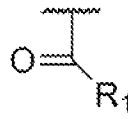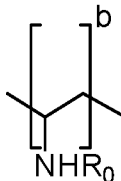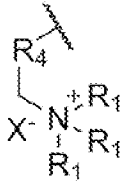

of hydrogen,

and combinations thereof. R_z is independently selected from H, -CH$_3$, and combinations thereof. R_x is independently selected from H, -OH, -COOH, -COOR$_1$, -OCOR$_1$, -R$_1$, -R$_3$OH, -OR$_1$, -NR$_1$R$_1$, -R$_3$NH$_2$, -NH$_2$, -COO(CH$_2$)$_2$N(R$_1$)$_2$, -COO(CH$_2$)$_3$N(R$_1$)$_2$, -COO(CH$_2$)$_2$N$^+$(R$_1$)$_3$X$^-$, -COO(CH$_2$)$_3$N$^+$(R$_1$)$_3$X$^-$, and combinations thereof, with the proviso that when R_x is -NH$_2$, R_z is -CH$_3$. Y is independently selected from H, -OH, -R$_1$, -OR$_1$, -NR$_1$R$_1$, -NH$_2$, and combinations thereof. Z is independently selected from H, -OH, -C=O, -R$_1$, -OR$_1$, -NR$_1$R$_1$, -NH$_2$ and combinations thereof. R_1 is independently selected from H, a straight chain or branched alkyl or alkenyl containing up to 22 carbons, and combinations thereof. R_2 is independently selected from H, a monosaccharide, an oligosaccharide, polysaccharide moiety, a straight or branched alkyl or alkenyl group up to 22 carbons optionally containing a hydroxyl or aldehyde group, and combinations thereof. R_3 is independently selected from a straight chain or branched alkyl or alkenyl containing up to 22 carbons or combinations thereof. R_4 is independently selected from a straight chain or branched alkyl group containing up to 18 carbons, optionally substituted with a hydroxyl group, and combinations thereof. R_5 is independently selected from H, -OH, -COOH, -COOR$_1$, -OCOR$_1$, -R$_1$, -R$_1$OH, -OR$_1$, -CONH$_2$, -CONHCHOHCHO, -NR$_1$, -NR$_1$R$_1$, -R$_1$NH$_2$, -NH$_2$, and combinations thereof. A is independently selected from C=O, -CH$_2$, and combinations thereof. Finally, X$^-$ is independently an anion.
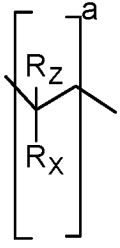
[0017]   As described above, (a), (b), (c), (d), and (e) of Formula I individually represent the molar percent of each repeating unit included in the nitrogen-containing polymer of Formula I. For ease of reference, the repeating unit with molar percent (a) will be referred to as repeating unit (a), the repeating unit with molar percent (b) will be referred to as repeating unit (b), the repeating unit with molar percent (c) will be referred to as repeating unit (c), the repeating unit with molar percent (d) will be referred to as repeating unit (d), and the repeating unit with molar percent (e) will be referred to as repeating unit (e). It should also be appreciated that the structural formula

representing each individual repeating unit represents multiple discrete repeating units. The molar percent for each repeat unit is the combined molar percent of each discrete unit represented by the repeating unit. For example, when the nitrogen-containing polymer of Formula I includes

repeating unit (b), NHR_0 with R0 represented by $\overset{O}{=}\overset{}{\underset{R_1}{}}$ in an amount of 50 mol.% and

repeating unit (b), NHR_0 , with R0 represented by $\underset{R_1}{\overset{R_4}{\underset{X^-N^+R_1}{N}}}$ in an amount of 50 mol.%, the nitrogen-containing polymer includes repeating unit (b) in a combined total amount of 100 mol.%. It is also to be appreciated that the individual repeating units within the nitrogen-containing polymer of Formula I are randomly distributed.

[0018]   The value of each individual molar percent represented by (a), (b), (c), (d), and (e) may range from 0 to 100 mol.%, with the sum of (a), (b), (c), (d), and (e) being 100 mol.%. This means that the nitrogen-containing polymer of Formula I does not include additional units that repeat within its structure. When the molar percent of (a) is zero, the nitrogen-containing polymer does not include repeating unit (a). Conversely, when the molar percent of (a) is 100, the nitrogen-containing polymer does not include repeats units (b), (c), (d), and (e).

[0019]   Referring now to repeating unit (a), $\left[\underset{R_x}{\overset{R_z}{|}}\right]_a$, typically the molar percent of (a) within repeating unit (a) is less than 100 mol.%. In other words, typically when repeating unit (a) is included in the nitrogen-containing polymer of Formula I, the nitrogen-containing polymer includes at least one additional repeating unit. Typically, when repeating unit (a) is combined with additional repeating units, the molar percent (a) of repeating unit (a) is less than 30 mol.%. However, when the molar percent (a) of repeating unit (a) is 100 mol.%, R_x is independently selected from $-NR_1R_1$, $-R_3NH_2$, $-NH_2$, $-COO(CH_2)_2N(R_1)_2$, $-COO(CH_2)_3N(R_1)_2$, -

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$COO(CH_2)_2N^+(R_1)_3X^-$, $-COO(CH_2)_3N^+(R_1)_3X^-$, and combinations thereof. In other words, when the molar percent of repeating unit (a) is 100 mol.%, R_x is selected such that repeating unit (a) includes nitrogen.
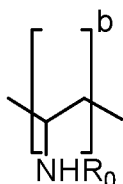
[0020] Referring now to repeating unit (b), , repeating unit (b) may be included in the nitrogen-containing polymer of Formula I in a molar percent from 0 to 100. When the nitrogen-containing polymer includes repeating unit (b), repeating unit (b) is typically included in an amount of at least 15 mol.%. Alternatively, the repeating unit (b) may be included in an amount of at least 30, 40, 50, 60, 70, 80, or 90, mol.%.

[0021] In certain embodiments, R_0 is independently selected from the group consisting of H,
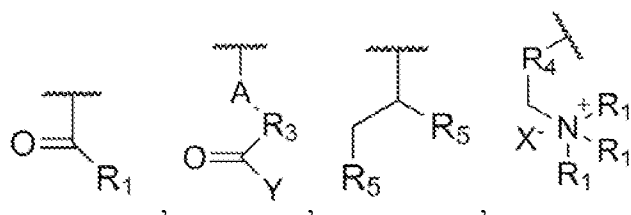
, and combinations thereof. In other words, in
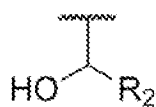
these embodiments, R_0 does not include   . In other embodiment, R_0 is independently
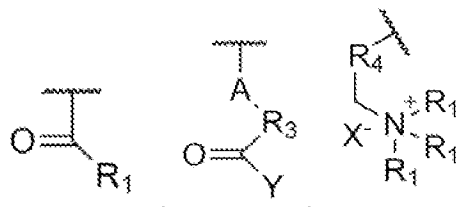
selected from the group consisting of H,   , and combinations thereof. In still further embodiments, R_0 is independently selected from the group consisting of
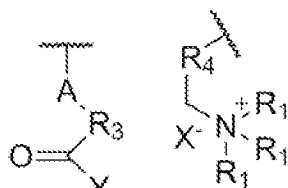
H,   , and combinations thereof. Although not required, in each of the embodiments within this paragraph, the combined molar percent of repeating units (c) and (d) is

typically less than 5 mol.%. In other words, in these embodiments, the combined molar percent of repeating units (a), (b), and (e) is at least 95 mol.% and typically 100 mol.%.

[0022] In certain embodiments, the retention aid is the nitrogen-containing polymer of Formula I and the combined molar percent of repeating units (c) and (d) is less than 5 mol.%. Or said differently, in these embodiments, the retention aid is the nitrogen-containing polymer of Formula I and repeating units (a), (b), and (e) collectively represent at least 95 mol.% of the nitrogen-containing polymer. Alternatively, the retention aid is the nitrogen-containing polymer of Formula I and repeating units (a), (b), and (e) collectively represent at least 96, 97, 98, 99, or 100 mol.%.

[0023] When the retention aid is the nitrogen-containing polymer of Formula I and repeating units (a), (b), and (e) are collectively present at 100 mol.%, the nitrogen-containing polymer is represented by Formula II:
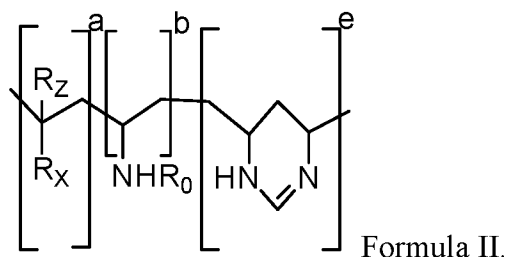
Formula II.

[0024] In certain embodiments when the retention aid is the nitrogen-containing polymer of

Formula II, R_0 is independently selected from the group consisting of H,
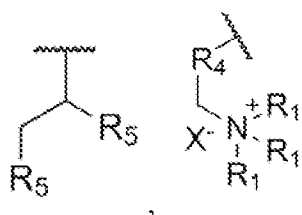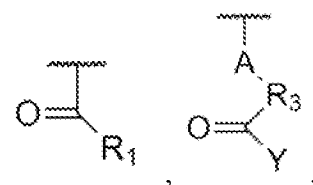
, and combinations thereof. In other embodiments of Formula II, R_0 is

independently selected from the group consisting of H,   ,   ,   , and

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combinations thereof. In still further embodiments of Formula II, R_0 is independently selected

from the group consisting of H, [structure with A, R_3, O, Y], [structure with R_4, X^-, N^+, R_1, R_1, R_1], and combinations thereof.

[0025] In certain embodiments when the retention aid is the nitrogen-containing polymer of Formula II, the retention aid is independently selected from a group consisting of (i) the nitrogen-containing polymer of Formula II with the combined molar percent of (b) and (e) being 100 mol.%,

and R_0 is independently selected from the group consisting of H, [structure O=, R_1] and combinations thereof, (ii) the nitrogen-containing polymer of Formula II with the molar percent of (a) being 100 mol.% with R_x represented by $-R_3NH_2$, and (iii) the nitrogen-containing polymer of Formula II with the molar percent of (b) being 100 mol.%, and R_0 independently selected from the group

consisting of H, [structure with A, R_3, O, Y], [structure with R_4, X^-, N^+, R_1, R_1, R_1], and combinations thereof. Within this embodiment, when the retention aid includes (i) the nitrogen-containing polymer of Formula II with the combined molar percent of (b) and (e) being 100 mol.%, and R_0 is independently selected from the group

consisting of H, [structure O=, R_1] and combinations, the retention aid may be more narrowly defined as Formula IIa:

[structure Formula IIa with b_1, b_2, e, NH_2, NH, HN=N, O, H]

Formula IIa.

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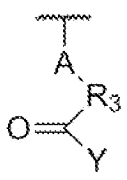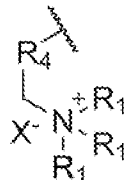
Likewise, within this embodiment, when the retention aid includes (ii) the nitrogen-containing polymer of Formula II with the molar percent of (a) being 100 mol.% with R_x represented by -R_3NH_2, the retention aid may be more narrowly defined as Formula IIb:

Formula IIb.

Likewise, within this embodiment, when the retention aid includes (iii) the nitrogen-containing polymer of Formula II with the molar percent of (b) being 100 mol.%, and R_0 independently

selected from the group consisting of H, , , and combinations thereof, the retention aid may be more narrowly defined as Formula IIc:
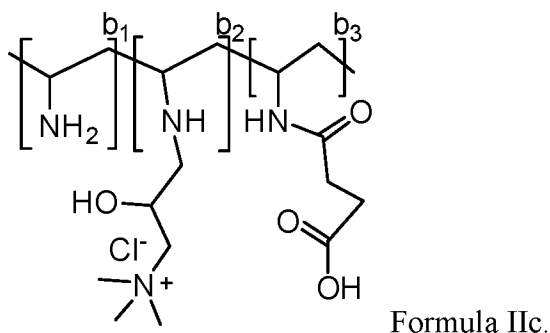
Formula IIc.

[0026] When the retention aid is represented by or includes Formula IIa, (b_1) and (b_2) represent the molar percent of the associated repeating unit, with the combined molar percent of (b_1) and (b_2) equal to the total molar percent of (b) in Formula II. In other words, repeating unit (b_1) is a first repeating unit derived from repeating unit (b) of Formula II and repeating unit (b_2) is a second repeating unit derived from repeating unit (b). Similarly, when the retention aid is represented by or includes Formula IIc, (b_1), (b_2), and (b_3) represent the molar percent of the associated repeating unit, with the combined molar percent of (b_1), (b_2), and (b_3) equal to the total molar percent of (b) in Formula II.

[0027] When the retention aid is or includes the nitrogen-containing polymer of Formula IIa, the nitrogen-containing polymer may be referred to as a partially hydrolyzed poly(n-vinylformamide).

The degree of hydrolysis will determine the molar value of each repeating unit. Typically, the partially hydrolyzed poly(n-vinylformamide) is hydrolyzed from 30 to 70%, based on the total amount of functional groups that were capable of being hydrolyzed. Alternatively, the partially hydrolyzed poly(n-vinylformamide) may be hydrolyzed from 30 to 60, 40 to 70, 40 to 60, or about 50%, based on the total amount of functional groups that were capable of being hydrolyzed.

[0028] When retention aid is or includes the nitrogen-containing polymer of Formula IIb, the nitrogen-containing polymer may be referred to as a polyallylamine. Although not required, the polyallylamine typically has a weight average molecular weight of from 30,000 to 100,000 daltons. Alternatively, the polyallylamine may have a weight average molecular weight of from 30,000 to 90,000, from 30,000 to 80,000, from 30,000 to 70,000, from 40,000 to 90,000, from 50,000 to 80,000, from 60,000 to 70,000, or about 65,000, daltons.

[0029] When the retention aid is or includes the nitrogen-containing polymer of Formula IIc, the nitrogen-containing polymer may be referred to as formamide, N-ethenyl-, homopolymer, hydrolyzed, N-(3-carboxy-1-oxopropyl) N-[2-hydroxy-3-(trimethylammonio)propyl] derivatives, chlorides (CAS Reg. No. 945630-11-5). Although persons of skill in the art would readily recognize that multiple reaction pathways may be used to synthesize the nitrogen-containing polymer of Formula IIc, example 5 of U.S. Pat. No. 8,604,134 discloses a suitable process. The disclosure of U.S. Pat. No. 8,604,134, as it relates to the nitrogen-containing polymer of Formula IIc, is hereby incorporated by reference.
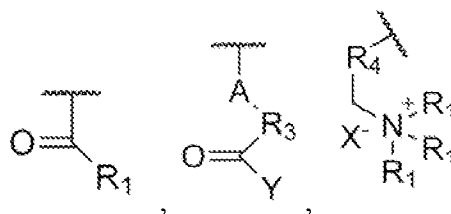
[0030] In certain embodiments when the retention aid is the nitrogen-containing polymer of Formula II, the retention aid is 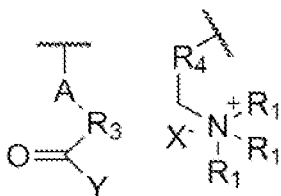independently selected from a group consisting of (i) the partially hydrolyzed poly(n-vinylformamide), with the degree of hydrolysis being from 30 to 70%, (ii) the nitrogen-containing polymer of Formula II with the molar percent of (a) being 100 mol.% with R_x represented by $-R_3NH_2$, and (iii) the nitrogen-containing polymer of Formula II with the molar percent of (b) being 100 mol.%, and R_0 independently selected from the group consisting of H,
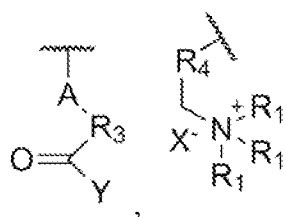
, and combinations thereof.

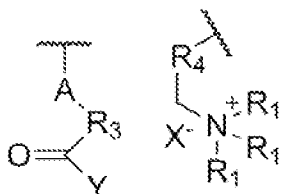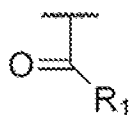[0031] In certain embodiments when the retention aid is the nitrogen-containing polymer of Formula II, the retention aid is independently selected from a group consisting of (i) the nitrogen-

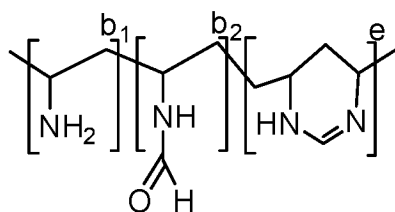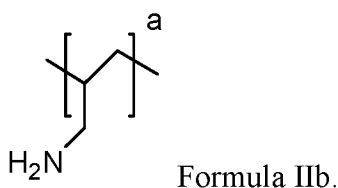containing polymer of Formula II with the combined molar percent of (b) and (e) being 100 mol.%,

$$O = \underset{R_1}{\overset{\wedge}{\biggr<}}$$
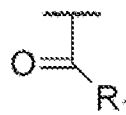
and R_0 is independently selected from the group consisting of H,   and combinations

thereof, (ii) the polyallylamine having a weight average molecular weight of from 30,000 to

100,000 daltons, and (iii) the nitrogen-containing polymer of Formula II with the molar percent of
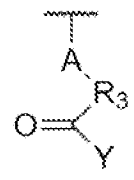
$$\underset{O=}{\overset{A}{\underset{\diagdown}{\biggr<}}} \underset{Y}{\overset{R_3}{\biggr<}}$$

(b) being 100 mol.%, and R_0 independently selected from the group consisting of H,   ,

$$X^- \underset{\underset{R_1}{|}}{\overset{R_4}{\underset{N^+}{\biggr<}}} \overset{R_1}{\underset{R_1}{\biggr<}}$$
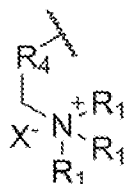
, and combinations thereof.

[0032]   In certain embodiments when the retention aid is the nitrogen-containing polymer of
Formula II, the retention aid is independently selected from a group consisting of (i) the nitrogen-
containing polymer of Formula II with the combined molar percent of (b) and (e) being 100 mol.%,

$$O = \underset{R_1}{\overset{\wedge}{\biggr<}}$$
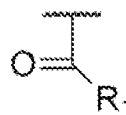
and R_0 is independently selected from the group consisting of H,   and combinations

thereof, (ii) the nitrogen-containing polymer of Formula II with the molar percent of (a) being 100

mol.% with R_x represented by -R_3NH_2, and (iii) the formamide, N-ethenyl-, homopolymer,

hydrolyzed, N-(3-carboxy-1-oxopropyl) N-[2-hydroxy-3-(trimethylammonio)propyl] derivatives,

chlorides (CAS Reg. No. 945630-11-5), and combinations thereof.

[0033]   In certain embodiments when the retention aid is the nitrogen-containing polymer of
Formula II, the molar concentration of repeating unit (a) is zero, such that Formula II is further
defined by Formula III:
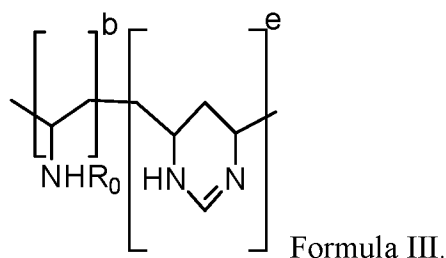
Formula III.

When the retention aid is the nitrogen-containing polymer of Formula III, the retention aid may be even further defined as Formula IIIa:
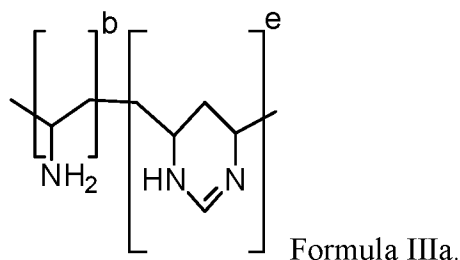
Formula IIIa.

[0034] The nitrogen-containing polymer of Formula IIIa may generally be referred to as a fully hydrolyzed poly(n-vinylformamide). In other words, unlike the nitrogen-containing polymer of Formula IIa, essentially all of the functional groups capable of being hydrolyzed are in fact hydrolyzed in the nitrogen-containing polymer of Formula IIIa.

[0035] In certain embodiments when the retention aid is the nitrogen-containing polymer of Formula I, the molar percent of (c) corresponding to repeating unit (c) is 100 mol.%, such that the nitrogen-containing polymer is a polyacrylamide according to Formula IV.

Formula IV.
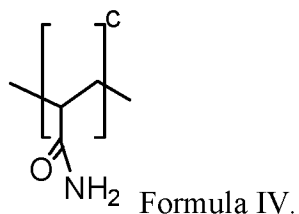
When the retention aid is a polyacrylamide, the polyacrylamide typically has a weight average molecular weight of from 5,000,000 to 6,000,000 daltons.

[0036] In different embodiments, the retention aid is a nitrogen-containing polymer selected from the group consisting of: (i) a polyethyleneimine, (ii) a polyaminoamide, (iii) a poly(diallyldimethylammonium chloride), and (iv) combinations thereof.

[0037] When the retention aid is a polyethyleneimine, the polyethyleneimine typically has a weight average molecular weight of from 40,000 to 100,000, daltons. In addition, typically from

15 to 35% of the amine groups within the polyethyleneimine are primary amines and from 35 to 65% of the amine groups within the polyethyleneimine are secondary amines, based on the total number of amine groups within the polyethyleneimine. Alternatively, 20 to 30% or about 25% of the amine groups within the polyethyleneimine are primary amines and from 45 to 55% or about 50% of the amine groups within the polyethyleneimine are secondary amines, based on the total number of amine groups within the polyethyleneimine.

[0038] The poly(diallyldimethylammonium chloride) may be a low molecular weight poly(diallyldimethylammonium chloride), a high molecular weight poly(diallyldimethylammonium chloride), or a combination thereof. In particular, the low molecular weight poly(diallyldimethylammonium chloride) has a weight average molecular weight of less than 200,000 daltons. In contrast, the high molecular weight poly(diallyldimethylammonium chloride) has a weight average molecular weight of from 300,000 to 400,000 daltons.

[0039] In each embodiment of the retention aid described above, the nitrogen-containing polymer may have a charge density of $> +0.1$ meq/g when the dispersion has a pH of 7. Although not required, typically the nitrogen-containing polymer has a charge density of from +5 to +13 meq/g. In addition, in each embodiment of the retention aid described above, when the nitrogen-containing polymer includes more than one repeating unit, the repeating units are typically randomly distributed within the nitrogen-containing polymer. Finally, in each embodiment of this disclosure, the dispersion is typically free of (i.e., does not include) fluorine containing polymers and fluorine containing performance additives.

[0040] The dispersion typically includes the retention aid in an amount of from 0.1 to 12 parts by weight, based on 100 parts by weight of the dispersion. Alternatively, the retention aid may be present in the dispersion in an amount of from 0.1 to 12, from 0.3 to 12, from 0.5 to 12, from 0.7 to 12, from 0.9 to 12, from 2.0 to 12, from 3.0 to 12, from 4.0 to 12, from 5.0 to 12, from 0.1 to 10, from 0.1 to 8, from 0.1 to 6, or from 0.1 to 4, parts by weight based on 100 parts by weight of the dispersion.

[0041] In certain embodiments, the dispersion includes the sizing agent selected from a group consisting of a stearate, beeswax, candelilla wax, palmitate, behenate, and combinations thereof. The dispersion also includes the nitrogen-containing polymer of Formula II:

Formula II.
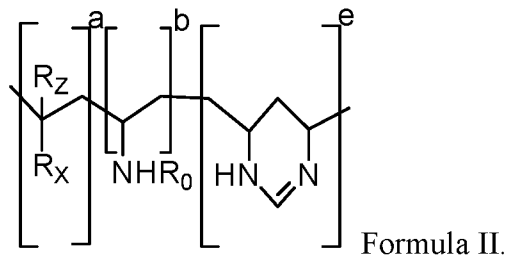
In these embodiments, the nitrogen-containing polymer has a charge density of > +0.1 meq/g when the dispersion has a pH of 7.

[0042] In other embodiments, the dispersion includes the sizing agent selected from a group consisting of a stearate, beeswax, candelilla wax, palmitate, behenate, and combinations thereof. The dispersion also includes the nitrogen-containing polymer selected from the group consisting of Formula IIa, Formula IIb, Formula IIc, and combinations thereof:
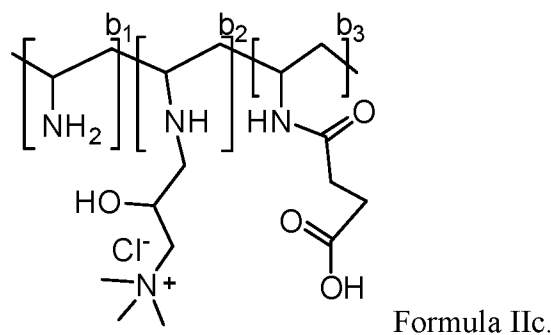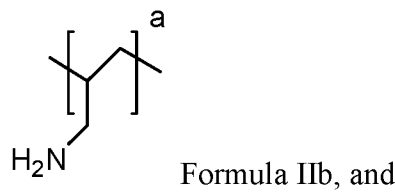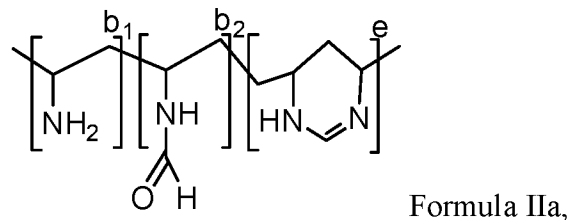
Formula IIa,

Formula IIb, and

Formula IIc.

In these embodiments, the nitrogen-containing polymer has a charge density of > +0.1 meq/g when the dispersion has a pH of 7.

[0043] In certain embodiments, the dispersion includes the sizing agent selected from a group consisting of a stearate, beeswax, candelilla wax, palmitate, behenate, and combinations thereof.

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In different embodiments, the retention aid is a nitrogen-containing polymer selected from the group consisting of: (i) a polyethyleneimine, (ii) a polyaminoamide, (iii) a poly(diallyldimethylammonium chloride), and (iv) combinations thereof. In one embodiment, the sizing agent is behenate and the retention aid is a nitrogen-containing polymer selected from the group consisting of: (i) a polyethyleneimine, (ii) a polyaminoamide, (iii) a poly(diallyldimethylammonium chloride), and (iv) combinations thereof. In addition, the nitrogen-containing polymer has a charge density of > +0.1 meq/g when the dispersion has a pH of 7.

[0044] When the nitrogen-containing polymer is or includes the polyethyleneimine, the polyethyleneimine typically has a weight average molecular weight of from 40,000 to 100,000, daltons and 20 to 30% of the amine groups within the polyethyleneimine are primary amines and from 45 to 55% of the amine groups within the polyethyleneimine are secondary amines, based on the total number of amine groups within the polyethyleneimine. When the nitrogen-containing polymer is or includes the poly(diallyldimethylammonium chloride), the poly(diallyldimethylammonium chloride) either has a weight average molecular weight of less than 200,000 daltons or from 300,000 to 400,000 daltons.

[0045] In certain embodiments, the dispersion includes the sizing agent selected from a group consisting of a stearate, beeswax, candelilla wax, palmitate, behenate, and combinations thereof. In these embodiments, the retention aid may also include or be a polyacrylamide having a weight average molecular weight of from 5,000,000 to 6,000,000 daltons.

[0046] Although not required the dispersion may also include a surfactant for increasing the stability of the dispersion. The surfactant may be an anionic surfactant, a nonionic surfactant, a cationic surfactant, an amphoteric surfactant, or a polymeric surfactant. Among these, anionic surfactants, nonionic surfactants or cationic surfactants are typically used. When included, the surfactant is typically present in an amount of from 0.1 to 5 parts by weight, based on 100 parts by weight of the dispersion. Suitable examples of anionic surfactants include alkyl carbonate-based compounds, alkyl sulfate-based compounds and alkyl phosphates. Specific examples of anionic surfactants include dioctyl sulfosuccinate sodium salt, sodium dodecyl sulfate, and sodium lauryl sulfate. Suitable examples of nonionic surfactants include ethylene oxide and/or propylene oxide adducts of alcohols having 1 to 18 carbon atoms, ethylene oxide and/or propylene oxide adducts of alkyl phenols, and ethylene oxide and/or propylene oxide adducts of alkylene glycols and/or

alkylene diamines. Suitable examples of cationic surfactants include primary to tertiary amines, pyridinium salts, alkyl pyridinium salts and quaternary ammonium salts such as quaternary alkyl halide ammonium salts.

[0047]   Without being held to any particular theory, it is believed that a first portion of the amine groups of the retention aid associate with the oxygen atoms present in the ester and/or acids of the sizing agent via hydrogen or electrostatic bonding. It is further believed that the remaining portion of the amine groups bond or associate with hydroxyl groups present on the fibers, such as cellulose-based pulp fibers, also included in the treated article. In other words, the retention aid bonds or associates with to both the sizing agent and to fibers. As described further below, during the process of making the treated article, the bonding of the retention aid to both the sizing agent and the fibers fixes, retains, anchors, incorporates, orients, etc. the retention aid between and on the surface of adjacent fibers to create a dense network/matrix. It is further believed that the particular sizing agents and retention aids of this disclosure have a strong interaction, which results in an effective dispersion of the retention aid and sizing agent throughout the treated article. Treated articles prepared with the dispersion of this disclosure, in comparison to conventional treated articles prepared without the dispersion of this disclosure, have relatively less air pockets and channels within the treated article. This result is believed to be achieved because the sizing agent and retention aid effectively fills or seals these air pockets and/or channels. This decrease in the relative amount of air pockets and channels is significant and provides the treated article with enhanced barrier properties. Specifically, a treated article prepared with the dispersion of this disclosure has a relatively greater resistance to both water and oil penetration in comparison to conventional treated articles.

[0048]   The present disclosure also provides a treated article formed from the dispersion. The treated article includes the retention aid, the sizing agent, and fibers. The type of fiber is not limited to any particular type, although in certain embodiments it may be advantageous to select a fiber that has the capability to bond with the amine group of the retention aid.

[0049]   The treated article may be a paper product, food packaging, non-food contact packaging, wood or construction materials, nonwovens, molded fiber such as paper plates, takeout containers, bowls, etc., or any paper-like substrate, especially paper-like substrates in which water and/or oil resistance is advantageous.

[0050]   The fibers may be natural fibers, synthetic fibers, semi-synthetic fibers, inorganic fibers, and combinations thereof. Specific examples of natural fibers include those derived from plant or wood matter, which may also be referred to as cellulosic fibers, such as bamboo fibers, bent grass fibers, sawgrass fibers, bagasse fibers, straw fibers, hay fibers, spruce fibers, pine fibers, fir fibers, larch fibers, eucalyptus fibers, aspen fibers, birch fibers, etc. When the natural fibers are derived from wood matter, the wood matter may be softwood and/or hardwood. Other examples of natural fibers include cotton, hemp, wool, silk, etc. Specific examples of synthetic fibers include polyamide fibers, polyester fibers, polyvinyl alcohol fibers, polyacrylonitrile fibers, polyvinyl chloride fibers, polypropylene fibers, etc. In certain embodiments, the fibers are pulp fibers from bleached and unbleached sulfate (kraft) hardwood or softwood pulps, groundwood, recycled cellulosic fibers, and bleached chemi-thermomechanical pulp (BCTMP), and combinations thereof.

[0051]   In one embodiment, the treated article (i.e., the dried and final treated article ready for a consumer) may include fibers in an amount of from 16 to 99.8 parts by weight, the sizing agent in an amount of from 0.1 to 80 parts by weight, and the retention aid in an amount of from 0.1 to 4 parts by weight, each based on 100 parts by weight of the treated article. Alternatively, the treated article may include fibers in an amount of from 47 to 99.8 parts by weight, the sizing agent in an amount of from 1 to 50 parts by weight, and the retention aid in an amount of from 0.2 to 3 parts by weight, each based on 100 parts by weight of the treated article. Alternatively still, the treated article may include fibers in an amount of from 78 to 97.2 parts by weight, the sizing agent in an amount of from 2.5 to 20 parts by weight, and the retention aid in an amount of from 0.3 to 2 parts by weight, each based on 100 parts by weight of the treated article.

[0052]   The treated article may also include components in addition to the retention aid, sizing agent and fibers. For example, the treated article may further include a starch, a resin, a crosslinking agent, a catalyst, an inorganic or organic filler, a coagulant, a supporting agent (e.g. dextrin), a holding agent, a flocculant, a buffering agent, a bactericide, a biocide, a metal ion-sealing agent, a hydrophobizing agent (e.g. alkenyl succinic anhydride and/or alkyl ketene dimer), and the like, as well as various combinations of such components.

[0053]   Specific examples of starches suitable for the treated article include, but are not limited to, a hydroxyethylated starch, a cationic starch, an amphoteric starch, an oxidized starch, a phosphorylated starch, an enzyme-modified starch, and combinations thereof.

[0054] Specific examples of resins suitable for the treated article include, but are not limited to, a polyvinyl alcohol, a polyvinyl chloride latex, a polyvinyl alcohol, etc.

[0055] Specific examples of crosslinking agents suitable for treated article include, but are not limited to, a condensate or precondensate of urea or melamine-formaldehyde, methylol-dihydroxyethylene-urea or a derivative thereof, urone, methylol-ethylene-urea, methylol-propylene-urea, methylol-triazone, a dicyandiamide-formaldehyde condensate, methylol carbamate, methylol(meth)acrylamide, a polymer thereof, divinyl sulfone, polyamide or a cationic derivative thereof, a pyridinium salt of ethylene glycol chloromethyl ether, glyoxal, and combinations thereof.

[0056] Specific examples of catalysts suitable for the purposes of the treated article include, but are not limited to, ammonium chloride, an alkanolamine salt, a zirconium acetate salt, and combinations thereof.

[0057] Specific examples of inorganic fillers include, but are not limited to, silica, alumina, sericin, resin powder, talc, kaolin, precipitated calcium carbonate, ground calcium carbonate, bentonite, clays, titanium dioxide, and the like.

[0058] The particular components present in the treated article, as well as their respective amounts, may vary dependent upon the particular fibers employed in the slurry, as well as the desired end use of the treated article.

[0059] The present disclosure also provides a method for making the treated article. The method includes providing a slurry including fibers. The slurry may be provided in any suitable manner. For example, the slurry may be prepared, obtained, purchased, etc. When the step of providing the slurry comprises preparing the slurry, the slurry may be prepared in accordance with methods generally known in the art. For example, in embodiments in which the fibers are cellulosic fibers, the slurry may be prepared by mechanical pulping processes; thermomechanical pulping processes; chemi-thermomechanical pulping processes; chemical pulping processes, such as Kraft processes, Sulfite processes, and Soda processes; recycled pulping processes; organosolv pulping processes; etc. Alternatively, the slurry may be prepared by purchasing or otherwise obtaining dried cellulosic fibers, which are generally referred to in the art as "market pulp." In these embodiments, the market pulp is generally reconstituted into water, which is referred to as hydropulping. The fibers may be bleached, contingent upon the desired appearance of the treated

article. When bleached, the fibers may be bleached with, for example, chlorine, chlorine dioxide, oxygen, ozone, hydrogen peroxide, etc.

[0060]   Typically, the fibers are present in the slurry in an amount of from greater than 0 to 5, alternatively from 0.2 to 3.75, alternatively from 0.3 to 3 parts by weight based on 100 parts by weight of the slurry. Of course, it is to be appreciated that the fibers may be present in the slurry in amounts other than those set forth above contingent on the presence or absence of various optional components, as described in greater detail below. The balance of the slurry typically comprises water or a combination of water and water-miscible solvent.

[0061]   In certain embodiments in which the fibers are cellulosic fibers, the fibers of the slurry are typically refined. Typically, the fibers of the slurry are refined by subjecting the slurry to shear forces, which separate cellulosic masses or fiber clusters into individual fibers. Generally, the fibers of the slurry are not refined until the slurry is prepared or provided, i.e., "market pulp" is typically not refined until it has been reconstituted into water to form the slurry.

[0062]   The method further includes combining the dispersion with the slurry.   In this embodiment of the method, persons having ordinary skill in the art recognize that the sizing agent may be more commonly referred to as an internal sizing agent. Once combined, the slurry and the dispersion are typically mixed to disperse the dispersion throughout the slurry.

[0063]   The method further includes forming a treated article from the slurry including the dispersion. Typically, the slurry is formed into at least one sheet. For purposes of clarity, the at least one sheet is referred to herein merely as "the sheet," which is to be understood to encompass even a plurality of sheets. Methods of forming treated articles into sheet form are well known in the art. For example, the sheet is typically formed on a metal substrate, such as stainless steel, or what is referred to in the art as monofilament wire. The relative dimensions (e.g. thickness, length, width) of the sheet may vary contingent on a variety of factors, such as the desired end use of the treated article formed via the method.

[0064]   Once formed, the sheet is typically dried to remove excess solvent (e.g. water and/or water-miscible solvent). The sheet may be dried via vacuum and/or foil dewatering. Alternatively, the sheet may be dried via press dewatering, in which a pressure is applied to the sheet. The pressure utilized when the sheet is dried via press dewatering is typically from 0.5 to 200 psig. Further, the sheet may be dried via contract dewatering, in which the sheet is dried via exposure to paper machine clothing, which absorbs excess water and/or the water-miscible solvent from the

sheet. In addition, the sheet may be dried via contract drying, in which the sheet is in contact with metal rollers having a smooth surface. The metal rollers utilized in contract drying are typically heated, e.g. from 150 to 280°F. Any combination of these methods, or additional methods of drying the sheet to remove excess water and/or water-miscible solvent which are known in the art, may be employed. In certain embodiments, all of the methods of drying the sheet described above are employed, typically in the order in which they are introduced above.

[0065]   The present disclosure also provides a method of providing a surface treated article. The method includes forming a sheet from a fiber slurry (e.g. a pulp slurry) as described above, except that the dispersion is not combined with the fiber slurry prior to the formation of the sheet. Instead, the dispersion is applied to at least one surface of the sheet after the sheet is formed.   In this embodiment of the method, persons having ordinary skill in the art recognize that the sizing agent may be more commonly referred to as an external sizing agent. The dispersion may be applied to the sheet before excess water is removed from the sheet or when the sheet is considered to be dried.

[0066]   The step of applying the dispersion to at least one surface of the sheet is not particularly limited so long as it is capable of creating intimate contact between the dispersion and the sheet. For example, the dispersion may be applied on at least one surface of the sheet by spraying, brushing, padding, size press coating, metering size press coating, film press coating, gravure coating, flexo coating, roller coating, rotor dampening, foaming, gate roll coating, bill blade coating, bar coating, intaglio coating, reverse roll coating, skid roll coating, transfer (offset) roll coating, knife coating, knife-over-roll coating, J-coating, air knife coating, curtain coating, and combinations thereof.

[0067]   In certain embodiments, the method of forming the treated article combines both methods described above. Specifically, in this embodiment, the dispersion is added both to the slurry prior to the formation of the sheet and then subsequently applied to at least one surface of the sheet after the sheet is formed. Persons having ordinary skill in the art recognize that this method includes both an internal and external sizing step.

[0068]   The disclosure further provides an additional method of making a treated article. Unlike the previous methods, this method does not form the dispersion and subsequently add the dispersion to the slurry. Instead, the retention aid and the sizing agent are separately added to the slurry without first being combined into a single composition. In other words, instead of adding a dispersion including the retention aid and the sizing agent to the slurry, the retention aid is added

to the slurry without the retention aid being previously combined with the sizing agent. Similarly, the sizing agent is added to the slurry without the sizing agent being previously combined with the retention aid. The order of addition of the sizing agent and the retention aid within this embodiment is not limited. For example, the sizing agent may be added to the slurry followed by the retention aid, or vice versa. Of course, the sizing agent and the retention aid can also be simultaneously added without being previously combined with each other.

[0069]   The present disclosure also provides another embodiment of the dispersion that is different than the previous embodiments. In this embodiment, the dispersion includes a reaction product of the sizing agent and the retention aid. Although not required, the reaction product may form when an amine group present on the retention aid reacts with an alkyl acid of the sizing agent. In certain embodiments, the dispersion may include the reaction product rather than separately including the sizing agent and the retention aid. Alternatively, the dispersion may include the solvent, the retention aid, the sizing agent, and further include the reaction product between the retention aid and the sizing agent. For example, the reaction product may be an amidation reaction between the amine group of the retention aid, typically a primary amine group, and the alkyl acid of the sizing agent.

[0070]   In one embodiment, the reaction product is formed when the retention aid is the polyethyleneimine and the sizing agent, such as when the sizing agent includes an alkyl acid (e.g. steric acid). In this embodiment, the retention aid typically is represented by the chemical structure shown below:
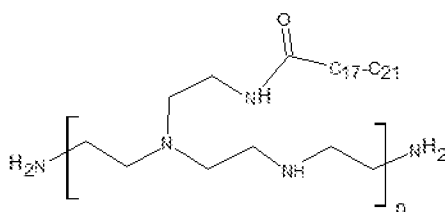
With n representing the number of repeat units.

[0071]   In another embodiment, the reaction product is formed from the reaction between the sizing agent and the primary amine group of Formula IIa,
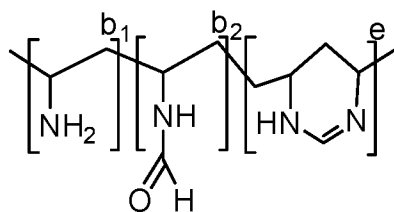
Formula IIa,

such that the reaction product is represented by Formula IIa':
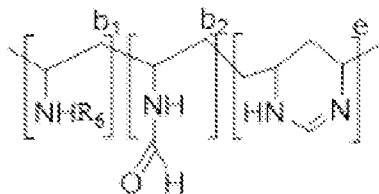
Formula IIa'.

In Formula IIa', R_6 represents $C(=O)R_1$. Although not required, R_1 is typically a straight chain or branched alkyl or alkenyl containing 17 to 21 carbon atoms.

[0072]   In another embodiment, the reaction product is formed from the reaction between the sizing agent and the primary amine group of Formula IIb,
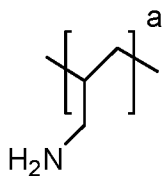
Formula IIb,

such that the reaction product is represented by Formula IIb'
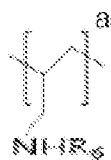
Formula IIb'.

In Formula IIb', R_6 represents $C(=O)R_1$. Although not required, R_1 is typically a straight chain or branched alkyl or alkenyl containing 17 to 21 carbon atoms.

[0073]   In another embodiment, the reaction product is formed from the reaction between the sizing agent and the primary amine group of Formula IIc,

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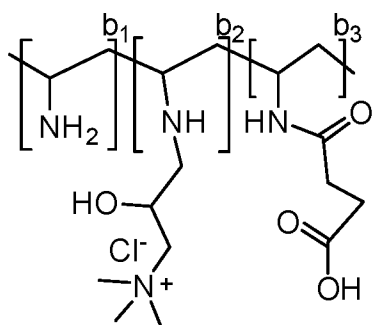
Formula IIc,

such that the reaction product is represented by Formula IIc':
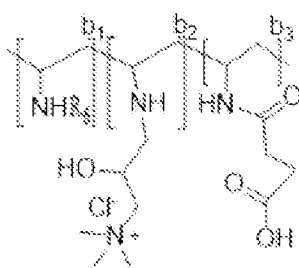
Formula IIc'

In Formula IIb', R_6 represents $C(=O)R_1$. Although not required, R_1 is typically a straight chain or branched alkyl or alkenyl containing 17 to 21 carbon atoms.

[0074]   In other embodiments, the reaction product can be more generally described as the reaction product Formula I with at least one of (a), (b) or (c) including a primary amine and the alkyl acid of the sizing agent. Typically, the alkyl acid includes from 17 to 21 carbon atoms. In each instance, the primary amine reacts with the alkyl acid such that the primary amine (NH_2) group is replaced with $NC(=O)R_1$. Typically, R_1 is an alkyl chain including 17 to 21 carbon atoms.

EXAMPLES

[0075]   Treated articles were prepared and evaluated by first making a dispersion and combining the dispersion with a pulp slurry. The composition of each dispersion is provided below. To prepare the pulp slurry, wood pulp was mixed in water to dilute the wood pulp to approximately 0.3 wt.% of solid pulp based on the total weight of the pulp slurry. The dispersion was then combined with the pulp slurry and further mixed. A sheet was then formed with a Noram TAPPI handsheet former and dried with an Adirondack drum dryer at 260°F. The resulting dried sheet was conditioned in a controlled humidity chamber at 23°C and 50% relative humidity for at least 4 hours.

[0076] The dried sheets were then evaluated for water repellency at room temperature and 85°C. The dried sheets were also evaluated for corn oil repellency at room temperature. The dried sheets were also evaluated for Cobb Water Absorbency and Breakthrough Cobb Oil Testing. The results are shown below in Table I.

[0077] To evaluate the repellency, a drop of water or corn oil at the specified temperature was placed on the sheet. After 15 seconds, the sheet was evaluated to determine whether the particular liquid bled through the sheet. The results are qualitatively recorded as a pass (P) or a fail (F).

[0078] To evaluate Cobb Water Absorbency, the sheet was first weighed and clamped into a Cobb ring apparatus. Exactly 100 grams of room temperature tap water was weighed and placed on the sheet within the Cobb ring apparatus and allowed to sit for one minute and 45 seconds. Then the water was poured off and the sheet was unclamped. The sheet was then sandwiched between two sheet forming blotters and a 10 kg Cobb roller was rolled across the sheet once in a forward direction and once in a reverse direction (total of two passes, each pass in opposite directions). The sheet was then immediately weighed, and the absorbency was then calculated using the initial weight and the exposed weight.

[0079] To evaluate Breakthrough Cobb Oil Testing, the sheet was first weighed. A clean circle of Whatman #4 qualitative circles was placed under the sheet as an absorbent blotter for breakthrough. A 20 mm diameter template was then placed on the sheet to define an initial exposure area. A 0.5 gram sample of oil was then collected using a pipet and the corn oil was then added to the sheet within the 20 mm diameter template and the oil was allowed to spread across the sheet until it was evenly spread across the template. After the oil was delivered to the sheet, the pipet was weighed to determine the exact mass of oil added to the sheet. Once the oil was evenly spread, the template was removed and a 300 gram weight was centered and placed on top of the oil and allowed to sit for 120 seconds. A sheet forming blotter was then placed on top of the sheet and a 10 kg Cobb roller was rolled across the sheet once in a forward direction and once in a reverse direction (total of two passes, each pass in opposite directions) to absorb excess oil on the surface of the sheet. The exposed sheet and Whatman #4 qualitative circle were then weighed and the % absorbance was calculated.

509-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	88.03	0
Wax	Synthetic Beeswax (acid value 22.8)	6.16	4.79
Solvent 2	Dipropylene glycol	2.32	1.8
Surfactant	Surfynol 465	0.95	0.74
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	2.54	0.24

509-5			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	79.33	0
Wax	Synthetic Beeswax (acid value 22.8)	10.93	4.77
Solvent 2	Propylene glycol	4.13	1.8
Surfactant 1	Span 60	0.53	0.23
Surfactant 2	Tween 60	0.53	0.23
Additive 1	Ammonium Hydroxide	0.05	0.023
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	4.50	0.24

509-7			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	86.87	0
Wax	Stearic Acid (acid value 208.9)	6.76	4.62
Solvent 2	Propylene glycol	2.55	1.74
Surfactant	Surfynol 465	1.05	0.71
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	2.78	0.23

617-1			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	68.00	0
Wax	Stearic Acid (acid value 208.9)	14.55	4.55
Solvent 2	Propylene glycol	5.33	1.9
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	12.12	0.45

617-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	69.64	0
Wax	Stearic Acid (acid value 208.9)	14.77	4.62
Solvent 2	Propylene glycol	5.33	1.9
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	10.26	0.38

617-3			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	71.76	0
Wax	Stearic Acid (acid value 208.9)	15.06	4.71
Solvent 2	Propylene glycol	5.33	1.9
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	7.84	0.29

617-4			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	73.08	0
Wax	Stearic Acid (acid value 208.9)	15.24	4.76
Solvent 2	Propylene glycol	5.33	1.9
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.35	0.24

617-5			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	67.11	0
Wax	Stearic Acid (acid value 208.9)	14.55	4.55
Solvent 2	Propylene glycol	5.33	1.9
Additive 1	Acetic acid	0.89	0.31
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	12.12	0.45

617-6			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	68.75	0
Wax	Stearic Acid (acid value 208.9)	14.77	4.62
Solvent 2	Propylene glycol	5.33	1.9
Additive 1	Acetic acid	0.89	0.31
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	10.26	0.38

617-7			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	70.88	0
Wax	Stearic Acid (acid value 208.9)	15.06	4.71
Solvent 2	Propylene glycol	5.33	1.9
Additive 1	Acetic acid	0.89	0.31
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	7.84	0.29

617-8			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	72.19	0
Wax	Stearic Acid (acid value 208.9)	15.24	4.76
Solvent 2	Propylene glycol	5.33	1.9
Additive 1	Acetic acid	0.89	0.31
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.35	0.24

719-1			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	72.40	0
Wax	Stearic Acid (acid value 208.9)	15.24	4.76
Solvent 2	Propylene glycol	6.02	1.9
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.35	0.24

719-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	72.93	0
Wax	90% C_{18} Stearic Acid (acid value 198)	15.28	4.77
Solvent 2	Propylene glycol	5.74	1.8
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.05	0.23

719-3			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	73.46	0
Wax	Behenic Acid (acid value 161-169)	15.32	4.79
Solvent 2	Propylene glycol	5.46	1.7
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	5.76	0.22

719-4			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	74.75	0
Wax	Kester FA-3 (acid value 160.9)	15.43	4.82
Solvent 2	Propylene glycol	4.78	1.5
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	5.04	0.19

720-1			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	72.40	0
Wax	Stearic Acid (acid value 208.9)	15.24	4.76
Solvent 2	Propylene glycol	6.02	1.9
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.35	0.37

720-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	72.93	0
Wax	90% C_{18} Stearic Acid (acid value 198)	15.28	4.77
Solvent 2	Propylene glycol	5.74	1.8
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.05	0.37

720-3			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	73.46	0
Wax	Behenic Acid (acid value 161-169)	15.32	4.79
Solvent 2	Propylene glycol	5.46	1.7
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	5.76	0.37

720-4			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	74.75	0
Wax	Kester FA-3 (acid value 160.9)	15.43	4.82
Solvent 2	Propylene glycol	4.78	1.5
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	5.04	0.37

720-5			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	72.40	0
Wax	Stearic Acid (acid value 208.9)	15.24	2.38
Solvent 2	Propylene glycol	6.02	0.94
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.35	0.37

720-6			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	72.93	0
Wax	90% C_{18} Stearic Acid (acid value 198)	15.28	2.39
Solvent 2	Propylene glycol	5.74	0.9
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.05	0.37

720-7			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	73.46	0
Wax	Behenic Acid (acid value 161-169)	15.32	2.40
Solvent 2	Propylene glycol	5.46	0.86
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	5.76	0.37

720-8			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	74.75	0
Wax	Kester FA-3 (acid value 160.9)	15.43	2.41
Solvent 2	Propylene glycol	4.78	0.75
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	5.04	0.37

720-9			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	72.40	0
Wax	Stearic Acid (acid value 208.9)	15.24	9.52
Solvent 2	Propylene glycol	6.02	3.76
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.35	0.48

720-10			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	72.93	0
Wax	90% C_{18} Stearic Acid (acid value 198)	15.28	9.54
Solvent 2	Propylene glycol	5.74	3.58
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.05	0.45

720-11			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	73.46	0
Wax	Behenic Acid (acid value 161-169)	15.32	9.58
Solvent 2	Propylene glycol	5.46	3.42
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	5.76	0.43

720-12			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	74.75	0
Wax	Kester FA-3 (acid value 160.9)	15.43	9.64
Solvent 2	Propylene glycol	4.78	2.98
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	5.04	0.38

910-1			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	72.40	0
Wax	90% C_{18} Stearic Acid (acid value 198)	15.24	4.62
Solvent 2	Propylene glycol	6.02	1.67
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.35	0.38

910-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	72.93	0
Wax	Lauric Acid (acid value 278-282)	15.28	4.62
Solvent 2	Propylene glycol	5.74	1.67
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	6.05	0.38

910-3			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	73.46	0
Wax	Oleic Acid (acid value 198.6)	15.32	4.62
Solvent 2	Propylene glycol	5.46	1.67
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	5.76	0.38

910-4			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	74.75	0
Wax	Lauric Acid (acid value 278-282)	15.43	4.47
Solvent 2	Propylene glycol	4.78	2.3
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	5.04	0.53

TABLE I

Sheet formed from:	Water drop repel 15 sec, room temp	Hot water drop repel (85°C) 15 sec	RT corn oil drop repel 15 sec	% sheet oil gain	% filter oil gain	Oil Bleed through
509-2	P	P	P	-	-	-
509-5	P	P	P	-	-	-
509-7	P	P	P	-	-	-
617-1	P	P	P	5.62	0.00	No
617-2	P	P	P	5.68	0.00	No
617-3	P	P	P	6.56	0.00	No
617-4	P	P	P	6.18	0.00	No
617-5	P	P	P	6.30	1.99	Yes
617-6	P	P	P	5.57	1.47	Yes
617-7	P	P	P	6.76	0.78	Yes
617-8	P	P	P	6.48	1.38	Yes
719-1	P	P	P	-	-	-
719-2	P	P	P	-	-	-
719-3	P	P	P	-	-	-
719-4	P	P	P	-	-	-
720-1	P	P	P	-	-	-
720-2	P	P	P	-	-	-
720-3	P	P	P	-	-	-
720-4	P	P	P	-	-	-
720-5	P	P	P	-	-	-
720-6	P	P	P	-	-	-
720-7	P	P	P	-	-	-
720-8	P	P	P	-	-	-
720-9	P	P	P	-	-	-
720-10	P	P	P	-	-	-
720-11	P	P	P	-	-	-
720-12	P	P	P	-	-	-
910-1	P	P	P	11.15	0.44	Slight
910-2	P	F	F	19.98	7.27	Yes
910-3	P	F	F	16.75	4.36	Yes
910-4	P	F	F	18.32	6.29	Yes

[0080] Additional treated articles were prepared and evaluated using the following method. A pulp slurry was made from wood pulp by mixing wood pulp in water to dilute the wood pulp to approximately 0.3 wt.% of solid pulp based on the total weight of the pulp slurry. A diluted solution of retention aid was then combined with the slurry and stirred for 60 seconds. A wax dispersion was then added to the slurry and mixed for an additional minute. A sheet was then

formed with a Noram TAPPI handsheet former and dried with an Adirondack drum dryer at 260°F. The resulting dried sheet was conditioned in a controlled humidity chamber at 23°C and 50% relative humidity for at least 4 hours. The composition of the wax dispersion and retention aid is described below. Testing performed on the resulting sheets is reported in Table II below.

218-1			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax	Synthetic Beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.37

218-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax	Synthetic Beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	none	-	0

218-3			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax	Synthetic Beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	1

218-4			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax	Synthetic Beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	1.5

218-5			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax	Synthetic Beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	fully hydrolyzed poly(n-vinylformamide)	-	0.371

218-6			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax	Synthetic Beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	polydimethylamine-epichlorohydrin	-	0.37

218-7			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	0.00	0
Wax	Synthetic Beeswax (acid value 22.8)	0.00	0
Solvent 2	Dipropylene glycol	0.00	0.00
Surfactant	Sodium Lauryl Sulfate	0.00	0.00
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

218-8			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	0.00	0
Wax	Synthetic Beeswax (acid value 22.8)	0.00	0
Solvent 2	Dipropylene glycol	0.00	0.00
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

39

218-9			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	0.00	0
Wax	Synthetic Beeswax (acid value 22.8)	0.00	0
Solvent 2	Dipropylene glycol	0.00	0.00
Surfactant	Sodium Lauryl Sulfate	1.08	0.22
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

221-1			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	59.19	0
Wax	Synthetic Beeswax (acid value 22.8)	23.15	5
Solvent 2	Dipropylene glycol	16.67	3.3
Surfactant	Sodium Lauryl Sulfate	0.99	0.2
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

221-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	59.19	0
Wax	Rice bran wax (acid value 1.4)	23.15	5
Solvent 2	Dipropylene glycol	16.67	3.3
Surfactant	Sodium Lauryl Sulfate	0.99	0.2
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

221-3			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	59.19	0
Wax	Carnauba T-3 wax (acid value 8.9)	23.15	5
Solvent 2	Dipropylene glycol	16.67	3.3
Surfactant	Sodium Lauryl Sulfate	0.99	0.2
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

221-4			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	59.19	0
Wax	#1 Yellow Carnauba Wax NF (acid value 5.3)	23.15	5
Solvent 2	Dipropylene glycol	16.67	3.3
Surfactant	Sodium Lauryl Sulfate	0.99	0.2
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

221-5			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	59.19	0
Wax	Candelilla wax (acid value 18.7)	23.15	5
Solvent 2	Dipropylene glycol	16.67	3.3
Surfactant	Sodium Lauryl Sulfate	0.99	0.2
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

221-7			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	59.19	0
Wax	Paraffin 140/145 wax (acid value <1)	23.15	5
Solvent 2	Dipropylene glycol	16.67	3.3
Surfactant	Sodium Lauryl Sulfate	0.99	0.2
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

221-8			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	59.19	0
Wax	Paraffin 150/155 wax (acid value <1)	23.15	5
Solvent 2	Dipropylene glycol	16.67	3.3
Surfactant	Sodium Lauryl Sulfate	0.99	0.2
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

221-9			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	59.19	0
Wax	White Beeswax (acid value 18.9)	23.15	5
Solvent 2	Dipropylene glycol	16.67	3.3
Surfactant	Sodium Lauryl Sulfate	0.99	0.2
	partially hydrolyzed poly(n-vinylformamide)	-	0.371

221-11			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	56.59	0
Wax	Synthetic Beeswax (acid value 22.8)	23.15	5
Solvent 2	Dipropylene glycol	18.67	3.7
Surfactant	Dioctyl sulfosuccinate sodium salt	1.59	0.3
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

227-1			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax	Synthetic beeswax (acid value 22.8)	25.00	7.5
Solvent 2	Dipropylene glycol	9.39	2.82
Surfactant	Sodium Lauryl Sulfate	0.47	0.14
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

227-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax	Synthetic beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	polyacrylamide (Mw 5,000,000-6,000,000)	-	0.371

227-3			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax	Synthetic beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	polyallylamine (Mw ~65,000)	-	0.371

318-1			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	59.19	0
Wax	White Beeswax (acid value 18.9)	23.15	5
Solvent 2	Dipropylene glycol	16.67	3.3
Surfactant	Sodium Lauryl Sulfate	0.99	0.2
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

318-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	-
Wax	Synthetic Beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	fully hydrolyzed poly(n-vinylformamide)	-	0.371

318-3			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax	Synthetic beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	polyacrylamide (Mw 5,000,000-6,000,000)	-	5.83

318-4			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax	Synthetic beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	Polyethyleneimine (Mw 70,000)	-	0.074

W0410-1			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	Paraffin 150/155 (acid value <1)	15.00	3
Wax 2	C20-40 Alkyl Stearate (acid value <1)	7.50	1.5
Wax 3	FA-3 >C14 fatty acids (acid value 160.9)	2.50	0.5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0410-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	Paraffin 150/155 (acid value <1)	15.00	3
Wax 2	C20-40 Alkyl Stearate (acid value <1)	7.50	0.5
Wax 3	FA-3 >C14 fatty acids (acid value 160.9)	2.50	1.5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0410-3			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	Paraffin 150/155 (acid value <1)	7.5	1.5
Wax 2	C20-40 Alkyl Stearate (acid value <1)	15	3
Wax 3	FA-3 >C14 fatty acids (acid value 160.9)	2.5	0.5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0410-5			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	Paraffin 150/155 (acid value <1)	2.5	0.5
Wax 2	C20-40 Alkyl Stearate (acid value <1)	15	3
Wax 3	FA-3 >C14 fatty acids (acid value 160.9)	7.5	1.5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

330-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	Acid-free Candelilla (acid value 0)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0515-1			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	SB Blend LM (acid value 17.7)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0515-2			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	SB Blend MM (acid value 18.1)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0515-3			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	SB Blend HM (acid value 18.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0515-4			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	SB High acid Blend (acid value 31.5)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0515-5			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	SB High acid Blend LM (acid value 29.3)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0515-6			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	SB High acid Blend MM (acid value 29.7)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0515-7			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	SB High acid Blend HM (acid value 29.9)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0515-8			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	Synthetic Beeswax (acid value 22.8)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0515-9			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	Stearic acid (acid value 208.9)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0515-10			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	Synthetic Beeswax (acid value 22.8)	12.50	2.5
Wax 2	Stearic acid (acid value 208.9)	12.50	2.5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.371

W0515-11			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	Stearic acid (acid value 208.9)	25.00	5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.742

W0515-12			
Component	Dispersion	Wt.% in dispersion	Wt.% based on dried pulp
Solvent 1	Tap water	65.14	0
Wax 1	Synthetic Beeswax (acid value 22.8)	12.50	2.5
Wax 2	Stearic acid (acid value 208.9)	12.50	2.5
Solvent 2	Dipropylene glycol	9.39	1.9
Surfactant	Sodium Lauryl Sulfate	0.47	0.09
Retention Aid	partially hydrolyzed poly(n-vinylformamide)	-	0.742

TABLE II

Sheet formed from:	Water drop repel 15 sec, room temp	Hot water drop repel (85C) 15 sec	RT corn oil drop repel 15 sec	Water Cobb value gsm	Water Cobb %	% sheet oil gain	% filter oil gain	Oil Bleed through
218-1	P	P	P	15.40	6.67	6.44	0.00	No
218-2	P	F	F	27.30	12.19	12.93	0.00	No
218-3	P	P	F	18.50	7.97	9.11	0.00	No
218-4	P	P	F	21.00	9.17	14.53	0.61	Slight
218-5	P	F	P	20.80	8.71	5.99	0.00	No
218-6	P	F	P	19.10	8.26	4.05	0.00	No
218-7	F	F	F	205.30	86.26	10.64	0.80	Slight
218-8	F	F	F	185.50	82.48	11.23	0.52	Slight
218-9	F	F	F	187.00	82.09	13.22	1.06	Slight
221-1	P	P	P	13.90	5.21	4.88	0.00	No
221-2	P	P	F	21.30	8.60	18.90	3.14	Yes
221-3	P	P	F	19.40	8.24	14.83	2.93	Yes
221-4	P	P	F	20.60	8.60	19.08	2.88	Yes
221-5	P	P	P	13.70	5.75	4.33	0.00	No
221-7	P	F	F	22.70	9.14	17.36	0.26	Slight
221-8	P	F	F	21.20	8.75	15.00	1.75	Yes
221-9	P	P	F	16.20	7.31	17.48	1.30	Slight
221-11	P	P	F	20.10	8.35	9.75	0.00	No
227-1	P	P	P	14.50	5.59	3.93	0.00	No
227-2	P	F	P	24.00	9.86	8.27	0.00	No
227-3	P	P	P	14.00	5.25	5.80	0.00	No
318-1	P	P	P	18.70	7.88	13.50	0.00	No
318-2	P	F	P	17.60	6.60	5.35	0.00	No
318-3	P	F	F	44.20	18.73	18.73	0.09	Slight
318-4	P	F	F	28.00	13.16	15.78	0.00	No
W0410-1	P	P	P	12.30	5.69	12.95	0.98	Yes
W0410-2	P	P	P	15.20	7.93	9.30	0.00	No
W0410-3	P	P	P	15.50	8.49	13.22	1.66	Yes
W0410-5	P	P	P	15.00	6.73	7.02	0.00	No
0330-2	P	F	F	13.80	6.61	17.76	5.87	Yes
W0515-1	P	P	P	41.20	11.52	9.99	0.00	No
W0515-2	P	P	P	47.50	12.95	7.28	0.70	Slight
W0515-3	P	P	P	38.30	12.77	8.96	0.35	Slight
W0515-4	P	P	P	36.90	11.92	11.73	0.26	Slight
W0515-5	P	P	P	38.80	11.92	8.46	0.00	No
W0515-6	P	P	P	36.20	11.15	9.78	0.26	Slight
W0515-7	P	P	P	34.80	11.19	9.44	0.00	No

W0515-8	P	P	P	38.30	11.58	7.92	0.00	No
W0515-9	P	P	P	43.10	12.77	7.95	0.00	No
W0515-10	P	P	P	35.20	11.12	10.44	0.00	No
W0515-11	P	P	P	41.00	12.35	7.38	0.00	No
W0515-12	P	P	P	32.10	9.76	8.60	0.00	No

[0081] The results shown above in Tables I and II indicate that the dispersions of this disclosure including the retention aid and the sizing agent comprising a wax or a component thereof having an acid value of from 10 mg to 220 mg, KOH/g produce superior articles when the articles are prepared and/or treated with the dispersion.

[0082] All combinations of the aforementioned embodiments throughout the entire disclosure are hereby expressly contemplated in one or more non-limiting embodiments even if such a disclosure is not described verbatim in a single paragraph or section above. In other words, an expressly contemplated embodiment may include any one or more elements described above selected and combined from any portion of the disclosure.

[0083] One or more of the values described above may vary by ± 5%, ± 10%, ± 15%, ± 20%, ± 25%, etc. so long as the variance remains within the scope of the disclosure. Unexpected results may be obtained from each member of a Markush group independent from all other members. Each member may be relied upon individually and or in combination and provides adequate support for specific embodiments within the scope of the appended claims. The subject matter of all combinations of independent and dependent claims, both singly and multiply dependent, is herein expressly contemplated. The disclosure is illustrative including words of description rather than of limitation. Many modifications and variations of the present disclosure are possible in light of the above teachings, and the disclosure may be practiced otherwise than as specifically described herein.

[0084] It is also to be understood that any ranges and subranges relied upon in describing various embodiments of the present disclosure independently and collectively fall within the scope of the appended claims, and are understood to describe and contemplate all ranges including whole and/or fractional values therein, even if such values are not expressly written herein. One of skill in the art readily recognizes that the enumerated ranges and subranges sufficiently describe and enable various embodiments of the present disclosure, and such ranges and subranges may be further delineated into relevant halves, thirds, quarters, fifths, and so on. As just one example, a range "of from 0.1 to 0.9" may be further delineated into a lower third, i.e. from 0.1 to 0.3, a middle
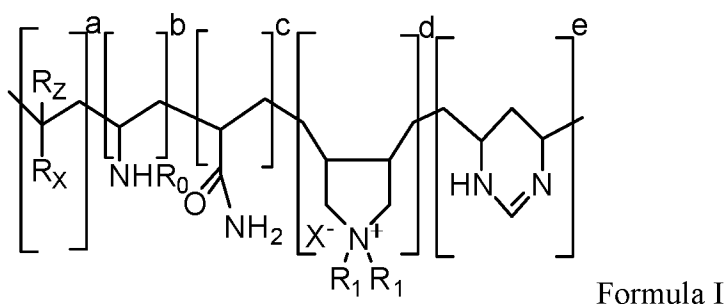
third, i.e. from 0.4 to 0.6, and an upper third, i.e. from 0.7 to 0.9, which individually and collectively are within the scope of the appended claims, and may be relied upon individually and/or collectively and provide adequate support for specific embodiments within the scope of the appended claims. In addition, with respect to the language which defines or modifies a range, such as "at least," "greater than," "less than," "no more than," and the like, it is to be understood that such language includes subranges and/or an upper or lower limit. As another example, a range of "at least 10" inherently includes a subrange of from at least 10 to 35, a subrange of from at least 10 to 25, a subrange of from 25 to 35, and so on, and each subrange may be relied upon individually and/or collectively and provides adequate support for specific embodiments within the scope of the appended claims. Finally, an individual number within a disclosed range may be relied upon and provides adequate support for specific embodiments within the scope of the appended claims. For example, a range "of from 1 to 9" includes various individual integers, such as 3, as well as individual numbers including a decimal point (or fraction), such as 4.1, which may be relied upon and provide adequate support for specific embodiments within the scope of the appended claims.

CLAIMS

What is claimed is:

1.   A dispersion for use in a process for making a treated article, the dispersion comprising:

a solvent;

a sizing agent comprising a wax or a component thereof having an acid value of from 10 mg to 220 mg, KOH/g as measured in accordance with USP 401; and

a retention aid comprising a nitrogen-containing polymer independently selected from the group consisting of,

i.   a nitrogen-containing polymer of Formula I,

Formula I

wherein (a), (b), (c), (d), and (e) individually represent the molar percent of each repeating unit included in the nitrogen-containing polymer of Formula I,

wherein R_0 is independently selected from the group consisting of:

of H,

and combinations thereof, and

wherein:

R_z is independently selected from H, $-CH_3$, and combinations thereof,

R_x is independently selected from H, -OH, -COOH, $-COOR_1$, - $OCOR_1$, $-R_1$, $-R_3OH$, $-OR_1$, $-NR_1R_1$, $-R_3NH_2$, $-NH_2$, $-COO(CH_2)_2N(R_1)_2$, $-COO(CH_2)_2N^+(R_1)_3X^-$, $-COO(CH_2)_3N^+(R_1)_3X^-$, and combinations thereof, with the proviso that when R_x is $-NH_2$, R_z is $-CH_3$,

Y is independently selected from H, -OH, -R_1, -OR_1, -NR_1R_1, -NH_2, and combinations thereof,

Z is independently selected from H, -OH, -C=O, -R_1, -OR_1, -NR_1R_1, -NH_2 and combinations thereof,

R_1 is independently selected from H, a straight chain or branched alkyl or alkenyl containing up to 22 carbons, and combinations thereof,

R_2 is independently selected from H, a monosaccharide, an oligosaccharide, polysaccharide moiety, a straight or branched alkyl or alkenyl group up to 22 carbons optionally containing a hydroxyl or aldehyde group, and combinations thereof,

R_3 is independently selected from a straight chain or branched alkyl or alkenyl containing up to 22 carbons or combinations thereof,

R_4 is independently selected from a straight chain or branched alkyl group containing up to 18 carbons, optionally substituted with a hydroxyl group, and combinations thereof,

R_5 is independently selected from H, -OH, -COOH, -$COOR_1$, -$OCOR_1$, -R_1, -R_1OH, -OR_1, -$CONH_2$, -CONHCHOHCHO, -NR_1, -NR_1R_1, -R_1NH_2, -NH_2, and combinations thereof,

A is independently selected from C=O, -CH_2, and combinations thereof, and

X^- is independently an anion;

ii.   a polyethyleneimine;

iii.   a polyaminoamide;

iv.   a copolymer formed from the reaction product of epichlorohydrin and dimethylamine; and

v.   combinations thereof.

2.   The dispersion as set forth in claim 1 wherein the retention aid is the nitrogen-containing polymer of Formula I and the combined molar percent of (c) and (d) is less than 5 mol.%.

3.   The dispersion as set forth in claim 2 wherein R_0 is independently selected from the group

consisting of H, , and combinations thereof.
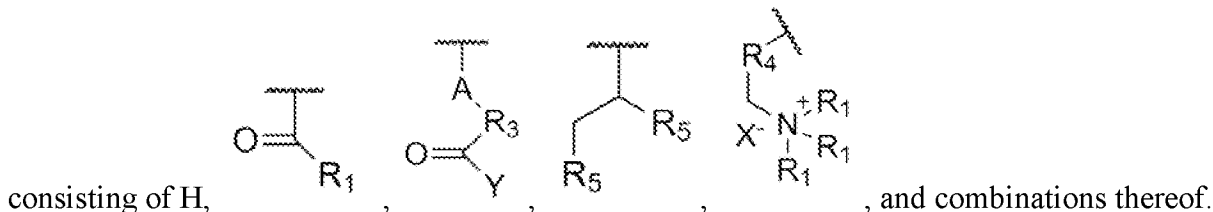
4.   The dispersion as set forth in claim 3 wherein R_0 is independently selected from the group

consisting of H, , and combinations thereof.
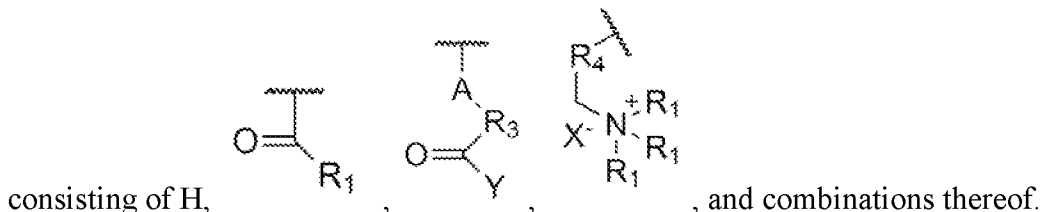
5.   The dispersion as set forth in any one of claims 1 through 4 wherein the retention aid is the nitrogen-containing polymer of Formula I and the combined molar percent of (a), (b), and (e) is 100 mol.% such that the nitrogen-containing polymer is expressed according to Formula II
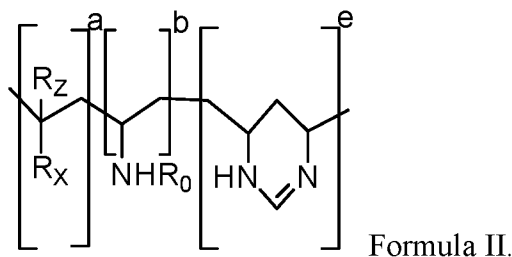
 Formula II.

6.   The dispersion as set forth in claim 5 wherein the retention aid is independently selected from the group consisting of:

        i.   the nitrogen-containing polymer of Formula II with the combined molar percent of (b) and (e) being 100 mol.%, and R_0 is independently selected from the group consisting of H,

  and combinations thereof;
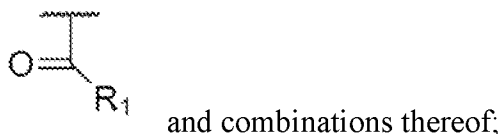
        ii.   the nitrogen-containing polymer of Formula II with the molar percent of (a) being 100 mol.% and R_x is $-R_3NH_2$; and

iii.   the nitrogen-containing polymer of Formula II with the molar percent of (b) being

100 mol.%, and R₀ independently selected from the group consisting of H,

, and combinations thereof.

7.   The dispersion as set forth in claim 5 or 6 wherein the retention aid is independently selected from the group consisting of:

i.   the nitrogen-containing polymer of Formula II as further defined according to Formula IIa:
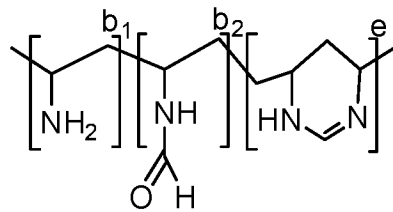
Formula IIa;

ii.   the nitrogen-containing polymer of Formula II as further defined according to Formula IIb:
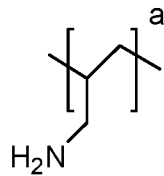
Formula IIb; and

iii.   the nitrogen-containing polymer of Formula II as further defined according to Formula IIc:
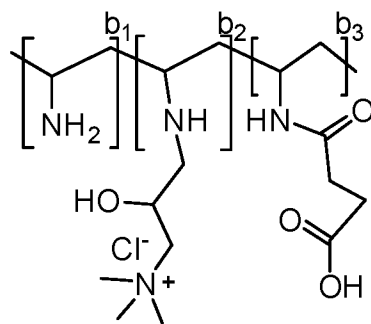
Formula IIc.

8.   The dispersion as set forth in claim 7 wherein the retention aid is the nitrogen-containing polymer of Formula IIa.

9.   The dispersion as set forth in claim 1 wherein the nitrogen-containing polymer is selected from the group consisting of:

i.   a polyethyleneimine;

ii.   a polyaminoamide;

iii.   a poly(diallyldimethylammonium chloride); and

iv.   combinations thereof.

10.   The dispersion as set forth in claim 1 or 9 wherein the nitrogen-containing polymer is a polyethyleneimine with a weight average molecular weight of from 40,000 to 100,000, daltons and wherein from 15% to 35% of the amine groups within the polyethyleneimine are primary amines and from 35 to 65% of the amine groups within the polyethyleneimine are secondary amines, based on the total number of amine groups within the polyethyleneimine.

11.   The dispersion as set forth in claim 1 or 9 wherein the nitrogen-containing polymer is a polyaminoamide.

12.   The dispersion as set forth in claim 1 or 9 wherein the nitrogen-containing polymer is a poly(diallyldimethylammonium chloride) with a weight average molecular weight of less than 200,000 or from 300,000 to 400,000.

13.   The dispersion as set forth in any one of claims 1 through 12 wherein the nitrogen-containing polymer has a charge density of $> +0.1$ meq/g at a pH of 7.

14.   The dispersion as set forth in any one of claims 1 through 13 wherein the sizing agent is independently selected from a group consisting of a stearate, beeswax, candelilla wax, palmitate, behenate, and combinations thereof.

15.   The dispersion as set forth in any one of claims 1 through 13 wherein the sizing agent has an acid value of from 150 to 220, mg KOH/g.

16.   The dispersion as set forth in any one of claims 1 through 15 wherein the sizing agent is stearic acid.

17.   The dispersion as set forth in any one of claims 1 through 14 wherein the sizing agent is beeswax.

18.   The dispersion as set forth in any one of claims 1 through 17 wherein the sizing agent is present in an amount of from 10 to 50 parts by weight and the retention aid is present in an amount of from 0.1 to 12 parts by weight, each based on 100 parts by weight of the dispersion.

19.   A dispersion for use in a process of making a treated article, the dispersion comprising:

    a solvent;

    a sizing agent present in an amount of from 10 to 50 parts by weight based on 100 parts by weight of the dispersion, with the sizing agent comprising a wax or the component thereof independently selected from a group consisting of a stearate, beeswax, candelilla wax, palmitate, behenate, and combinations thereof, with the wax or component thereof having an acid value of from 10 mg to 220 mg, KOH/g as measured in accordance with USP 401; and

    a retention aid present in an amount of from 0.1 to 12 parts by weight based on 100 parts by weight of the dispersion, with the retention aid selected from the group consisting of,

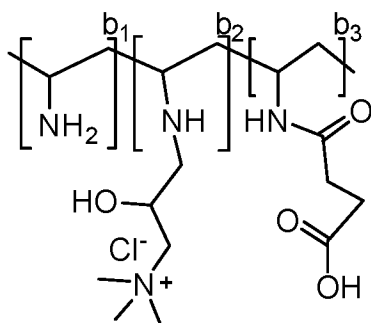   i.   a nitrogen-containing according to Formula IIa:
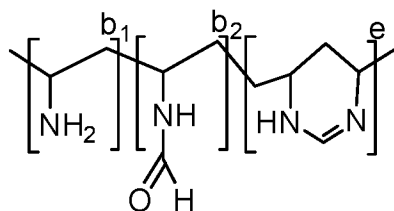
                                                                Formula IIa,

        ii.   a nitrogen-containing polymer according to Formula IIb:
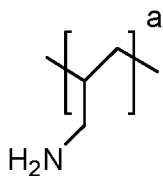
Formula IIb,

   iii.   a nitrogen-containing polymer according to Formula IIc:

Formula IIc, and

   iv.   combinations thereof,

wherein the (a), (b_1), (b_2), (b_3), and (e) represent the molar percent of the individual repeating unit.

20.   A fiber slurry comprising:

the dispersion as set forth in any one of claims 1 through 18;

fibers; and

a second solvent that is the same as or different than the solvent of the dispersion.

21.   A method for making a treated article, the method comprising:

combining the dispersion as set forth in any one of claims 1 through 18 with a fiber slurry; and

forming a treated article from the fiber slurry including the dispersion.

22.   A method of making a treated article, the method comprising:

forming an article a from a fiber slurry, with the article having a top surface and a bottom surface; and

applying the dispersion of any one of claims 1 through 18 to at least one surface of the article to form the treated article.

23.   A method of making a treated article, the method comprising:

providing a fiber slurry including fibers and water;

combining a sizing agent with the fiber slurry, the sizing agent comprising a wax or a component thereof having an acid value of from 10 mg to 220 mg, KOH/g as measured in accordance with USP 401;
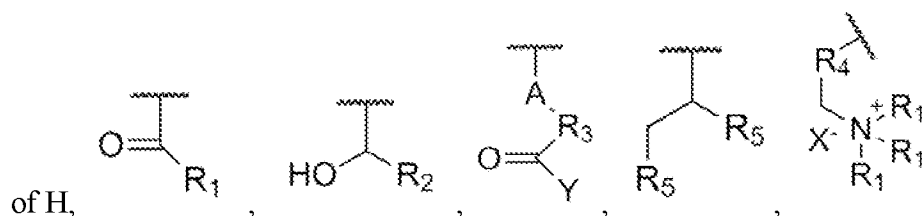
combining a retention aid with the fiber slurry, the retention aid comprising a nitrogen-containing polymer independently selected from the group consisting of,

      i.   a nitrogen-containing polymer of Formula I,

Formula I

wherein (a), (b), (c), (d), and (e) individually represent the molar percent of each repeating unit included in the nitrogen-containing polymer of Formula I,

wherein R_0 is independently selected from the group consisting of:

of H,   ,   ,   ,   ,

and combinations thereof, and

wherein: R_z is independently selected from H, $-CH_3$, and combinations thereof,

R_x is independently selected from H, -OH, -COOH, $-COOR_1$, $-OCOR_1$, $-R_1$, $-R_3OH$, $-OR_1$, $-NR_1R_1$, $-R_3NH_2$, $-NH_2$, $-COO(CH_2)_2N(R_1)_2$, $-COO(CH_2)_2N^+(R_1)_3X^-$, $-COO(CH_2)_3N^+(R_1)_3X^-$, and combinations thereof,

Y is independently selected from H, -OH, $-R_1$, $-OR_1$, $-NR_1R_1$, $-NH_2$, and combinations thereof,

Z is independently selected from H, -OH, -C=O, $-R_1$, $-OR_1$, $-NR_1R_1$, $-NH_2$ and combinations thereof,

R_1 is independently selected from H, a straight chain or branched alkyl or alkenyl containing up to 22 carbons, and combinations thereof,

R_2 is independently selected from H, a monosaccharide, an oligosaccharide, polysaccharide moiety, a straight or branched alkyl or alkenyl group up to 22 carbons optionally containing a hydroxyl or aldehyde group, and combinations thereof,

R_3 is independently selected from a straight chain or branched alkyl or alkenyl containing up to 22 carbons or combinations thereof,

R_4 is independently selected from a straight chain or branched alkyl group containing up to 18 carbons, optionally substituted with a hydroxyl group, and combinations thereof,

R_5 is independently selected from H, -OH, -COOH, -COOR$_1$, -OCOR$_1$, -R$_1$, -R$_1$OH, -OR$_1$, -CONH$_2$, -CONHCHOHCHO, -NR$_1$, -NR$_1$R$_1$, -R$_1$NH$_2$, -NH$_2$, and combinations thereof,

A is independently selected from C=O, -CH$_2$, and combinations thereof, and

X^- is independently an anion;

ii.   a polyethyleneimine;

iii.   a polyaminoamide;

iv.   a copolymer formed from the reaction product of epichlorohydrin and dimethylamine; and

v.   combinations thereof; and

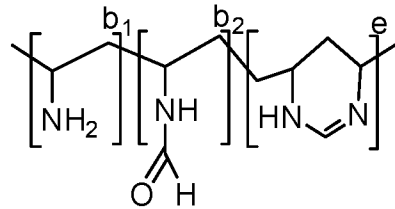forming the fiber slurry including the sizing agent and the retention aid into a treated article.

24.   A method of making a treated article, the method comprising:

providing a fiber slurry including fibers and water;

combining a sizing agent with the fiber slurry, the sizing agent comprising a wax or a component thereof having an acid value of from 10 mg to 220 mg, KOH/g as measured in accordance with USP 401;
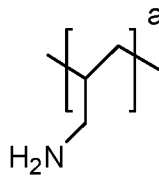
combining a retention aid with the fiber slurry, with the retention aid selected from the group consisting of,

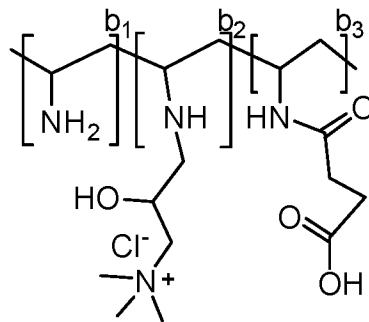   i.   a nitrogen-containing according to Formula IIa:

Formula IIa,

    ii.   a nitrogen-containing polymer according to Formula IIb:

Formula IIb,

    iii.   a nitrogen-containing polymer according to Formula IIc:

Formula IIc, and

    iv.   and combinations thereof,

wherein the (a), (b_1), (b_2), (b_3), and (e) represent the molar percent of the individual repeating unit; and

forming the fiber slurry including the sizing agent and the retention aid into a treated article.

25.   A treated article comprising:

    a fiber matrix;

    a sizing agent comprising a wax or a component thereof having an acid value of from 10 mg to 220 mg, KOH/g as measured in accordance with USP 401; and

    a retention aid with the fiber slurry, the retention aid comprising a nitrogen-containing polymer independently selected from the group consisting of,
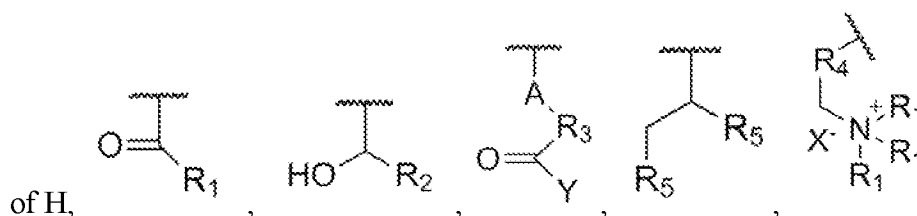
    i.   a nitrogen-containing polymer of Formula I,

Formula I

wherein (a), (b), (c), (d), and (e) individually represent the molar percent of each repeating unit included in the nitrogen-containing polymer of Formula I,

wherein R_0 is independently selected from the group consisting of:

of H,

and combinations thereof, and

wherein: R_z is independently selected from H, $-CH_3$, and combinations thereof,

R_x is independently selected from H, $-OH$, $-COOH$, $-COOR_1$, $-OCOR_1$, $-R_1$, $-R_3OH$, $-OR_1$, $-NR_1R_1$, $-R_3NH_2$, $-NH_2$, $-COO(CH_2)_2N(R_1)_2$, $-COO(CH_2)_2N^+(R_1)_3X^-$, $-COO(CH_2)_3N^+(R_1)_3X^-$, and combinations thereof,

Y is independently selected from H, $-OH$, $-R_1$, $-OR_1$, $-NR_1R_1$, $-NH_2$, and combinations thereof,

Z is independently selected from H, $-OH$, $-C=O$, $-R_1$, $-OR_1$, $-NR_1R_1$, $-NH_2$ and combinations thereof,

R_1 is independently selected from H, a straight chain or branched alkyl or alkenyl containing up to 22 carbons, and combinations thereof,

R_2 is independently selected from H, a monosaccharide, an oligosaccharide, polysaccharide moiety, a straight or branched alkyl or alkenyl group up to 22 carbons optionally containing a hydroxyl or aldehyde group, and combinations thereof,

R_3 is independently selected from a straight chain or branched alkyl or alkenyl containing up to 22 carbons or combinations thereof,

66

R$_4$ is independently selected from a straight chain or branched alkyl group containing up to 18 carbons, optionally substituted with a hydroxyl group, and combinations thereof,
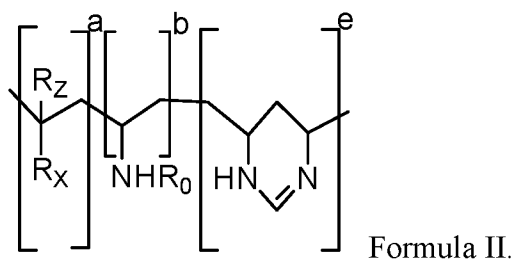
R$_5$ is independently selected from H, -OH, -COOH, -COOR$_1$, -OCOR$_1$, -R$_1$, -R$_1$OH, -OR$_1$, -CONH$_2$, -CONHCHOHCHO, -NR$_1$, -NR$_1$R$_1$, -R$_1$NH$_2$, -NH$_2$, and combinations thereof,

A is independently selected from C=O, -CH$_2$, and combinations thereof, and

X$^-$ is independently an anion;

ii.   a polyethyleneimine;

iii.   a polyaminoamide;

iv.   a copolymer formed from the reaction product of epichlorohydrin and dimethylamine; and

v.   combinations thereof.

26.   The treated article as set forth in claim 25 wherein the retention aid is the nitrogen-containing polymer of Formula I and the combined molar percent of (a), (b), and (e) is 100 mol.% such that the nitrogen-containing polymer is expressed according to Formula II

Formula II.

27.   The treated article as set forth in claim 26 wherein the retention aid is independently selected from the group consisting of:

i.   the nitrogen-containing polymer of Formula II with the combined molar percent of (b) and (e) being 100 mol.%, and R$_0$ is independently selected from the group consisting of H,

and combinations thereof;

ii.   the nitrogen-containing polymer of Formula II with the molar percent of a being

100 mol.% and R_x is $-R_3NH_2$; and

iii.   the nitrogen-containing polymer of Formula II with the molar percent of (b) being

100 mol.%, and R_0 independently selected from the group consisting of H,
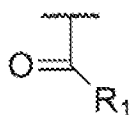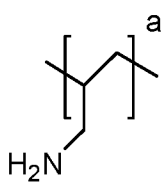
, and combinations thereof.

28.   The treated article as set forth in claim 27 wherein the retention aid is independently

selected from the group consisting of:

i.   the nitrogen-containing polymer of Formula II as further defined according to
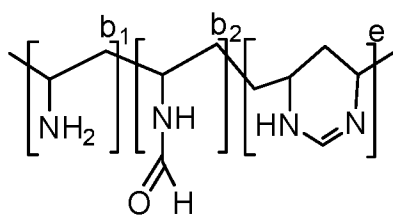
Formula IIa:

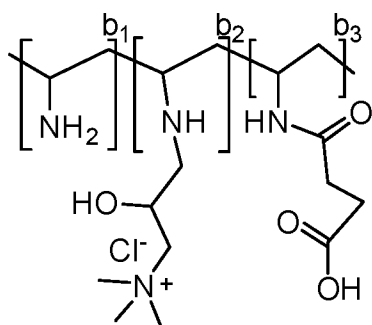   Formula IIa;

ii.   the nitrogen-containing polymer of Formula II as further defined according to
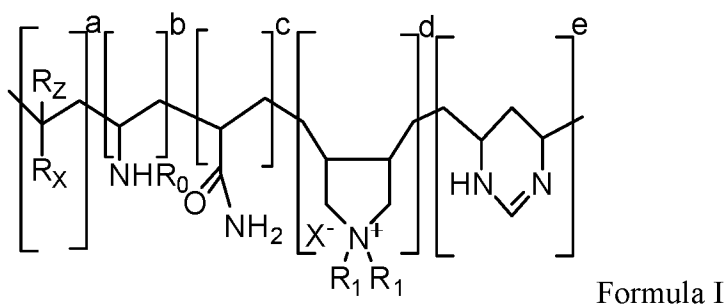
Formula IIb:

Formula IIb; and

iii.   the nitrogen-containing polymer of Formula II as further defined according to
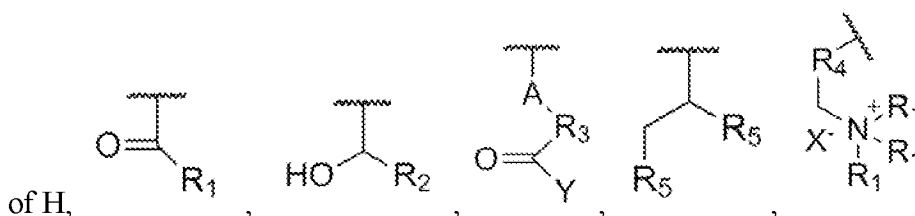
Formula IIc:

Formula IIc.

29. The dispersion as set forth in any one of claims 1 through 14 wherein the sizing agent is candelilla wax.

30. The dispersion as set forth in any one of claims 1 through 14 wherein the sizing agent is palmitate.

31. The dispersion as set forth in any one of claims 1 through 14 wherein the sizing agent is behenate.

32. A method of preparing the dispersion according to any one of claims 1 through 18, the method comprising:

combining the solvent, the sizing agent, and the retention aid.

33. A dispersion for use in a process for making a treated article, the dispersion comprising:

a solvent; and

a reaction product between

    I.   a sizing agent comprising a wax or a component thereof having an acid value of from 10 mg to 220 mg, KOH/g as measured in accordance with USP 401; and

    II.   a retention aid comprising a nitrogen-containing polymer independently selected from the group consisting of,

        i.   a nitrogen-containing polymer of Formula I,

Formula I

wherein (a), (b), (c), (d), and (e) individually represent the molar percent of each repeating unit included in the nitrogen-containing polymer of Formula I,

wherein R_0 is independently selected from the group consisting of:

of H,

and combinations thereof, and

wherein: R_z is independently selected from H, $-CH_3$, and combinations thereof,

R_x is independently selected from H, $-OH$, $-COOH$, $-COOR_1$, $-OCOR_1$, $-R_1$, $-R_3OH$, $-OR_1$, $-NR_1R_1$, $-R_3NH_2$, $-NH_2$, $-COO(CH_2)_2N(R_1)_2$, $-COO(CH_2)_2N^+(R_1)_3X^-$, $-COO(CH_2)_3N^+(R_1)_3X^-$, and combinations thereof, with the proviso that when R_x is $-NH_2$, R_z is $-CH_3$,

Y is independently selected from H, $-OH$, $-R_1$, $-OR_1$, $-NR_1R_1$, $-NH_2$, and combinations thereof,

Z is independently selected from H, $-OH$, $-C=O$, $-R_1$, $-OR_1$, $-NR_1R_1$, $-NH_2$ and combinations thereof,

R_1 is independently selected from H, a straight chain or branched alkyl or alkenyl containing up to 22 carbons, and combinations thereof,

R_2 is independently selected from H, a monosaccharide, an oligosaccharide, polysaccharide moiety, a straight or branched alkyl or alkenyl group up to 22 carbons optionally containing a hydroxyl or aldehyde group, and combinations thereof,

R$_3$ is independently selected from a straight chain or branched alkyl or alkenyl containing up to 22 carbons or combinations thereof,

R$_4$ is independently selected from a straight chain or branched alkyl group containing up to 18 carbons, optionally substituted with a hydroxyl group, and combinations thereof,

R$_5$ is independently selected from H, -OH, -COOH, -COOR$_1$, -OCOR$_1$, -R$_1$, -R$_1$OH, -OR$_1$, -CONH$_2$, -CONHCHOHCHO, -NR$_1$, -NR$_1$R$_1$, -R$_1$NH$_2$, -NH$_2$, and combinations thereof,

A is independently selected from C=O, -CH$_2$, and combinations thereof, and

X$^-$ is independently an anion;

ii. a polyethyleneimine;

iii. a polyaminoamide;

iv. a copolymer formed from the reaction product of epichlorohydrin and dimethylamine; and

v. combinations thereof.

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. D21H17/14   D21H17/45   D21H17/55   D21H17/00   D21H19/10
     D21H19/20   D21H21/10   D21H21/16
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

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	US 2010/000693 A1 (CHAMP SIMON [DE] ET AL) 7 January 2010 (2010-01-07) paragraphs [0020], [0021], [0123] – [0127] claims 1-21	1-33
A	EP 1 491 682 A1 (JUJO PAPER CO LTD [JP]; SAN NOPCO KK [JP]) 29 December 2004 (2004-12-29) claims 1-6	1-33

☐ Further documents are listed in the continuation of Box C.   ☒ 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

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"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
20 January 2022	31/01/2022

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 Ponsaud, Philippe

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

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