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(54) **USE OF A FABRIC SOFTENING COMPOSITION TO REDUCE AIRBORNE FIBRES RELEASE FROM A DRYER**

VERWENDUNG EINER TEXTILWEICHMACHERZUSAMMENSETZUNG ZUR VERMINDERUNG DER FREISETZUNG VON FASERN IN DER LUFT AUS EINEM TROCKNER

UTILISATION D'UNE COMPOSITION D'ADOUCCISSANT POUR TISSUS POUR RÉDUIRE LA LIBÉRATION DE FIBRES EN SUSPENSION DANS L'AIR D'UNE SÈCHEUSE

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- **GAYLARDE CHRISTINE ET AL: "Plastic microfibre pollution: how important is clothes' laundering?", HELIYON, vol. 7, no. 5, 1 May 2021 (2021-05-01), GB, pages e07105, XP055915536, ISSN: 2405-8440, DOI: 10.1016/j.heliyon.2021.e07105**
- **RAMASAMY RATHINAMOORTHY ET AL: "Synthetic textile and microfiber pollution: a review on mitigation strategies", ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH, SPRINGER BERLIN HEIDELBERG, BERLIN/HEIDELBERG, vol. 28, no. 31, 8 June 2021 (2021-06-08), pages 41596 - 41611, XP037535196, ISSN: 0944-1344, [retrieved on 20210608], DOI: 10.1007/S11356-021-14763-Z**

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Description

FIELD OF THE INVENTION

- 5 **[0001]** The present invention is in the field of fabric treatments. In particular the invention relates to the use of a fabric softening composition to reduce airborne fibers release during the treatment of fabrics in a dryer.

BACKGROUND OF THE INVENTION

- 10 **[0002]** Vented tumble dryers release moist warm air from the fabric drying process to the external environment, usually through pipework linking the appliance to a vent in an exterior wall. Although such dryers have an integrated lint filter intended to remove fibers from this air stream, recent reports suggest that this process is incomplete, leading to fibers being released in the ducted warm air and subsequently polluting the external environment.

- 15 **[0003]** GAYLARDE CHRISTINE ET AL in "Plastic microfibre pollution: how important is clothes' laundering?", HELIYON, vol. 7, no. 5, 1 May 2021 provide information on worldwide plastic microfibre pollution caused by textile laundering and some possibilities for its control.

- 20 **[0004]** RAMASAMY RATHINAMOORTHY ET AL in "Synthetic textile and microfiber pollution: a review on mitigation strategies", ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH, SPRINGER BERLIN HEIDELBERG, BERLIN/HEIDELBERG, vol. 28, no. 31, 8 June 2021 report the contribution of synthetic textiles on microfiber pollution in the environment. The results of this review show that using quality materials and controlling the textile parameters are potential options to prevent microfiber emission from the textile.

- [0005]** The objective of the present invention is to reduce the release of airborne fibers during the treatment of fabrics in a vented tumble dryer.

25 SUMMARY OF THE INVENTION

- [0006]** The present invention provides the use of a fabric softening composition to reduce the release of airborne fibers during the treatment of fabrics in a vented tumble dryer. The fabric softening composition is delivered in a first fabric treatment process and/or applied directly to the fabric. The fabric is subsequently treated in a tumble dryer. Preferably, the softening composition comprises a quaternary ammonium softening compound. Preferably, the softening composition comprises a silicone softening compound. Even better results, in terms of reduction of airborne fibers, are obtained when the treatment of the fabric in the tumble dryer takes place in the presence of a dryer sheet. Preferably the dryer sheet comprises a non-woven substrate and more preferably when the non-woven substrate comprises polyester. Preferably the dryer sheet comprises a fabric treatment composition, more preferably a softening composition, preferably the softening composition comprises a quaternary ammonium softening compound. Preferably, the softening composition comprises a silicone softening compound.

DETAILED DESCRIPTION OF THE INVENTION

- 40 **[0007]** The present invention encompasses the use of a fabric softening composition to reduce airborne fibers release during the treatment of a fabric in a vented tumble dryer, preferably the treatment is drying.

- [0008]** The yarns in fabrics are made up of filaments that are twisted together. During washing, with the effects of water, friction and abrasion those filaments shed. Filaments also shed during treatment in a tumble dryer. Different types of fabric shed more than others. A tightly woven fabric with tightly twisted yarn (one that feels flat and smooth) sheds less than a loosely woven fabric with loosely twisted yarn (one that feels fluffy or fuzzy).

- 45 **[0009]** The first fabric treatment process may take place in any suitable vessel, in its entirety or partially, for example it may take place in an automatic washing machine. Such machines may be top-loading machines or front-loading machines. The first fabric treatment process preferably takes place in a washing machine. The first fabric treatment process could alternatively be done by hand.

- 50 **[0010]** The first fabric treatment process includes a rinse treatment step. The rinse may follow a washing step or it may be a stand-alone rinse. The aqueous treatment liquor may be an aqueous rinse liquor. The fabric softening composition to be delivered during a rinse stage of a first fabric treatment process may be added to the drawer or drum of an automatic washing machine during a rinse stage.

- 55 **[0011]** The first fabric treatment process may include contacting the fabric with an aqueous wash liquor. The step of contacting the fabric with an aqueous wash liquor may occur prior to contacting the fabric with an aqueous rinse liquor. Such steps may occur during a single treatment cycle. The aqueous wash liquor may comprise a cleaning composition, such as a granular or liquid laundry detergent composition, that is dissolved or diluted in water. The detergent composition may include anionic surfactant. The aqueous wash liquor may comprise from about 50 to about 5000 ppm, or from about

100 to about 1000 ppm, anionic surfactant.

[0012] Alternative, the aqueous liquor can be delivered to the fabric from a product in the form of a spray from a spray dispenser.

[0013] During the course of the work leading to the present invention, it was found that the treatment of a fabric with a fabric softening composition reduces the amount of airborne fibers released during a subsequent treatment of the fabric in a vented tumble dryer. This reduction is further increased if the treatment in the vented tumble dryer takes place in the presence of a dryer sheet, preferably if the dryer sheet also comprises a fabric softening composition. The sheets were found to collect fibers during the drying process.

[0014] Tumble dryer sheets are used in some markets to deliver softness, anti-static and freshness benefits to fabrics during treatment, preferably drying, in a tumble dryer.

[0015] The fabric to be treated in the dryer can be wet or humid or it can be dry. It can be treated wet after being washed and then rinsed or only rinsed in the presence of a fabric softening composition. Alternatively, the fabric can be treated dry in order to refresh it.

[0016] As used herein, the articles "a" and "an" when used in a claim, are understood to mean one or more of what is claimed or described. As used herein, the terms "include," "includes," and "including" are meant to be non-limiting. The compositions of the present disclosure can comprise, consist essentially of, or consist of, the components of the present disclosure.

[0017] All percentages, ratios and proportions used herein are by weight percent of the composition, unless otherwise specified. All average values are calculated "by weight" of the composition, unless otherwise expressly indicated. All ratios are calculated as a weight/weight level, unless otherwise specified.

[0018] All measurements are performed at 25°C unless otherwise specified.

Unless otherwise noted, all component or composition levels are in reference to the active portion of that component or composition, and are exclusive of impurities, for example, residual solvents or by-products, which may be present in commercially available sources of such components or compositions.

[0019] As used herein, the term "airborne fiber" means a fiber that can be transported by air.

[0020] As used herein, the term "fabric" is intended to include any object, article or item made from or containing at least in part some woven or non-woven fabric portion that may be treated in an automatic dryer cycle.

[0021] The "fabric softening composition" is herein sometimes referred to as "the fabric softening composition of the invention" or "the composition of the invention".

[0022] As used herein, the term "dryer sheet" means a sheet for use in the dryer, the sheet is dry and it is not part of the fabric to be treated. The "dryer sheet" is used to provide benefits to the treated fabrics. The "dryer sheet" is sometimes herein referred as the "dryer sheet of the invention".

[0023] The dryer for use in the invention is a vented tumble dryer. In a tumble-type dryer the fabric and optionally the dryer sheet are provided within a rotating drum that causes the fabric to tumble during the operation of the dryer. Tumble-type dryers are commonly found in residences and in commercial and industrial laundry operations. As mentioned herein before, the fabric can be wet, damp or dry. The drying cycle is initiated in the dryer. Usually, the fabric is subject to a temperature in the range of from about 40°C to about 100°C. The duration of the drying process is usually determined as function of the wetness of the fabric.

[0024] The dryer sheet disclosed herein is conveniently employed to treat fabrics in the dryer, preferably during a drying process in a dryer. The dryer sheet can be used to treat fabrics that have not been washed or after the fabrics have been washed with a laundry detergent or after the fabric has been treated by direct application, such as for example spraying on the fabric softening composition.

Fabric softening composition

[0025] The composition of the invention may provide softness, anti-wrinkle, anti-static, conditioning, anti-stretch, color, and/or appearance benefits. Fabric softening actives include quaternary ammonium ester compounds, silicones, non-ester quaternary ammonium compounds, amines, fatty esters, sucrose esters, dispersible polyolefins, polysaccharides, fatty acids, softening or conditioning oils, polymer latexes, or combinations thereof.

[0026] The composition may be in any suitable form. It may be in the form of a liquid composition, a granular composition, a single-compartment pouch, a multi-compartment pouch, a sheet, a pastille or bead, a fibrous article, a tablet, a bar, flake, or a mixture thereof. The product can be selected from a liquid, solid, or combination thereof.

[0027] The composition may be in the form of a liquid. The composition may include water. The composition may be aqueous. The composition, which may be a liquid composition, may comprise at least 50% by weight of water, preferably at least 90%, or even more than 95% by weight of water. The composition may comprise from about 10% to about 98%, by weight of the composition, of water, preferably from about 25% to about 96%, more preferably from about 45% to about 95%. The liquid composition may be packaged in a pourable bottle. The liquid may be packaged in an aerosol can or other spray bottle and it can be applied directly onto the fabric.

[0028] The fabric softening composition may have a viscosity of from 1 to 1500 centipoises (1-1500 mPa*s), from 100 to 1000 centipoises (100-1000 mPa*s), or from 200 to 500 centipoises (200-500 mPa*s) at 20 s⁻¹ and 21°C.

[0029] The composition may be in the form of a unitized dose article, such as a tablet, a pouch, a sheet, or a fibrous article. Such pouches typically include a water-soluble film, such as a polyvinyl alcohol water-soluble film, that at least partially encapsulates a composition. Suitable films are available from MonoSol, LLC (Indiana, USA). The composition can be encapsulated in a single or multi-compartment pouch. A multi-compartment pouch may have at least two, at least three, or at least four compartments. A multi-compartmented pouch may include compartments that are side-by-side and/or superposed. The composition contained in the pouch or compartments thereof may be liquid, solid (such as powders), or combinations thereof. Pouched compositions may have relatively low amounts of water, for example less than about 20%, or less than about 15%, or less than about 12%, or less than about 10%, or less than about 8%, by weight of the detergent composition, of water.

[0030] The composition may be in the form of a pastille or bead. The pastille may include polyethylene glycol as a carrier. The polyethylene glycol may have a weight average molecular weight of from about 2000 to about 20,000 Daltons, preferably from about 5000 to about 15,000 Daltons, more preferably from about 6000 to about 12,000 Daltons.

[0031] The fabric softening composition of the present disclosure preferably comprise a quaternary ammonium softening compound, more preferable may contain a quaternary ammonium ester compound. The quaternary ammonium ester compounds may act as fabric softening actives that may provide softness, anti-wrinkle, anti-static, conditioning, anti-stretch, color, and/or appearance benefits.

[0032] Preferably, the quaternary ammonium ester compound comprises triester quaternary ammonium material ("triestester quat").

[0033] The present disclosure also relates to fabric softening compositions wherein the quaternary ammonium ester compound is derived from fatty acids having an alkyl portion containing from about 13 to about 22 carbon atoms.

[0034] The fabric softening compositions of the present disclosure may be characterized by a pH of from about 2 to about 12, or from about 2 to about 8.5, or from about 2 to about 7, or from about 2 to about 5. The compositions of the present disclosure may have a pH of from about 2 to about 4, preferably a pH of from about 2 to about 3.7, more preferably a pH from about 2 to about 3.5, preferably in the form of an aqueous liquid. It is believed that such pH levels facilitate stability of the quaternary ammonium ester compound. The pH of a composition is determined by dissolving/dispersing the composition in deionized water to form a solution at 10% concentration, at about 20°C.

Quaternary Ammonium Ester Compound

[0035] The composition may comprise a quaternary ammonium ester compound, which may act as a fabric conditioning active ("FCA"). The type and amount of quaternary ammonium ester compound may be selected for the target benefit to be delivered and/or the fabrics targeted for treatment.

[0036] The quaternary ammonium ester compound (sometimes referred to as an "ester quat") may be present at a level of from about 0.1% to about 50%, or from about 2% to about 40%, or from about 3% to about 25%, preferably from 4% to 18%, more preferably from 5% to 15%, by weight of the composition. The quaternary ammonium ester compound may be present at a level of from greater than 0% to about 30%, or from about 1% to about 25%, or from about 3% to about 20%, or from about 4.0% to 18%, more preferably from 4.5% to 15%, even more preferably from 5.0% to 12% by weight of the composition. The quaternary ammonium ester compound may be present at a level of from about 1% to about 8%, or from about 1.5% to about 5%, by weight of the fabric care composition. The level of quaternary ammonium ester compound may depend of the desired concentration of total fabric conditioning active in the composition (diluted or concentrated composition) and of the presence (or not) of other FCAs. However, the risk on increasing viscosities over time is typically higher in fabric treatment compositions with higher FCA levels. On the other hand, at very high FCA levels, the viscosity may no longer be sufficiently controlled which renders the product unfit for use.

[0037] Quaternary ammonium ester compounds may be derived from fatty acids (sometimes called parent fatty acids). The fatty acids may include saturated fatty acids and/or unsaturated fatty acids. The fatty acids may be characterized by an iodine value (see Methods). Preferably, the iodine value of the fatty acid from which the quaternary ammonium fabric compound is formed is from 0 to 140, or from 0 to about 90, or from about 10 to about 70, or from about 15 to about 50, or from about 18 to about 30. The iodine value may be from about 25 to 50, preferably from 30 to 48, more preferably from 32 to 45. Without being bound by theory, lower melting points resulting in easier processability of the FCA are obtained when the fatty acid from which the quaternary ammonium compound is formed is at least partially unsaturated. In particular, it is believed that double unsaturated fatty acids enable easy-to-process FCAs.

[0038] The fatty acids may include an alkyl portion containing, on average by weight, from about 13 to about 22 carbon atoms, or from about 14 to about 20 carbon atoms, preferably from about 16 to about 18 carbon atoms.

[0039] Suitable fatty acids may include those derived from (1) an animal fat, and/or a partially hydrogenated animal fat, such as beef tallow, lard, etc.; (2) a vegetable oil, and/or a partially hydrogenated vegetable oil such as canola oil, safflower oil, peanut oil, sunflower oil, sesame seed oil, rapeseed oil, cottonseed oil, corn oil, soybean oil, tall oil, rice bran oil, palm

oil, palm kernel oil, coconut oil, other tropical palm oils, linseed oil, tung oil, etc.; (3) processed and/or bodied oils, such as linseed oil or tung oil via thermal, pressure, alkali-isomerization and catalytic treatments; (4) a mixture thereof, to yield saturated (e.g. stearic acid), unsaturated (e.g. oleic acid), polyunsaturated (linoleic acid), branched (e.g. isostearic acid) or cyclic (e.g. saturated or unsaturated α -disubstituted cyclopentyl or cyclohexyl derivatives of polyunsaturated acids) fatty acids.

[0040] The quaternary ammonium ester compound may comprise compounds formed from fatty acids that are unsaturated. The fatty acids may comprise unsaturated C18 chains, which may include a single double bond ("C18:1") or may be double unsaturated ("C18:2").

[0041] The quaternary ammonium ester compound may be derived from fatty acids and optionally from triethanolamine, preferably unsaturated fatty acids that include eighteen carbons ("C18 fatty acids"), more preferably C18 fatty acids that include a single double bond ("C18:1 fatty acids"). The quaternary ammonium ester compound may comprise from about 10% to about 40%, or from about 10% to about 30%, or from about 15% to about 30%, by weight of the quaternary ammonium ester compound, of compounds derived from triethanolamine and C18:1 fatty acids. Such levels of fatty acids may facilitate handling of the resulting ester quat material.

[0042] The fatty acid from which the quaternary ammonium conditioning actives is formed may comprise from 1.0% to 20.0%, preferably from 1.5% to 18.0%, or from 3.0% to 15.0%, more preferably from 4.0% to 15.0% of double unsaturated C18 chains ("C18:2") by weight of total fatty acid chains. From about 2% to about 10%, or from about 2% to about 8%, or from about 2% to about 6%, by weight of the total fatty acids used to form the quaternary ammonium ester compounds, may be C18:2 fatty acids.

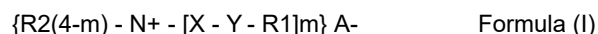
[0043] On the other hand, very high levels of unsaturated fatty acid chains are to be avoided to minimize malodour formation as a result of oxidation of the fabric softener composition over time.

[0044] Suitable quaternary ammonium ester compounds may include materials selected from the group consisting of monoester quaternary material ("monoester quats"), diester quaternary material ("diester quats"), triester quaternary material ("trimester quats"), and mixtures thereof. The level of monoester quat may be from 2% to 40%, the level of diester quat may be from 40% to 98%, and the level of triester quat may be from 0% to 30%, by weight of total quaternary ammonium ester compound. The level of monoester quat may be from 2% to 40%, the level of diester quat may be from 40% to 98%, and the level of triester quat may be less than 5%, or less than 1%, or even 0%, by weight of total quaternary ammonium ester compound. The level of monoester quat may be from 15% to 40%, the level of diester quat may be from 40% to 60%, and the level of triester quat may be from 15% to 38%, by weight of total quaternary ammonium ester compound. The quaternary ammonium ester compound may comprise triester quaternary ammonium material ("triester quats").

[0045] Suitable quaternary ammonium ester compounds may be derived from alkanolamines, for example, C1-C4 alkanolamines, preferably C2 alkanolamines (e.g., ethanolamines). The quaternary ammonium ester compounds may be derived from monoalkanolamines, dialkanolamines, trialkanolamines, or mixtures thereof, preferably monoethanolamines, diethanolamines, di-isopropanolamines, triethanolamines, or mixtures thereof. The quaternary ammonium ester compounds may be derived from diethanolamines. The quaternary ammonium ester compounds may be derived from di-isopropanolamines. The quaternary ammonium ester compounds may be derived from triethanolamines. The alkanolamines from which the quaternary ammonium ester compounds are derived may be alkylated mono- or dialkanolamines, for example C1-C4 alkylated alkanolamines, preferably C1 alkylated alkanolamines (e.g. N-methyldiethanolamine).

[0046] The quaternary ammonium ester compound may comprise a quaternized nitrogen atom that is substituted, at least in part. The quaternized nitrogen atom may be substituted, at least in part, with one or more C1-C3 alkyl or C1-C3 hydroxyl alkyl groups. The quaternized nitrogen atom may be substituted, at least in part, with a moiety selected from the group consisting of methyl, ethyl, propyl, hydroxyethyl, 2-hydroxypropyl, 1-methyl-2 hydroxyethyl, poly(C2-C3-alkoxy), polyethoxy, benzyl, more preferably methyl or hydroxyethyl.

[0047] The quaternary ammonium ester compound may comprise compounds according to Formula (I):



wherein:

m is 1, 2 or 3, with provisos that, in a given molecule, the value of each m is identical, and when (a) the quaternary ammonium ester compound comprises triester quaternary ammonium material ("triester quat"), for at least some of the compounds according to Formula (I), m is 3 (i.e., a triester);

each R₁, which may comprise from 13 to 22 carbon atoms, is independently a linear hydrocarbyl or branched hydrocarbyl group, preferably R₁ is linear, more preferably R₁ is partially unsaturated linear alkyl chain;

each R₂ is independently a C1-C3 alkyl or hydroxyalkyl group and/or each R₂ is selected from methyl, ethyl, propyl, hydroxyethyl, 2-hydroxypropyl, 1-methyl-2 hydroxyethyl, poly(C2-C3-alkoxy), polyethoxy, benzyl, more preferably methyl or hydroxyethyl;

each X is independently $-(CH_2)_n-$, $-CH_2-CH(CH_3)-$ or $-CH(CH_3)-CH_2-$, where each n is independently 1, 2, 3 or 4, preferably each n is 2;

each Y is independently $-O-(O)C-$ or $-C(O)-O-$; and

A- is independently selected from the group consisting of chloride, bromide, methyl sulfate, ethyl sulfate, sulfate, and nitrate, preferably A- is selected from the group consisting of chloride and methyl sulfate, more preferably A is methyl sulfate.

[0048] At least one X, preferably each X, may be independently selected from $-CH_2-CH(CH_3)-$ or $-CH(CH_3)-CH_2-$. When m is 2, X may be selected from $^*-CH_2-CH(CH_3)-$, $^*-CH(CH_3)-CH_2-$, or a mixture thereof, where the * indicates the end nearest the nitrogen of the quaternary ammonium ester compound. When there are two or more X groups present in a single compound, at least two of the X groups may be different from each other. For example, when m is 2, one X (e.g., a first X) may be $^*-CH_2-CH(CH_3)-$, and the other X (e.g., a second X) may be $^*-CH(CH_3)-CH_2-$, where the * indicates the end nearest the nitrogen of the quaternary ammonium ester compound. It has been found that such selections of the m index and X groups can improve the hydrolytic stability of the quaternary ammonium ester compound, and hence further improve the stability of the composition.

[0049] For similar stability reasons, the quaternary ammonium ester compound may comprise a mixture of: bis-(2-hydroxypropyl)-dimethylammonium methylsulfate fatty acid ester; (2-hydroxypropyl)-(1-methyl-2-hydroxyethyl)-dimethylammonium methylsulfate fatty acid ester; and bis-(1-methyl-2-hydroxyethyl)-dimethylammonium methylsulfate fatty acid ester; where the fatty acid esters are produced from a C12-C18 fatty acid mixture. The quaternary ammonium ester compound may comprise any of the fatty acid esters, individually or as a mixture, listed in this paragraph.

[0050] Each X may be $-(CH_2)_n-$, where each n is independently 1, 2, 3 or 4, preferably each n is 2.

[0051] Each R1 group may correspond to, and/or be derived from, the alkyl portion(s) of any of the parent fatty acids provided above. The R1 groups may comprise, by weight average, from about 13 to about 22 carbon atoms, or from about 14 to about 20 carbon atoms, preferably from about 16 to about 18 carbon atoms. It may be that when Y is $^*-O-(O)C-$ (where the * indicates the end nearest the X moiety), the sum of carbons in each R1 is from 13 to 21, preferably from 13 to 19.

[0052] The quaternary ammonium compounds of the present disclosure may include a mixture of quaternary ammonium compounds according to Formula (I), for example, having some compounds where m = 1 (e.g., monoesters) and some compounds where m = 2 (e.g., diesters). Some mixtures may even contain compounds where m = 3 (e.g., triesters). The quaternary ammonium compounds may include compounds according to Formula (I), where m is 1 or 2, but not 3 (e.g., is substantially free of triesters).

[0053] The quaternary ammonium compounds of the present disclosure may include compounds according to Formula (I), wherein each R2 is a methyl group. The quaternary ammonium compounds of the present disclosure may include compounds according to Formula (I), wherein at least one R2, preferably wherein at least one R2 is a hydroxyethyl group and at least one R2 is a methyl group. For compounds according to Formula (I), m may equal 1, and only one R2 may be a hydroxyethyl group.

[0054] The quaternary ammonium compounds of the present disclosure may include methyl sulfate as a counterion.

[0055] The quaternary ammonium compounds of the present disclosure may comprise one or more members selected from the group consisting of:

(A) bis-(2-hydroxypropyl)-dimethylammonium methylsulfate fatty acid ester and isomers of bis-(2-hydroxypropyl)-dimethylammonium methylsulfate fatty acid ester and/or mixtures thereof; N,N-bis-(2-(acyl-oxy)-propyl)-N,N-dimethylammonium methylsulfate and/or N-(2-(acyl-oxy)-propyl) N--(2-(acyl-oxy) 1-methyl-ethyl) N,N-dimethylammonium methylsulfate and/or mixtures thereof, in which the acyl moiety is derived from C12-C22 fatty acids such as Palm, Tallow, Canola and/or other suitable fatty acids, which can be fractionated and/or hydrogenated, and/or mixtures thereof;

(B) 1,2-di(acyloxy)-3-trimethylammonio propane chloride in which the acyl moiety is derived from C12-C22 fatty acids such as palm, tallow, canola and/or other suitable fatty acids, which can be fractionated and/or hydrogenated, and/or mixtures thereof;

(C) N,N-bis(hydroxyethyl)-N,N-dimethyl ammonium chloride fatty acid esters; N,N-bis(acyl-oxy-ethyl)-N,N-dimethyl ammonium chloride in which the acyl moiety is derived from C12-C22 fatty acids such as palm, tallow, canola and/or other suitable fatty acids, which can be fractionated and/or hydrogenated, and/or mixtures thereof, such as N,N-bis(tallowoyl-oxy-ethyl) N,N-dimethyl ammonium chloride;

(D) esterification products of Fatty Acids with Triethanolamine, quaternized with Dimethyl Sulphate; N,N-bis(acyl-oxy-ethyl) N-(2-hydroxyethyl)-N-methyl ammonium methylsulfate in which the acyl moiety is derived from C12-C22 fatty acids such as palm, tallow, canola and/or other suitable fatty acids, which can be fractionated and/or hydrogenated, and/or mixtures thereof, such as N,N-bis(tallowoyl-oxy-ethyl) N-(2-hydroxyethyl)-N-methyl ammonium methylsulfate;

(E) dicanoladimethylammonium chloride; di(hard)tallowdimethylammonium chloride; dicanoladimethylammonium

methylsulfate; 1-methyl-1-stearoylamidoethyl-2-stearoylimidazolium methylsulfate; 1-tallowylamidoethyl-2-tallowylimidazoline; dipalmylmethyl hydroxyethylammonium methylsulfate; and/or (F) mixtures thereof.

[0056] Examples of suitable quaternary ammonium ester compound are commercially available from Evonik under the tradename Rewoquat WE 18 and/or Rewoquat WE 20, and from Stepan under the tradename Stepantex GA90, Stepantex VK90, and/or Stepantex VL90A.

[0057] It is understood that compositions that comprise a quaternary ammonium ester compound as a fabric softening active may further comprise non-quaternized derivatives of such compounds, as well as unreacted reactants (e.g., free fatty acids).

[0058] The fabric softening compositions of the present disclosure may comprise other fabric softening actives, for example in addition to a quaternary ammonium ester compound. Other FCAs may include silicones, non-ester quaternary ammonium compounds, amines, fatty esters, sucrose esters, silicones, dispersible polyolefins, polysaccharides, fatty acids, softening or conditioning oils, polymer latexes, or combinations thereof, preferably silicone. The combined total amount of quaternary ammonium ester compound and silicone may be from about 5% to about 70%, or from about 6% to about 50%, or from about 7% to about 40%, or from about 10% to about 30%, or from about 15% to about 25%, by weight of the composition. The composition may include a quaternary ammonium ester compound and silicone in a weight ratio of from about 1:10 to about 10:1, or from about 1:5 to about 5:1, or from about 1:3 to about 1:3, or from about 1:2 to about 2:1, or about 1:1.5 to about 1.5:1, or about 1:1.

Spray dispenser

[0059] The fabric softening composition may be directly applied to the fabric by using a spray dispenser. The spray dispenser may be capable of withstanding internal pressure in the range of about 137.90 kPa (20 psig) to about 965.27 kPa (140 psig), alternatively about 551.58 kPa to 896.32 kPa (80 to about 130 psig). The total composition output and the spray droplet/particle size distribution may be selected to support the particulate removal efficacy but avoid a surface wetness problem. Total output is determined by the flow rate of the composition as it is released from the spray dispenser. To achieve a spray profile that produces minimal surface wetness, it is desirable to have a low flow rate and small spray droplets.

[0060] The flow rate of the composition being released from the spray dispenser may be from about 0.0001 grams/second (g/s) to about 2.5 grams/second. Alternatively, the flow rate may be from about 0.001 grams/second to about 2.5 grams/second, or about 0.01 grams/second to about 2.0 grams/second. For an aerosol sprayer, the flow rate is determined by measuring the rate of composition expelled by a spray dispenser for any 60 second period of use.

[0061] The Sauter Mean Diameter of the spray droplets may be in the range of from about 10 μm to about 100 μm , alternatively from about 20 μm to about 60 μm . At least some of the spray droplets are sufficiently small in size to be suspended in the air for at least about 10 minutes, and in some cases, for at least about 15 minutes, or at least about 30 minutes. Small particles can be efficiently created when the spray is dispensed in a wide cone angle. For a given nozzle component and delivery tube, cone angles can be modified by varying the insertion depth of the nozzle in the delivery tube. The cone angle may be greater than about 20 degrees, or greater than about 30 degrees, or greater than about 35 degrees, or greater than about 40 degrees, or greater than about 50 degrees.

[0062] The spray dispenser may be configured to spray the softening composition at an angle that is between an angle that is parallel to the base of the container and an angle that is perpendicular thereto. The desired size of spray droplets can be delivered by other types of spray dispensers that are capable of being set to provide a narrow range of droplet size. Such other spray dispensers include, but are not limited to: foggers, ultrasonic nebulizers, electrostatic sprayers, and spinning disk sprayers. The spray dispenser may be comprised of various materials, including plastic, metal, glass, or combinations thereof. The spray dispenser may be pressurized, unpressurized or non-aerosol.

[0063] A non-aerosol spray dispenser may include a pre-compression trigger sprayer.

[0064] One suitable non-aerosol spray dispenser is a plastic non-aerosol dispenser. The dispenser may be constructed of polyethylene such as a high-density polyethylene; polypropylene; polyethyleneterephthalate ("PET"); vinyl acetate, rubber elastomer, and combinations thereof. The spray dispenser may be made of clear PET. Another suitable spray dispenser includes a continuous action sprayer, such as FLAIROSOL™ dispenser from Afa Dispensing Group. The FLAIROSOL™ dispenser includes a bag-in-bag or bag-in-can container with a pre-compression spray engine, and aerosol-like pressurization of the freshening composition. An example of the FLAIROSOL™ dispenser is described in US Patent No. 8,905,271B2.

[0065] A pressurized spray dispenser may include a propellant. Various propellants may be used. The propellant may comprise hydrocarbon(s); compressed gas(es), such as nitrogen, carbon dioxide, air; liquefied gas(es) or hydrofluoro olefin ("HFO"); and mixtures thereof. Preferably, the product comprises a propellant selected from the group consisting of compressed gas such as compressed air, compressed nitrogen, and combinations thereof. Propellants listed in the U.S.

Federal Register 30 49 C.F.R. §1.73.115, Class 2, Division 2.2 are considered acceptable. The propellant may particularly comprise a trans-1,3,3,3-tetrafluoroprop-1-ene, and optionally a CAS number 1645-83-6 gas. Such propellants provide the benefit that they are not flammable, although the freshening compositions are not limited to inflammable propellants. One such propellant is commercially available from Honeywell International of Morristown, New Jersey under the trade name HFO-5 1234ze or GWP-6. If desired, the propellant may be condensable. By "condensable", it is meant that the propellant transforms from a gaseous state of matter to a liquid state of matter in the spray dispenser and under the pressures encountered in use. Generally, the highest pressure occurs after the spray dispenser is charged with a freshening composition but before that first dispensing of that freshening composition by the user. A condensable propellant provides the benefit of a flatter depressurization curve as the freshening composition is depleted during usage.

[0066] The pressurized spray dispenser may be free of a hydrocarbon propellant. The softening composition may be delivered from the spray dispenser which includes delivery components including but not limited to a valve to control flow and to seal the freshening composition within the spray dispenser, a button actuator and a nozzle for dispensing the freshening composition to the environment. The softening composition may be contained in a bag-in-can plastic spray dispenser.

Dryer sheet

[0067] The dryer sheet of the invention comprises a substrate and optionally a fabric treatment composition, preferably a fabric softener composition.

[0068] Dryer sheets can be prepared by soaking an absorbent flexible substrate with a liquid mixture of a fabric treatment composition, pressing the resultant soaked sheet to remove any excess liquid and then drying the sheet. Dryer sheets known in the art are preferably prepared by coating an absorbent flexible substrate with a molten mixture of the fabric treating composition and then solidifying the mixture. The fabric treatment composition transfers to the fabric during a drying operation to impart the fabric conditioning properties to the fabric. At an activation temperature that is achieved during a drying cycle in a dryer, at least a portion of the fabric treatment composition transfers from the substrate to the fabric to impart fabric conditioning properties. The activation temperature refers to the temperature at which the fabric treatment composition transfers to the fabrics.

[0069] The dryer sheet can be provided from components that are considered biodegradable or compostable. The terms biodegradable or compostable, are meant to refer to the ability of the dryer sheet to undergo degradation via biodegradation or hydrolysis under conditions favorable to biodegradation or hydrolysis (e.g., composting environment at 95% relative humidity and 180° F.) so that at least 95% of the components are considered degraded within a time period of about 90 days. The dryer sheet can be manufactured from only materials that are considered biodegradable or compostable, or the dryer sheet can be manufactured from a combination of materials that are considered biodegradable or compostable and materials that do not satisfy the biodegradable or compostable test. In addition, the dryer sheet can be provided so that it is characterized as biodegradable under ASTM D 6868-03. Although ASTM D 6868-03 refers to the definition of biodegradability for plastics used as coatings on paper, this definition can be used for determining the biodegradability of paper products.

[0070] The dryer sheet preferably comprises a fibrous substrate, it can be a woven or nonwoven substrate. The substrate can be a single layer substrate or dual-layer substrate. A dual-layer substrate comprises a fibrous first layer, the first layer having a first layer interior surface and a first layer exterior surface opposing the first layer interior surface, wherein the first layer exterior surface has a first layer exterior surface area; a nonwoven fibrous second layer joined to the first layer, the second layer having a second layer interior surface and a second layer exterior surface opposing the second layer interior surface, wherein the second layer exterior surface has a second layer exterior surface area, wherein the second layer interior surface is oriented towards the first layer interior surface. The dryer sheet preferably comprises a fabric treatment composition. In a dual layer-substrate part of the fabric treatment composition is preferably on the first layer interior surface and partially penetrating into the first layer; wherein the first layer exterior surface is free from the fabric treatment composition over more than about 60% of the first layer exterior surface; wherein the second layer exterior surface is free from the fabric treatment composition over more than about 60% of the second layer exterior surface. Preferably the fabric treatment composition is present at a weight ratio relative to the first layer and the second layer combined from about 10:1 to about 1000:1.

Nonwoven Fibrous Materials

[0071] Nonwoven fibrous materials provide for adequate function as a carrier for the cleaning microorganism and fabric treatment composition. The nonwoven fibrous material can be a polyester nonwoven fibrous material. For example, the nonwoven fibrous material can be polyester terephthalate. The nonwoven fibrous material can be a spun bonded polyester terephthalate. Optionally, the nonwoven fibrous material can be continuous filament spun bonded polyester terephthalate. Other nonwoven fibrous materials, such as rayon, can also be practical.

[0072] The nonwoven fibrous material can have a basis weight from about 10 g/m² to about 50 g/m². Such fibrous materials have sufficient constitution to carry the desired quantity of a treatment composition.

[0073] To provide for the desired release of the treatment composition, the nonwoven fibrous material can have a permeability of from about 50 Darcys to about 150 Darcys, optionally about 90 Darcys to about 140 Darcys. The fibers constituting the nonwoven fibrous material can have a denier from about 2 to about 6. The nonwoven fibrous material can have a caliper from about 0.1 mm to about 0.5 mm, or optionally from about 0.1 mm to about 0.4 mm. The greater the caliper, the more space within the nonwoven fibrous material to hold a fabric treatment composition.

[0074] The nonwoven substrate can comprise natural fiber and regenerated cellulose fiber. The substrate can include a sufficient amount of regenerated cellulose fiber to provide the nonwoven substrate with desired cloth or hand feel characteristics, and to provide the nonwoven substrate with desired porosity.

[0075] Natural fiber refers to fiber formed from plants or animals. Natural fibers are not fibers that are formed as a result of extrusion or spinning. The natural fibers can be obtained from a source of fiber using techniques such as chemical pulping, chemical mechanical pulping, semi chemical pulping, or mechanical pulping. Natural fibers from plants are often referred to as cellulosic fibers.

[0076] Exemplary natural fibers that can be used to form the nonwoven substrate include wood fibers and non-wood natural fibers such as vegetable fibers, cotton, various straws (e.g., wheat, rye, and others), various canes (e.g., bagasse and kenaf), silk, animal fiber (e.g., wool), grasses (e.g., bamboo, etc.), hemp, corn stalks, abaca, etc.

[0077] Wood fiber can be obtained from wood pulp. The wood pulp can include hardwood fibers, softwood fibers, or a blend of hardwood fibers and softwood fibers. The pulp can be provided as cellulose fiber from chemical pulped wood and can include a blend from coniferous and deciduous trees. By way of example, wood fibers can be from northern hardwood, northern softwood, southern hardwood, or southern softwood. Hardwood fibers tend to be more brittle but are generally more cost effective for use because the yield of pulp from hardwood is higher than the yield of pulp from softwood. The pulp can contain about 0 to about 100% or about 0 to about 70% hardwood fibers based on the weight of the fibers. Softwood fibers have desired paper making characteristics but are generally more expensive than hardwood fibers. The pulp can contain about 0 to about 100% softwood fibers based on the weight of the fibers. The pulp can contain a blend of hardwood and softwood fibers.

[0078] The natural fibers can be extracted with various pulping techniques. For example, mechanical or high yield pulping can be used for stone ground wood, pressurized ground wood, refiner mechanical pulp, and thermomechanical pulp. Chemical pulping can be used incorporating kraft, sulfite, and soda processing. Semi-chemical and chemi-mechanical pulping can also be used which includes combinations of mechanical and chemical processes to produce chemi-thermomechanical pulp.

[0079] The natural fibers can also be bleached or unbleached. One of skill in the art will appreciate that the bleaching can be accomplished through many methods including the use of chlorine, hypochlorite, chlorine dioxide, oxygen, peroxide, ozone, or a caustic extraction.

[0080] The pulp can include a recycle source for reclaimed fiber. Exemplary recycle sources include post-consumer waste (PCW) fiber, office waste, and corrugated carton waste. Post-consumer waste fiber refers to fiber recovered from paper that is recycled after consumer use. Office waste refers to fiber obtained from office waste, and corrugated carton waste refers to fiber obtained from corrugated cartons. Additional sources of reclaimed fiber include newsprint and magazines. Reclaimed fiber can include both natural and synthetic fiber. Incorporation of reclaimed fiber in the nonwoven substrate can aid in efficient use of resources and increase satisfaction of the end user of the dryer sheet.

[0081] Refining is the treatment of pulp fibers to develop their papermaking properties. Refining increases the strength of fiber to fiber bonds by increasing the surface area of the fibers and making the fibers more pliable to conform around each other, which increases the bonding surface area and leads to a denser sheet, with fewer voids. Most strength properties of paper increase with pulp refining, since they rely on fiber to fiber bonding. The tear strength, which depends highly on the strength of the individual fibers, has a tendency to decrease with refining. Refining of pulp increases the fibers flexibility and leads to a denser substrate. This means bulk, opacity, and porosity decrease (densometer values increase) with refining. Fibrillation is a result of refining paper fibers. Fibrillation is the production of rough surfaces on fibers by mechanical and/or chemical action; refiners break the outer layer of fibers, e.g., the primary cell wall, causing the fibrils from the secondary cell wall to protrude from the fiber surfaces.

[0082] The fibers can be refined so that the resulting nonwoven substrate provides the desired Canadian Standard Freeness value. In general, less refined fiber can provide a nonwoven substrate having more holes and voids and thereby permitting greater penetration into the nonwoven substrate. It may be desirable to provide a desired level of refining to control the presence of holes or voids so that the nonwoven substrate can contain a desired amount or loading of the fabric softening composition.

[0083] The nonwoven substrate can comprise natural fiber and regenerated cellulose fiber. The substrate can include a sufficient amount of regenerated cellulose fiber to provide the nonwoven substrate with desired cloth or hand feel characteristics, and to provide the nonwoven substrate with desired porosity.

[0084] Regenerated cellulose fiber can be considered a type of fiber prepared from cellulose and wherein the fiber is

formed as a result of extrusion or spinning. An exemplary regenerated cellulose fiber can be referred to as rayon or as viscose. It is understood that viscose is generally another term for rayon.

[0085] The nonwoven substrate can contain a sufficient amount of the regenerated cellulose fiber so that the dryer sheet exhibits desirable cloth and hand feel characteristics. In general, the cloth or hand feel characteristics of the dryer sheet can be provided so that they are similar to the cloth or hand feel characteristics of commercial dryer sheet products such as those available under the names Bounce® and Downy® from The Procter & Gamble Company. The natural fiber can provide a nonwoven substrate for use as a dryer sheet that is relatively inexpensive but has a tendency to provide the dryer sheet with stiffness. Regenerated cellulose fiber can be included in the nonwoven substrate in an amount sufficient to improve the cloth and hand feel characteristics of the nonwoven substrate.

[0086] The nonwoven substrate can contain a sufficient amount of the regenerated cellulose fiber so that the resulting nonwoven substrate has a desired level of porosity or air permeability. In general, providing the nonwoven substrate with a desired level of air permeability allows the nonwoven substrate to handle or contain a desired amount or loading of fabric conditioning agent. The air permeability of the nonwoven substrate can be controlled to allow for sufficient loading of the fabric conditioning agent onto the nonwoven substrate. It can be desirable for the nonwoven substrate to have an air permeability of at least 1.83 m³ per minute per m² (6 CFM (cubic feet per minute per ft²) according to Tappi T 251CM-85.

[0087] The nonwoven substrate can be prepared from fibers containing natural fiber, regenerated cellulose fiber, or a mixture of natural fiber and regenerated cellulose fiber. The nonwoven substrate can contain 0 wt. % to 100 wt. % natural fiber and can contain 0 wt. % to 100 wt. % regenerated cellulose fiber, based on the weight of the fiber of the nonwoven substrate. In order to provide the nonwoven substrate with desired cloth and hand feel properties or to provide the nonwoven substrate with desired air permeability, the nonwoven substrate can be prepared from a mixture of natural fiber and regenerated cellulose fiber. The nonwoven substrate can be prepared from a mixture containing about 10 wt. % to about 95 wt. % natural fiber, about 20 wt. % to about 92 wt. % natural fiber, about 40 wt. % to about 90 wt. % natural fiber, or about 50 wt. % to about 85 wt. % natural fiber. The nonwoven substrate can be prepared from a mixture containing about 0.5 wt. % to about 75 wt. % regenerated cellulose fiber, about 2 wt. % to about 60 wt. % regenerated cellulose fiber, about 10 wt. % to about 55 wt. % regenerated cellulose fiber, or about 20 wt. % to about 50 wt. % regenerated cellulose fiber. The weight percent of fiber is based upon the fiber content of the nonwoven substrate.

[0088] It can be desirable to provide the regenerated cellulose fiber having a length that is as long as possible to form a nonwoven substrate on a paper making machine in order to obtain the maximum benefit of the presence of the regenerated cellulose fiber. In general, it is expected that by using a longer regenerated cellulose fiber, it may be possible to use less of the regenerated cellulose fiber prepared with a nonwoven substrate that uses shorter fiber. In general, an exemplary regenerated cellulose fiber length that can be used on a paper making machine is about 3 mm to about 6 mm (about 1/8 inch to about 1/4 inch). It may be desirable to provide the regenerated cellulose fiber having a length of up to about 5.08 cm (2 inches).

[0089] The regenerated cellulose fiber can have a denier selected to provide desired cloth or hand feel characteristics. In general, a small denier can be used to enhance the cloth or hand feel characteristics. Fibers having a larger denier tend to be more coarse. Accordingly, the regenerated cellulose fiber can have a denier of about 0.5 to about 20, a denier of about 0.5 to about 10, a denier of about 0.5 to about 5, or a denier of about 1.0 to about 2.

[0090] The nonwoven fibrous material can be a continuous filament of polyester homopolymer and binder filaments formed of a polyester copolymer. The nonwoven fibrous material can be a polyolefin nonwoven. The nonwoven fibrous material can be spunbonded nonwoven. The nonwoven fibrous material can be an area bonded or point bonded nonwoven. The nonwoven fibrous material can be a spun bonded polyethylene terephthalate having trilobal fibers having a denier from about 5 to about 6. The nonwoven fibrous material can be a spun bonded a bicomponent fiber having a polyethylene terephthalate core and copolyethylene terephthalate with isophthalate and or mixture thereof.

[0091] The nonwoven fibrous material can comprise bicomponent fibers. The bicomponent fibers can be core-sheath constructions or lobed constructions. The nonwoven fibrous material can comprise bicomponent fibers that are polyethylene/polyethylene terephthalate core-sheath constructions, with either constituent forming the core or sheath. The bicomponent fibers can be polyethylene/polypropylene, with either constituent forming the core or sheath.

[0092] The nonwoven fibrous material can be the nonwoven fibrous material used presently or in the past or like that used presently or in the past in BOUNCE dryer sheets, available from The Procter & Gamble Company, Cincinnati, OH, United States of America, SNUGGLE dryer sheets, available from Henkel Corporation, Stamford, Connecticut, United States of America, and or SUAVITEL dryer sheets, available from Colgate-Palmolive Company, New York, New York, United States of America.

[0093] The nonwoven fibrous material can be cellulose.

Process of Manufacture

[0094] The dryer sheet can be practically formed using a continuous web converting process. A nonwoven fibrous web can be provided. The nonwoven fibrous web can have a top surface and an opposing bottom surface and a pair of web

transverse edges. A fabric treatment composition, preferably a fabric softener composition, can be applied to the top surface. The nonwoven fibrous web can be folded toward the top surface about a fold line that divides the first layer and the second layer to bring the web transverse edges into alignment with one another so that the second layer is above the first layer. The nonwoven fibrous web can be cut to form the dryer sheet. The nonwoven fibrous web can practically be cut

before it is folded or after it is folded but may be simpler to convert if the nonwoven fibrous web is cut after being folded. [0095] The fabric treatment composition, can be applied to the top surface by slot coating, spray coating, kiss rolling, printing, rotogravure, and other processes for applying the cleaning microorganisms as a liquid. One practical approach for applying the fabric treatment composition to a nonwoven fibrous material, as the nonwoven fibrous layers are employed herein, is to slot coat the nonwoven fibrous material and use a scraper set at or just above the surface to which the composition is applied to scrape off the composition at some level at or above the surface of the nonwoven fibrous material so that excess composition is removed.

[0096] The fabric treatment composition may partially penetrate into the nonwoven fibrous web. The fabric treatment composition may be applied to one of what becomes the first layer interior surface and or the second layer interior surface. The step of folding can be conveniently accomplished with a folding rail. Other folding process may be employed if the nonwoven fibrous web is cut in the cross direction CD prior to folding or individual pieces of nonwoven fibrous web are provided and then each dryer sheet is folded individually.

[0097] Once the nonwoven fibrous web, or an individual piece of nonwoven fibrous web, is folded over on itself, the web transverse edges can be bonded to one another. The step of bonding can be performed before or after the step of cutting in the cross direction CD. The bonding can provide coherency to the dryer sheet as described previously.

[0098] Once the first layer and second layer, or the pieces or parts of nonwoven fibrous web that ultimately become the first layer and second layer, are positioned as desired, the layers can be embossed to provide embossments to the layers and to squeeze the fabric treatment composition, if present, within the layers so that the fabric treatment composition fully penetrates the layers. Embossing can be accomplished by an embossing roll such as a cylindrical roll having raised embossing features of the desired pattern that is in operative relationship with an anvil roll.

[0099] Another approach for forming the dryer sheet is to provide the first layer and the second layer. The first layer and the second layer can be provided integral with one another as a single nonwoven fibrous web moving in the machine direction MD. The fabric treatment composition can be applied to the first layer interior surface and or the second layer interior surface, if the first layer and second layer are provided as individual lanes, or the nonwoven fibrous web can be cut in the machine direction MD after the fabric treatment composition is applied to form lanes of the material that ultimately becomes the first layer and second layer.

[0100] One of the first layer and the second layer can be flipped. Flipping can position the surface of the layers to which the treatment composition is applied to be oriented towards one another when the first layer is stacked onto the second layer. Flipping can be performed before or after the nonwoven fibrous web is cut in the cross direction CD.

[0101] Once one of the layers is flipped, the first layer and the second layer can be stacked so that the first layer interior surface is oriented towards the second layer interior surface. The first layer can be bonded to the second layer, which provides the benefit of helping to maintain the form of the dryer sheet before, during, and after use.

Fabric Treatment Composition

[0102] The dryer sheet preferable comprises a fabric treatment composition, the fabric treatment composition can provide care, fragrance, antiwrinkle, color protection, antistatic, softening benefits and any other benefits that add to the longevity and good feeling of fabrics. The fabric treatment composition can be a fabric softening composition such as any of the fabric softening compositions used presently or in the past or like that used presently or in the past in BOUNCE dryer sheets, available from The Procter & Gamble Company, Cincinnati, OH, United States of America, SNUGGLE dryer sheets, available from Henkel Corporation, Stamford, Connecticut, United States of America, and or SUAVITEL dryer sheets, available from Colgate-Palmolive Company, New York, New York, United States of America

[0103] The fabric treatment composition is preferably a fabric softening composition. The fabric softening composition preferably comprises from about 10% to about 90% by weight of the composition of a softening agent, preferably a quaternary ammonium softening compound. The quaternary ammonium compound may be ester and or amide linked.

[0104] The fabric softening composition may comprise a cationic nitrogen-containing compound such as a quaternary ammonium compound having one or two straight-chain organic groups of at least 8 carbon atoms; optionally one or two such groups of from 12 to 22 carbon atoms and, optionally be ester and or amide linked. Specific non-limiting examples of fabric softening actives include the following: Di Tallow, Di Methyl Ammonium Methyl Sulfate, N,N-di(oleyl-oxy-ethyl)-N,N-dimethyl ammonium chloride, N,N-di(canolyl-oxy-ethyl)-N,N-dimethyl ammonium chloride, N,N-di(oleyl-oxy-ethyl)-N-methyl, N-(2-hydroxyethyl) ammonium methyl sulfate, N,N-di(canolyl-oxy-ethyl)-N-methyl, N-(2-hydroxyethyl) ammonium methyl sulfate-, N,N-di(oleylamidoethyl)-N-methyl, N-(2-hydroxyethyl) ammonium methyl sulfate, N,N-di(2-oleyl-oxy-oxo-ethyl)-N,N-dimethyl ammonium chloride, N,N-di(2-canolyl-oxy-oxo-ethyl)-N,N-dimethyl ammonium chloride-, N,N-di(2-oleyl-oxyethylcarbonyloxyethyl)-N,N-dimethyl ammonium chloride, N,N-di(2-canolyl-oxyethylcarbonyloxyethyl)-N,N-

dimethyl ammonium chloride, N-(2-olexyloxy ethyl)-N-(2-olexyloxy oxo-ethyl)-N,N-dimethyl ammonium chloride; N-(2-canolyloxy ethyl)-N-(2-canolyloxy oxo-ethyl)-N,N-dimethyl ammonium chloride, N,N,N-tri(oleyl-oxy-ethyl)-N-methyl ammonium chloride, N,N,N-tri(canolyloxy-ethyl)-N-methyl ammonium chloride-, N-(2-olexyloxy oxoethyl)-N-(oleyl)-N,N-dimethyl ammonium chloride, N-(2-canolyloxy oxoethyl)-N-(canolyl)-N,N-dimethyl ammonium chloride, 1,2-dioleyloxy N,N,N-trimethylammonio propane chloride, and 5,2-dicanolyloxy N,N,N-trimethylammonio propane chloride, and combinations thereof. In one embodiment, the fabric conditioning active is N,N-di(tallowyl-oxy-ethyl)-N-methyl, N-(2-hydroxyethyl) ammonium methyl sulfate.

The fabric softening composition may comprise ingredients such as a nonionic material. Suitable nonionic materials may include polyoxyalkylene glycols, higher fatty alcohol esters of polyoxyalkylene glycols, higher fatty alcohol esters of polyoxyalkylene glycols, ethoxylates of long chained alcohols of from 8 to 30 carbon atoms such as the ethoxylates of coconut, palm, tallow alcohols or hydrogenated alcohols with 4 to 40 moles of ethylene oxide, and alkanolamides. The fabric softening composition may further comprise, with or without a non-ionic material, fatty acids, ethoxylated fatty acids, and combinations thereof. Suitable fatty acids include those wherein the long chain is unsubstituted or substituted alkyl or alkenyl group of from about 8 to 30 carbon atoms. Examples of specific fatty acids are lauric, palmitic, stearic, oleic, and/or combinations thereof.

[0105] The fabric softening composition may comprise one or more organic compounds having at least one relatively long hydrocarbon group serving to provide lubricity and or antistatic effects. Among such groups are alkyl groups containing 8 or more carbon atoms or even 12 to 22 carbon atoms. Suitable fabric softening compositions may comprise cationic, anionic, nonionic, or zwitterionic compounds. Cationic nitrogen containing compounds such as quaternary ammonium compounds having one or two straight chain organic groups of at least eight carbon atoms are practical.

[0106] The fabric softening composition can contain less than about 5% by weight of fatty acid. The fabric softening composition can be selected from the group consisting of polyglyceryl distearate, paraffin wax, branched paraffin wax, polyglyceryl ethers, and combinations thereof. Suitable fabric softening compositions include cationic, anionic, nonionic, or zwitterionic compounds. The fabric softening composition can be a quaternary imidazolium salt. Optionally, the fabric softening composition can be a polyoxyalkylene glycol, including higher fatty alcohol esters of polyoxyalkylene glycol and higher fatty alcohol ethers of polyoxyalkylene glycol. The fabric softening composition can be a fatty acid ester of sorbitan and ethoxylates of such esters.

Other fabric treatment ingredients

[0107] The fabric treatment composition can comprise a variety of ingredients. The fabric treatment composition may comprise unencapsulated perfume, encapsulated perfume, and combinations thereof. The encapsulated perfume, if provided, can be selected from the group consisting of friable encapsulates, moisture activated encapsulates, heat activated encapsulates and combinations thereof.

[0108] The fabric softening composition can comprise ingredients selected from the group consisting of softening agents, soil release agents, anti-static agents, crisping agents, water/stain repellents, stain release agents, refreshing agents, disinfecting agents, wrinkle resistant agents, wrinkle release agents, odor resistance agents, malodor control agents, abrasion resistance and protection agents, solvents, insect/pet repellents, wetting agents, chlorine scavenging agents, optical brighteners, UV protection agents, skin/fabric conditioning agents, skin/fabric nurturing agents, skin/fabric hydrating agents, color protection agents, dye fixatives, dye transfer inhibiting agents, silicones, preservatives and antimicrobials, fungicides, fabric shrinkage-reducing agents, brighteners, hueing dyes, bleaches, chelants, antifoams, anti-scum agents, whitening agents, catalysts, cyclodextrin, zeolite, petrolatum, glycerin, triglycerides, vitamins, other skin care actives such as aloe vera, chamomile, shea butter and the like, mineral oils, and combinations thereof.

Perfume

[0109] In addition to the fabric treatment composition, the dryer sheet can further comprise 0.1% to about 20% by weight perfume. The perfume can be unencapsulated perfume, encapsulated perfume, perfume provided by a perfume delivery technology, or a perfume provided in some other manner. Perfumes are generally described in U.S. Patent No. 7,186,680 at column 10, line 56, to column 25, line 22. The dryer sheet can comprise unencapsulated perfume and are essentially free of perfume carriers, such as a perfume microcapsules. The dryer sheet can comprise perfume carrier materials (and perfume contained therein). Examples of perfume carrier materials are described in U.S. Patent No. 7,186,680, column 25, line 23, to column 31, line 7. Specific examples of perfume carrier materials may include cyclodextrin and zeolites.

[0110] The dryer sheet can comprise about 0.1% to about 20%, alternatively about 1% to about 15%, alternatively 2% to about 10%, alternatively combinations thereof and any whole percentages within any of the aforementioned ranges, of perfume by weight of the dryer sheet. The dryer sheet can comprise from about 0.1% by weight to about 6% by weight of the dryer sheet of perfume. The perfume can be unencapsulated perfume and or encapsulated perfume.

[0111] The dryer sheet can be free or substantially free of a perfume carrier. The dryer sheet may comprise about 0.1% to

about 20%, alternatively about 1% to about 15%, alternatively 2% to about 10%, alternatively combinations thereof and any whole percentages within any dryer sheet.

[0112] The dryer sheet can comprise unencapsulated perfume and perfume microcapsules. The dryer sheet may comprise about 0.1% to about 20%, alternatively about 1% to about 15%, alternatively from about 2% to about 10%, alternatively combinations thereof and any whole percentages or ranges of whole percentages within any of the aforementioned ranges, of the unencapsulated perfume by weight of the dryer sheet. Such levels of unencapsulated perfume can be appropriate for any of the dryer sheet disclosed herein that have unencapsulated perfume.

[0113] The dryer sheet can comprise unencapsulated perfume and a perfume microcapsule but be free or essentially free of other perfume carriers. The dryer sheet can comprise unencapsulated perfume and perfume microcapsules and be free of other perfume carriers.

[0114] The dryer sheet can comprise encapsulated perfume. Encapsulated perfume can be provided as plurality of perfume microcapsules. A perfume microcapsule is perfume oil enclosed within a shell. The shell can have an average shell thickness less than the maximum dimension of the perfume core. The perfume microcapsules can be friable perfume microcapsules. The perfume microcapsules can be moisture activated perfume microcapsules.

[0115] The perfume microcapsules can comprise a melamine/formaldehyde shell. Perfume microcapsules may be obtained from Appleton, Quest International, or International Flavor & Fragrances, or other suitable source. The perfume microcapsule shell can be coated with polymer to enhance the ability of the perfume microcapsule to adhere to fabric. This can be desirable if the particles are designed to be a fabric treatment composition. The perfume microcapsules can be those described in U.S. Patent Pub. 2008/0305982.

[0116] The dryer sheet can comprise about 0.1% to about 20%, alternatively about 0.1% to about 10%, alternatively about 1% to about 15%, alternatively 2% to about 10%, alternatively combinations thereof and any whole percentages within any of the aforementioned ranges, of encapsulated perfume by weight of the dryer sheet.

[0117] The dryer sheet can comprise perfume microcapsules but be free of or essentially free of unencapsulated perfume. The particles may comprise about 0.1% to about 20%, alternatively about 1% to about 15%, alternatively about 2% to about 10%, alternatively combinations thereof and any whole percentages within any of the aforementioned ranges, of encapsulated perfume by weight of the dryer sheet.

[0118] Suitable fabric softening compositions for use in the present invention are presented in the table below.

Ingredient (weight % active)	Composition 1	Composition 2
Fabric Softener Active (1)	7.7	-
Rewoquat WE18(2)	-	8.9
Refined Coconut Oil	0.3	-
Isopropanol	0.8	-
perfume	1.0	1.0
Formic Acid	0.05	-
Hydrochloric acid	0.01	0.01
Sodium salt of 1-hydroxyethane 1,1-diphosphonic acid (Na HEDP)	0.01	-
MP10 antifoam emulsion (3)	0.10	-
Demineralised water	balance	balance
(1) N,N-bis(hydroxyethyl)-N,N-dimethyl ammonium chloride fatty acid ester. The iodine value of the parent fatty acid of this material is between 18 and 22. The material as obtained from Evonik contains impurities in the form of free fatty acid, the monoester form of N,N-bis(hydroxyethyl)-N,N-dimethyl ammonium chloride fatty acid ester, and fatty acid esters of N,N-bis(hydroxyethyl)-N-methylamine.		
(2) Di-(tallow carboxyethyl) hydroxyethyl methylammonium active methosulfate available from Evonik, 90% active		
(3) MP10 [®] , supplied by Dow Corning, 8% activity		

EXAMPLES

General washing and drying conditions

[0119] The following examples involve testing conducted to evaluate the impact of different liquid fabric softening compositions on airborne fiber release from vented tumble dryers. Each test involved four washing and drying cycles of a

new unsoiled laundry load comprising 10 cotton T-shirts (Fruit of the Loom® Original T-shirt, product code 61-082, size L, 100% cotton, density 145 g/m²) and 10 polyester T-shirts (Fruit of the Loom® Performance T-shirt, product code 61-390, size L, 100% polyester, density 140 g/m²).

[0120] All tests involved North American washing conditions and were conducted using 102.6 ppm (6 grains per U.S. gallon) hardness water and a High Efficiency top-loader washing machine Maytag® Bravo (Model MVWX655DW1). Tests were conducted using the customized North America Median program (Cycle settings: Medium soil, Fabric Conditioner knob set to "ON", Extra rinse knob set to "OFF", Washing temperature: 25°C, Main wash volume: 38 L, Rinse temperature: 15°C, Rinse volume: 43 L, and 52 minutes total duration). The test garments were washed and rinsed using these conditions, and the same conditions were used for two washout cycles afterwards conducted without fabrics and products to clean the machine. All tests were conducted using sets of four identical machines fed by the same water supply. Treatments were rotated between the four washing machines and conducted in triplicate for four consecutive washing cycles. After each wash cycle, the wash loads were dried using Indesit® vented tumble dryers (model IDV75) for one hour on the high heat setting. The detergent was added to the drum of the washing machine at the start of each cycle. In legs where it is present, fabric conditioner was added to the dedicated compartment in the washing machine at the start of each cycle for automatic release into the final rinse.

General method for the quantification of fiber release from the vented tumble dryer

[0121] During the drying step of each cycle, released fibers were collected from the exhaust of the tumble dryer using a 20 µm CellMicroSieve® (BioDesign Inc., Carmel, N.Y., U.S.A.), attached to the dryer exhaust using a 100 mm plastic pipe connector (model 414c, Manrose Manufacturing Ltd., U.K.). The CellMicroSieve® was connected to one side of the plastic pipe connector using 450 mm long, 10 mm wide cable ties (product 90526, Screwfix Direct Ltd., U.K.). At the end of each drying cycle, the built-in lint filter designed to safely collect fibers produced by the dryer for safe disposal in household waste was cleaned and its fiber contents suspended in around 1L of cold tap water. The CellMicroSieve® attached to collect fibers released from the dryer exhaust was washed thoroughly and its fiber contents suspended in around 3L of cold tap water. The fibers collected at both the lint filter and dryer exhaust were quantified gravimetrically by filtration onto white filter paper using the protocol described in Lant NJ, Hayward AS, Peththawadu MMD, Sheridan KJ, Dean JR. Microfiber release from real soiled consumer laundry and the impact of fabric care products and washing conditions. PLoS One. 2020;15: 1-18. doi: 10. 1371/journal.pone.0233332.

[0122] Results are presented as average fiber release in ppm (mg fiber collected per kg fabric load) across all four wash cycles and three replicates of each treatment, i.e. n=12 per leg. Also given is the percentage change in fiber release for the Invention relative to the Comparative Reference. Statistically significant differences at 95% confidence level are denoted by the letter 's' following the percentage change, based on Student's t-test and a p-value < 0.05.

Example 1

[0123] This test evaluated the impact of a rinse-added liquid fabric softening composition, Ultra Downy® April Fresh. This is a commercial product manufactured by Procter & Gamble and sold in the USA with the following ingredients listing:

Ultra Downy® April Fresh - Ingredients
 Water
 Diethylester Dimethyl Ammonium Chloride
 Fragrance
 Polyquaternium-33
 Formic Acid
 Blend of Polyoxyalkylene Substituted Chromophores (Blue And Red)
 Pentasodium Pentetate

Results

[0124]

	Comparative	Invention
Detergent	1 Tide® Pod	1 Tide® Pod
Liquid fabric conditioner	None	101g Ultra Downy® April Fresh
1. Average fiber collection - dryer lint filter (ppm)	106.04	137.75 (+29.9s)

(continued)

	Comparative	Invention
(% Change vs Reference)		
2. Average fiber release - dryer exhaust (ppm) (% Change vs Reference)	50.25	39.38 (-21.6s)
Total fiber release in dryer (sum of 1 + 2) (% Change vs Reference)	156.29	177.13 (+13.3s)

[0125] Results show that the use of a liquid softening composition in accordance with the invention significantly reduced the level of airborne fibers released from the dryer exhaust by 21.6% relative to the comparative example which did not involve the use of a fabric softening composition. The use of liquid softening composition was associated with significantly increased fiber collection on the dryer lint filter by 29.9%.

Example 2

[0126] This test evaluated the impact of a rinse-added liquid fabric conditioner designed for anti-wrinkle performance, Downy® WrinkleGuard Fresh. This is a commercial product manufactured by Procter & Gamble and sold in the USA with the following ingredients listing:

Downy® WrinkleGuard Fresh - Ingredients
 Water
 Diethylester Dimethyl Ammonium Chloride
 Amodimethicone
 Fragrance
 Polyquaternium-33
 Calcium Chloride
 Formic Acid
 Pentasodium Pentetate

Results

[0127]

	Comparative	Invention
Detergent	1 Tide® Pod	1 Tide® Pod
Liquid fabric conditioner	None	120g Downy® WrinkleGuard Fresh
1. Average fiber collection - dryer lint filter (ppm) (% Change vs Reference)	87.26	128.29 (+47.0s)
2. Average fiber release - dryer exhaust (ppm) (% Change vs Reference)	39.29	25.28 (-35.6s)
Total fiber release in dryer (sum of 1 + 2) (% Change vs Reference)	126.55	153.57 (+21.1s)

[0128] Results show that the use of liquid anti-wrinkle fabric conditioner in accordance with the softening composition of the invention significantly reduced the level of airborne fibers released from the dryer exhaust by 35.6% relative to the comparative example which did not involve liquid anti-wrinkle fabric conditioner use. The use of liquid anti-wrinkle fabric conditioner was associated with significantly increased fiber collection on the dryer lint filter by 47.0%.

[0129] The data from both examples concludes that different types of rinse-added fabric softening compositions significantly reduce airborne fiber pollution by increasing the efficiency of the dryer's lint filter. This is surprising, as fabric conditioners are associated with increased fiber lubrication and therefore might be expected to exacerbate fiber loss during tumble drying leading to higher levels of airborne fiber release. The above results show that total fiber release in the dryer is indeed increased by use of rinse-added fabric softening composition, but this is unexpectedly accompanied by a

reduction in airborne fiber release from the exhaust.

Claims

1. Use of a fabric softening composition:

- i) during a rinse stage of a first fabric treatment process; or
- ii) directly applied to a fabric

to reduce airborne fibers release during a subsequent treatment of the fabric in a vented tumble dryer.

2. Use according to claim 1 wherein the fabric softening composition comprises from 1 to 30%, preferably from 2 to 15% by weight of the composition of a quaternary ammonium softening compound.

3. Use according to any of claims 1 or 2 wherein the fabric softening composition comprises from 0.5 to 6%, preferably from 1 to 5% by weight of the composition of a silicone compound.

4. Use according to any of the preceding claims wherein the first fabric treatment process takes place in a washing machine.

5. Use according to the preceding claim wherein the fabric softening composition is delivered into the last rinse stage.

6. Use according to any of claims 1 to 3 wherein the fabric softening composition is directly applied to the fabric in spray form.

7. Use according to any of the preceding claims wherein the subsequent treatment is a drying process.

8. Use according to any of the preceding claims wherein the subsequent treatment involves the use of a dryer sheet.

9. Use according to the preceding claim wherein the dryer sheet comprises a non-woven substrate.

10. Use according to the preceding claim wherein the non-woven substrate comprises polyester.

11. Use according to claim 9 wherein the non-woven substrate comprises natural fibers.

12. Use according to the preceding claim wherein the natural fibers comprise cellulosic fibers.

13. Use according to any of claims 8 to 12 wherein the dryer sheet comprises a fabric treatment composition.

14. Use according to the preceding claim wherein the fabric treatment composition on the sheet comprises a softening composition.

15. Use according to the preceding claim wherein said fabric softening composition comprises a quaternary ammonium softening compound.

Patentansprüche

1. Verwendung einer Stoffweichmacherzusammensetzung:

- i) während einer Spülstufe eines ersten Stoffbehandlungsverfahrens; oder
 - ii) direkt auf einen Stoff aufgetragen
- um eine Freisetzung von Fasern aus der Luft bei einer nachfolgenden Behandlung des Stoffs in einem Ablufttrommeltrockner zu verringern.

2. Verwendung nach Anspruch 1, wobei die Stoffweichmacherzusammensetzung zu 1 bis 30 Gew.-%, vorzugsweise zu 2 bis 15 Gew.-% der Zusammensetzung eine weichmachende quartäre Ammoniumverbindung umfasst.

3. Verwendung nach einem der Ansprüche 1 oder 2, wobei die Stoffweichmacherzusammensetzung zu 0,5 bis 6 Gew.-%, vorzugsweise zu 1 bis 5 Gew.-% eine Siliconverbindung umfasst.
- 5 4. Verwendung nach einem der vorstehenden Ansprüche, wobei das erste Stoffbehandlungsverfahren in einer Waschmaschine stattfindet.
5. Verwendung nach dem vorstehenden Anspruch, wobei die Stoffweichmacherzusammensetzung in der letzten Spülstufe abgegeben wird.
- 10 6. Verwendung nach einem der Ansprüche 1 bis 3, wobei die Stoffweichmacherzusammensetzung in Sprühform direkt auf den Stoff aufgetragen wird.
7. Verfahren nach einem der vorstehenden Ansprüche, wobei die nachfolgende Behandlung ein Trocknungsverfahren ist.
- 15 8. Verwendung nach einem der vorstehenden Ansprüche, wobei die nachfolgende Behandlung die Verwendung eines Trocknertuchs beinhaltet.
9. Verwendung nach dem vorstehenden Anspruch, wobei das Trocknertuch ein Vliessubstrat umfasst.
- 20 10. Verwendung nach dem vorstehenden Anspruch, wobei das Vliessubstrat Polyester umfasst.
11. Verwendung nach Anspruch 9, wobei das Vliessubstrat Naturfasern umfasst.
- 25 12. Verwendung nach dem vorstehenden Anspruch, wobei die Naturfasern Cellulosefasern umfassen.
13. Verwendung nach einem der Ansprüche 8 bis 12, wobei das Trocknertuch eine Stoffbehandlungszusammensetzung umfasst.
- 30 14. Verwendung nach dem vorstehenden Anspruch, wobei die Stoffbehandlungszusammensetzung auf dem Tuch eine Weichmacherzusammensetzung umfasst.
15. Verwendung nach dem vorstehenden Anspruch, wobei die Stoffweichmacherzusammensetzung eine weichmachende quartäre Ammoniumverbindung umfasst.
- 35

Revendications

- 40 1. Utilisation d'une composition assouplissante :
- i) au cours d'une étape de rinçage d'un premier processus de traitement de tissu ; ou
ii) en application directe sur un tissu
pour réduire la libération de fibres en suspension dans l'air au cours d'un traitement ultérieur du tissu dans un sèche-linge à évacuation.
- 45 2. Utilisation selon la revendication 1, dans laquelle la composition assouplissante comprend de 1 à 30 %, de préférence de 2 à 15 % en poids de la composition d'un composé assouplissant à base d'ammonium quaternaire.
- 50 3. Utilisation selon l'une quelconque des revendications 1 ou 2, dans laquelle la composition assouplissante comprend de 0,5 à 6 %, de préférence de 1 à 5 % en poids de la composition d'un composé de silicone.
4. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle le premier processus de traitement du tissu a lieu dans une machine à laver.
- 55 5. Utilisation selon la revendication précédente, dans laquelle la composition assouplissante est administrée au cours de la dernière étape de rinçage.
6. Utilisation selon l'une quelconque des revendications 1 à 3, dans laquelle la composition assouplissante est

appliquée directement au tissu sous forme de jet pulvérisé.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel le traitement ultérieur est un processus de séchage.

8. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle le traitement ultérieur implique l'utilisation d'une feuille de séchage.

9. Utilisation selon la revendication précédente, dans laquelle la feuille de séchage comprend un substrat non tissé.

10. Utilisation selon la revendication précédente, dans laquelle le substrat non tissé comprend du polyester.

11. Utilisation selon la revendication 9, dans laquelle le substrat non tissé comprend des fibres naturelles.

12. Utilisation selon la revendication précédente, dans laquelle les fibres naturelles comprennent des fibres cellulosiques.

13. Utilisation selon l'une quelconque des revendications 8 à 12, dans laquelle la feuille de séchage comprend une composition de traitement de tissu.

14. Utilisation selon la revendication précédente, dans laquelle la composition de traitement de tissu sur la feuille comprend une composition assouplissante.

15. Utilisation selon la revendication précédente, dans laquelle ladite composition assouplissante comprend un composé assouplissant à base d'ammonium quaternaire.

REFERENCES CITED IN THE DESCRIPTION

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