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(54) **TEXTILE FINISHING PROCESS**

(57) The present invention is directed to a textile finishing process comprising the steps: providing a continuous supply of a textile; piezoelectric drop-on-demand ink jet printing one or more textile finishing compositions on a side of the textile, or on one or more regions of a side of the textile; drying the textile; and calendaring the dried textile, and a finished textile obtained by said process.

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to the technical field of processes for chemical textile finishing.

BACKGROUND OF THE INVENTION

[0002] Nowadays, the textile industry uses many industrial finishing treatments. Thus, textiles are frequently subjected to a finishing process, which provides to the textile its final appearance and properties. The finishing process can be carried out mechanically (e.g. emerizing, compressive shrinkage, shearing) or chemically.

[0003] Chemical finishing consists of the modification of textile fibers through chemical action. Chemical finishing is typically carried out by padding, during which the textile is fully immersed in a textile finishing composition and subsequently, subjected to repeated cycles of drying, fixation and condensation. Typically the drying step is conducted by exposure to infrared (IR) light, while the fixation step takes place by exposure to hot air (e.g. 60 seconds at 120 °C) using a high temperature fixation frame. The padding process leads to considerable use of resources, such as finishing compositions, water and energy. Generally, several properties (e.g. softness, water-repellence, improved wicking properties, UV-blocking properties, flame retardancy properties) must be imparted to the finished textile to meet the client's expectations. Consequently, several textile finishing compositions, and several separate textile padders (one per textile finishing composition) together with the corresponding IR dryers and high temperature frames are required. Because the individual finishing processes are carried out individually in separate devices, the textile finishing process requires a relatively large area, usually spread over different room areas, and significant human intervention.

[0004] To address the drawbacks of the padding based finishing processes, US patent application publication number US20090298368A1 proposes a finishing composition printable by continuous inkjet and a process for finishing a textile based on continuous inkjet printing. The process comprises providing a continuous supply of a textile substrate, providing an array of continuous flow inkjet nozzles, supplying to the nozzles a finishing composition, and selectively dispensing the composition from the nozzles to deposit a predetermined distribution of droplets onto the substrate. The exemplified finishing composition contains 10 wt-% of a finishing agent, 15 wt-% of polyethylene glycol, 10 wt-% of poly-vinylpyrollidone, 64.75 wt-% water, a surfactant, a biocide and an anti-foaming agent. Prior to the finishing process, the textile is coated with one or more coatings (thin functional layers for protecting or increasing the durability of the substrate, and for receiving the finishing composition). To influence the coating and/or the finishing, US20090298368A1 suggests drying the textile after each coating step and prior to the finishing step by exposure to infrared light. To impart several different properties to the finished product, US20090298368A1 suggests using several arrays of continuous flow inkjet nozzles, wherein each of said several arrays is supplied with a finishing composition. The number of arrays of continuous flow inkjet nozzles required for applying the coating and the finishing compositions results in costly equipment in terms of acquisition and maintenance. The process described by US20090298368A1 seems to enable a reduction of the water, finishing compositions and energy consumption compared to the finishing processes including a padding step. Nevertheless, it requires coating of the textile prior to the continuous inkjet printing of the finishing composition, which leads to an increase in the chemicals consumption. Furthermore, because of the high drop volume (800 pL) and the mechanism required for the drop generation in continuous inkjet, which leads to an increase of the viscosity of the finishing composition during the printing process, the resulting finishing is relatively thick, nonuniform (because of the overlap of the deposited droplets and the increase in the viscosity during the printing process) and impairs the breathability of the finished textile by fully covering the openings between the fibers.

[0005] Given the drawbacks of the known textile finishing processes, there is a need for an environmentally-friendly process in terms of water, chemicals and energy consumption that meets the industry requirements in terms of quality of the finished textile, finishing speed, space required by the finishing equipment, acquisition and maintenance price, and human intervention.

SUMMARY OF THE INVENTION

[0006] Accordingly it is an object of the present invention to provide a textile finishing process comprising the following steps:

a) providing a continuous supply of a textile;
b) piezoelectric drop-on-demand ink jet printing one or more textile finishing compositions on a side of the textile, or on one or more regions of a side of the textile;
c) drying the textile by exposure to an air having a temperature from about 120 °C to about 140 °C to provide a dried textile; and

d) calendaring the dried textile for at least 10 seconds at a temperature from about 180 °C to about 220 °C to provide a finished textile.

[0007] Preferably steps a), b), c) and d) are carried out continuously and/or at step b) at least two, preferably at least three, more preferably at least four textile finishing compositions, are applied with a single piezoelectric drop-on-demand ink jet printhead.

[0008] A further aspect according to the present invention is directed to a finished textile obtained by the process claimed and described herein and to a garment comprising the finished textile.

DETAILED DESCRIPTION OF THE INVENTION

[0009] Thus, it is an object of the present invention to address the need for a textile finishing process that is environmentally friendly in terms of water, chemicals and energy consumption, does not require cost intensive and voluminous equipment, and continuous human intervention and provides finished textiles having an uniform and wash durable finishing in a time-expedient manner that is compatible with the textile industry requirements. The objective is achieved by the textile finishing process according to claim 1. Preferred embodiments are described in the specification and the claims.

[0010] The present invention will be described in more detail below.

[0011] Where the present description refers to "preferred" embodiments/features, combinations of these "preferred" embodiments/features are also deemed to be disclosed as long as the specific combination of the "preferred" embodiments/features is technically meaningful.

[0012] Unless otherwise stated, the following definitions shall apply in this specification:
As used herein, the term "a", "an", "the" and similar terms used in the context of the present invention (especially in the context of the claims) are to be construed to cover both the singular and plural unless otherwise indicated herein or clearly contradicted by the context.

[0013] As used herein, the term "and/or" means that either all or only one of the elements of said group may be present. For example, "A and/or B" means "only A, or only B, or both A and B". In the case of "only A", the term also covers the possibility that B is absent, i.e. "only A, but not B".

[0014] As used herein, the terms "including", "containing" and "comprising" are used herein in their open-ended, non-limiting sense. It is understood that the various embodiments, preferences and ranges may be combined at will. Thus, for instance a solution comprising a compound A may include other compounds besides A. However, the term "comprising" also covers, as a particular embodiment thereof, the more restrictive meanings of "consisting essentially of" and "consisting of, so that for instance "a solution comprising A, B and optionally C" may also (essentially) consist of A and B, or (essentially) consist of A, B and C. As used herein, the transitional phrase "consisting essentially of" (and grammatical variants) is to be interpreted as encompassing the recited materials or steps and those that do not materially affect the basic and novel characteristic(s) of the claimed invention. Thus, the term "consisting essentially of" should not be interpreted as equivalent of "comprising".

[0015] As used herein, the term "about" means that the amount or value in question may be the specific value designated or some other value in its neighborhood. Generally, the term "about" denoting a certain value is intended to denote a range within $\pm$ 5 % of the value. As one example, the phrase "about 100" denotes a range of 100 $\pm$ 5, i.e. the range from 95 to 105. Preferably, the range denoted by the term "about" denotes a range within $\pm$ 3 % of the value, more preferably $\pm$ 1 %. Generally, when the term "about" is used, it can be expected that similar results or effects according to the invention can be obtained within a range of $\pm$5 % of the indicated value.

[0016] Surprisingly, it has been found that process comprising the following steps:

a) providing a continuous supply of a textile;
b) piezoelectric drop-on-demand ink jet printing one or more textile finishing compositions on a side of the textile, or on one or more regions of a side of the textile;
c) drying the textile by exposure to an air having a temperature from about 120 °C to about 140 °C to provide a dried textile; and
d) calendaring the dried textile for at least 10 seconds at a temperature from about 180 °C to about 220 °C to provide a finished textile, results in finished textiles having an uniform and wash durable finishing.

[0017] As used herein, the term "textile" is intended to encompass all forms of textile substrates, including woven, knitted and nonwoven textile substrates. The term is intended to exclude fibrous substrates having two-dimensional rigidity such as carpets, paper and cardboard. The fibrous substrates, although sometimes referred as textiles, are internally linked in such a way that they maintain a substantially fixed two-dimensional form. Even though they may be flexible in a third dimension they are not generally free to stretch or distort within the plane of the fiber layer, as is inherent

in a true textile. Preferably, the textile is more than 100 meters (e.g. 500 meters) in length and can be provided on a roll having a width of greater than 1 meter. Preferably, the textile is a woven, knitted or nonwoven fabric. The fabric preferably contains synthetic and/or natural fibers, preferably selected from cellulose fibers, elastane fibers, polyamide fibers and polyester fibers. Preferably, the textile is colored i.e. the fibers making the textile have been previously dyed or the textile *per se* has been previously contacted with one or more colorants (e.g. a dye or a pigment) in a dyeing and/or printing process. The textile supplied at step a) of the process claimed and described herein does not require a coating pretreatment.

[0018] At step b) of the process claimed and described herein, one or more textile finishing compositions are applied by piezoelectric drop-on-demand ink jet printing on a side of the textile, or on one or more regions of a side of the textile. As used herein, the term "textile finishing composition" refers to a ready-to-use aqueous colorless composition, which is printable by piezoelectric drop-on-demand ink jet printing and contains one or more finishing agents (i.e. substances that change a property, other than a color, of a textile). The textile finishing compositions impart to the textile a variety of properties, including but not limited to water-repellency, softness and improved wicking behavior. A ready-to-use finishing composition does not require a preparation onsite and before each finishing process as it is the case for finishing processes including a padding step. The textile finishing compositions described herein are colorless i.e. they do not contain pigments and/or dyes having a color detectable by the naked eye. As well known in the art, the term "side" refers to the front side or the back side of a textile. Advantageously, the use of the piezoelectric drop-on-demand inkjet printing enables selective deposit of the one or more textile finishing compositions on a side of a textile or one or more regions (areas) of a side of a substrate. Such selective finishing cannot be achieved by padding. The low drop volume (5 pL, 7 pL, 12 pL, 18 pL) ejected by and the precise deposit achieved with a piezoelectric drop-on-demand inkjet printhead provides a uniform finishing to the textile, without impacting the breathability of the textile. Such uniform finishing cannot be achieved with the known finishing process using arrays of continuous flow inkjet nozzles because of the high volume of the ejected droplet (800 pL) leading to an overlap of the deposited droplets, and the increase in the viscosity of the finishing composition during the printing process. Owing to the accurate dosing of the textile finishing composition and the low droplet volume achieved by piezoelectric drop-on-demand inkjet printing, the volume of applied textile finishing composition is significantly lower (4 to 6 times lower) than the one required for finishing by padding, and a constant deposit of the finishing composition is applied on the entire surface to be treated, leading to a high quality of the finishing, which cannot be achieved by padding processes or continuous inkjet printing processes. Further, the volume of wastewater produced in the finishing process is reduced by a factor 4 to 6 compared to the padding finishing process. Also, the consumed energy is significantly reduced with the present finishing process.

[0019] Preferably, the one or more textile finishing compositions are printed on the textile in a total amount (wet deposit) from 10 g/m^2 to 30 g/m^2, preferably from 10 g/m^2 to 25 g/m^2. Thus, in a preferred finishing process according to the present invention, a wet deposit from 10 g/m^2 to 30 g/m^2, preferably from 10 g/m^2 to 25 g/m^2, of the one or more finishing compositions is deposited on the side of the textile, or on the one or more regions of the side of the textile. With the present finishing process and the finishing compositions described herein, total amounts (wet deposits) of textile finishing compositions as low as 10 g/m^2 are sufficient for imparting the required properties to the textile. These amounts are significantly lower than the wet deposits required with the finishing processes known in the art.

[0020] Conveniently, the finishing process claimed and described herein enables the simultaneous application of several finishing compositions on a region (area) of the textile with a single piezoelectric drop-on-demand ink jet printhead. Hence, the equipment required is significantly cheaper, and more compact and reliable than the one required for finishing processes using arrays of continuous flow inkjet nozzles or separate padders. Moreover, the present finishing process is more expedient than the padding based finishing processes. Preferably, at step b) of the inventive process at least two (e.g. a textile softening composition and a water-repellent textile finishing composition), preferably at least three (e.g. a textile softening composition, a water-repellent textile finishing composition, and a textile finishing composition for improving the wicking properties), more preferably at least four distinct textile finishing compositions, are applied with a single piezoelectric drop-on-demand ink jet printhead. The wet deposit for the at least two, preferably at least three, more preferably at least four textile finishing compositions may be the same or different.

[0021] At step c) of the present finishing process, the textile obtained at step b) is subjected to drying to evaporate the water contained in the textile finishing compositions and furnish a dried textile. This step is achieved by exposure of the printed textile to an air having a temperature from about 120 °C to about 140 °C. The exposure time depends on the surface density (g/m^2) of the deposited finishing composition and the used temperature and is preferably lower than 3 minutes, more preferably lower than 2 minutes, much preferably about 1 minute, and meets the speed-requirements of the industrial manufacturing processes for textiles.

[0022] The dried textile is subsequently calendared for at least 10 seconds, preferably for about 30 seconds, at a temperature from about 180 °C to about 220 °C. Preferably, the dried textile is calendared for less than 60 seconds. This step ensures the fixation of the finishing agent to the textile fibers and increases the wash durability (i.e. the property imparted to the textile is maintained for at least twenty washings). The calendaring step is faster than the conventionally used fixation step for padding-based finishing process using a high temperature (HT) fixation frame, which typically

requires about 60 seconds at 120 °C. The HT frame/machine currently used in the textile industry is a large installation (length of the heated tunnel is between 10 to 20 meters) requiring a lot of space. Thus, the calendar (rotary heat press roll to roll) used in the present process occupies significantly lower space than the industrial available HT frame/machine.

[0023] Preferably, steps a), b), c) and d) of the process claimed and described herein are carried out continuously. In this embodiment, the units for the continuous supply of the textile, the piezoelectric drop-on-demand ink-jet printing, the drying and the fixing are mounted one after another and the textile to be finished is moved through them continuously. The units for steps a)- d) can also be combined in a single machine. The textile is transported continuously through the machine and is thus in the finished state when it leaves the machine.

[0024] The present finishing process may be conducted using a commercially available industrial textile printer (e.g. Panthera D8 or Panthera S4 from Swiss Performance Chemicals; LaRIO from MS Printing Solutions) and a calendar (rotary heat press roll to roll). The industrial textile printer (e.g Panthera D8) and the calendar require significantly less space than the currently available industrial textile padder and the corresponding HT fixation frame.

[0025] With the process claimed and described herein finishing speeds of about 50 m/min may be achieved.

[0026] Preferably, the one or more finishing compositions are selected from water-repellent finishing compositions, softening compositions, flame retardant treatment compositions, antimicrobial treatment compositions, wrinkle-resistant treatment compositions, UV-enhancing finishing compositions, finishing compositions for moisture management, and finishing compositions for improving the wicking properties. Said compositions preferably contain biodegradable ingredients that are not harmful for the humans and the environment. Silicones (polyxiloxanes), including epoxy or/and amino-modified polysiloxanes, polyether-modified polysiloxanes, which contain polyether active groups grafted on the side chains of polysiloxane chains, and linear multiblock polysiloxane copolymers, are widely used as softeners or softening agents in a textile softening composition to impart softness to and improve the wear feeling of the treated textile. Silicone softening agents are synthetic compounds, the synthesis of which generally requires a lot of energy. Moreover, the production of textile softening composition using silicone softeners has a high carbon footprint since a lot of energy is required for obtaining the desired emulsion. Furthermore, silicone softening agents are not biodegradable and accumulate in the environment. Fluorinated compounds, in particular per- or polyfluoroalkyl substances (PFAS), are typically used in water-repellent finishing compositions. Fluorinated compounds are known to accumulate in the environment, drinking water and food, and to be harmful to the environment and the human body. In a preferred embodiment, the textile finishing compositions described herein do not contain silicone and fluorinated compounds.

[0027] The one or more textile finishing compositions preferably comprise:

i) from about 10.0 wt-% to about 30.0 wt-% 1,2,3-propanetriol, preferably of vegetal origin;
ii) from about 0.05 wt-% to about 10.0 wt-% of a surfactant, preferably a biodegradable surfactant;
iii) from about 1.0 wt-% to about 10 wt-% of a fatty acid ester containing finishing agent selected from an oil of vegetal origin, a wax of vegetal origin, a beeswax, and an esterquat, with the proviso that if the fatty acid ester containing finishing agent is a wax of vegetal origin or a beeswax, the composition further comprises a wax extender;
iv) optionally a thickening agent and/or a biocide and/or a pH adjusting agent; and
v) water up to 100 wt-%; wherein the wt-% are based on the total weight of the composition. Such textile finishing compositions are useful for imparting to the textile softness, water-repellence and/or improved wicking properties. Advantageously, the majority of the ingredients contained by the compositions are natural and biodegradable. Further, the compositions do not contain silicones and fluorinated compounds, which are known to be non-biodegradable and even toxic.

[0028] The finishing composition described herein may contain up to 1.0 wt-% of a thickening agent. As well known to the skilled person, a thickening agent or a thickener is a substance that increases the viscosity of a liquid without substantially changing its other properties. A person skilled in the art is in a position to adjust the amount of the thickening agent so as to obtain the viscosity required for the textile finishing composition. Preferably, the thickening agent is a polysaccharide (e.g. starches, vegetable gums) of vegetal origin. Examples of suitable thickening agents include, but are not limited to, carob (also known as locust bean gum or carob gum containing at least 75% galactomannan), such as commercially available Carob EXC 25 from HEIQ - Switzerland, guar gum, carrageenan, and alginin. Advantageously, the thickening agent is commercially available and easily dispersible in water upon mixing.

[0029] Further, the finishing composition may contain up to 0.5 wt-% of a biocide. The biocide prevents biodeterioration of the textile, assists in preventing spread of infectious diseases without requiring the need for frequent sterilization and ensures the stability of the textile finishing composition for at least 12 months. Any conventionally used biocide in textile industry is suitable to be used in the textile finishing composition according to the present invention. Such biocides include, but are not limited to, 1,2-benzisothiazolin-3-one (commercially available at Zeneca Specialties as a solution sold under the commercial name Proxel GXL), organo-copper compounds, organo-tin compounds, chlorinated phenols, silver-based microbial agents and metal-based inorganic compounds, such as zinc oxide, zinc salts and cupric salts.

[0030] Preferably, the textile finishing composition has a pH value of between 5 and 9. The pH value depends on the

intended use (e.g. softening, water-repellency) and the stability conditions of the finishing composition, as well as on the performance and effect obtained in the fabric. If required, the textile finishing composition may further contain up to 0.5 wt-% a pH adjusting agent, preferably of vegetal origin. Preferably, the pH adjusting agent is selected from acetic acid, citric acid, ascorbic acid, malic acid, etc. Preferably, citric acid is used for adjusting the pH value of the composition in the pH value range from 5 to 7, while acetic acid is used for adjusting the pH value of the composition in the pH value range from 7 to 9.

[0031] The one or more finishing compositions preferably have a viscosity from 5 cP to 9 cP, more preferably from 6 to 7 cP, at 25 °C and a shear rate 200-400 s^{-1}. To avoid clogging of the printhead, the particle size of the solid ingredients potentially present in the textile finishing compositions is preferably lower than 1 μm. As used herein, particle size lower than 1 μm is intended to refer to D99 diameter lower than 1 μm.

[0032] The textile finishing composition preferably contains

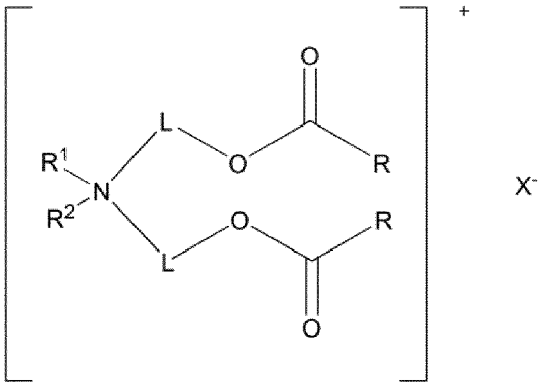
iii-1) from about 1.0 wt-% to about 6.0 wt-% of an oil of a vegetal origin. Such textile finishing composition is particularly useful for imparting to the textile improved softness and/or wicking properties. The term "oil of vegetal origin" encompasses any oil or triglyceride extracted from plants, e.g. from fruits or seeds. Examples of suitable oils, include but are not limited to, almond oil, babassu oil, borage oil, canola oil, coconut oil, corn oil (maize oil), cottonseed oil, flaxseed oil, grape seed oil, hazelnut oil, oat oil, olive oil, palm oil, palm kernel oil, peanut oil, rapeseed oil, safflower oil, sesame oil, linseed oil, soybean oil, tucum oil, sunflower oil, walnut oil, apricot oil, sweet almond oil, avocado oil, baobab oil, blueberry seed oil, calendula oil, camellia oil, cherry kernel oil, cranberry seed oil, hemp oil, jojoba oil, kukur nut oil, macadamia nut oil, manketti oil, melon seed oil, moringe oil, peach kernel oil, pistachio oil, raspberry seed oil, rice bran oil, rosehip oil, soya oil, wheat germ oil, yangu oil, algae oil; their hydrogenated derivatives, and mixtures thereof. In a preferred embodiment, the oil of vegetal origin is selected from rapeseed oil, linseed oil, algae oil; their hydrogenated derivatives, and mixtures thereof.

[0033] An alternative textile finishing composition preferably contains

iii-2) from about 6.5 wt-% to about 10 wt-% of a wax of a vegetal origin or a beeswax, and from about 1.5 wt-% from about 4.5 wt-% of a wax extender. Such finishing composition is particularly useful for imparting water repellence to the textile. Advantageously, the composition described herein is also free of paraffin wax, a non-biodegradable ingredient widely used in water-repellent textile finishing compositions. The term "wax of vegetal origin" encompasses all waxes originating from plants. Examples of suitable vegetable waxes, include, but are not limited to: carnauba wax, soy wax, jojoba wax, candelilla wax, rice-bran wax, sugar cane wax, and mixtures/blends thereof. As well known in the art, carnauba wax (also called palm wax) is a common plant wax type harvested from the leaves of the plant by drying the leaves and beating them to loosen the wax. The Carnauba wax contains aliphatic esters (approx. 40 wt-%), diesters of 4-hydroxycinnamic acid (approx. 21.0 wt-%), ω-hydroxycarboxylic acids (approx. 13.0 wt-%), and fatty alcohols (approx. 12 wt%). The compounds are predominantly derived from acids and alcohols in the C26-C30 range. Preferably, the wax of vegetal origin is candelilla wax. Candelilla wax comes from the small leaves of Candelilla shrubs native to northern Mexico and the southwestern U.S. It is harvested by immersing the whole plant in acidified boiling water. The wax then floats to the surface of the boiling water. As well known in the art, a wax extender is a substance used in combination with a wax to improve the performance of said wax e.g. by increasing the water-repellency of the treated textile or the wash durability. Preferably, the wax extender is a urethane or an emulsion of Carnauba wax in 1,2,3-propanetriol.

[0034] A further alternative textile finishing composition suitable to be used in the process claimed and described herein contains

iii-3) from about 4.0 wt-% to about 7.5 wt-% of an esterquat. This textile finishing composition is particularly suitable for providing long-term softness and improved wicking properties (i.e. the softness/wicking property is maintained after multiple washings e.g. for fashion garments) to the treated textiles. As known to the skilled person, an "esterquat" or "ester quat" is a quaternary ammonium salt of an alkanol- and/or alkyl-amine esterified with an average of two fatty acid moieties per molecule. In the composition claimed and described herein, the esterquat is preferably a compound of formula (I)



(I)

wherein

R-C(O) represents the residue of a fatty acid having from about 12 to about 24, preferably from about 14 to about 22, more preferably from about 16 to 20 carbon atoms;
R^1 is an alkyl group of 1 to 4 carbon atoms,
R^2 is an alkyl group of 1 to 4 carbon atoms or a hydroxyalkyl group of 1 to 4 carbon atoms,
-L- is an alkylene of 1 to 4 carbon atoms, and X^- is a salt forming anion. The salt forming cation X- renders the esterquat soluble or dispersible in water, and is preferably selected from a halide, e.g. a chloride, a bromide or an iodide; a sulfate, a methosulfate, a nitrite, a nitrate, a phosphate, and a carboxylate, e.g. an acetate, an adipate, a proprionate. Examples of suitable commercially available esterquats, include, but are not limited to bis-(oleic isopropyl ester) dimethyl ammonium methosulfate (supplier: Evonik; commercial name: REWOQUAT® CR 3099).

[0035] The textile finishing composition described herein contains from about 10.0 wt-% to about 30.0 wt-%, preferably from about 15.0 wt-% to about 30.0 wt-%, 1,2,3-propanetriol. The used 1,2,3-propanetriol is preferably of vegetal origin e.g. derived from from soybean, coconut, palm or corn oils. The 1,2,3-propanetriol in the specified amount renders the compositions stable during the shell-life (at least 12 months) and ejectable by piezoelectric drop-on-demand inkjet printing.
[0036] Further, the textile finishing composition described herein contains from about 0.05 wt-% to about 10.0 wt-% of a surfactant. The term "surfactant" is known in the field. It particularly includes compounds that reduce surface tension and / or improve dispersion properties. A person skilled in the art is in a position to identify surfactants suitable for compositions printable by piezoelectric drop-on-demand ink jet printing. The term includes cationic, anionic, non-ionic and zwitterionic surfactants. Preferably, the surfactant is biodegradable and/or obtained from renewable raw materials. Examples of suitable commercially available surfactants include, but are not limited to, rhamnolipids (e.g. biosurfactant REWOFERM® RL 100 commercially available from Evonik), sophorolipids (e.g. biosurfactant REWOFERM® SL ONE commercially available from Evonik), sorbitane monooleate (commercially available under the commercial name Span® 80 from Sigma Aldrich), polyethylene glycol sorbitan monooleate (e.g. Tween® 80 commercially available from Sigma Aldrich), sodium dioctylsulfosuccinate, ethoxylated 2,4,7,9-tetramethyl-5-decyne-4,7-diol, and mixtures thereof (e.g. Surfinol® PSA 336 commercially available from Evonik which is a blend of sodium dioctylsulfosuccinate and ethoxylated 2,4,7,9-tetramethyl-5-decyne-4,7-diol).
[0037] The textile finishing composition may be a piezoelectric drop-on-demand inkjet printable water-repellent finishing composition comprising

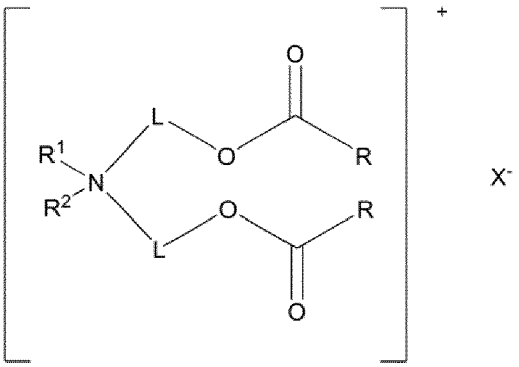
i) from about 20.0 wt-% to about 30.0 wt-% 1,2,3-propanetriol, preferably of vegetal origin;
ii) from about 0.2 wt-% to about 1.0 wt-% of a surfactant as described herein;
iii-2) from about 6.5 wt-% to about 10 wt-% of a wax of vegetal origin as described herein or a beeswax, and from about 1.5 wt-% from about 4.5 wt-% of a wax extender as described herein;
iv) optionally a thickening agent as described herein and/or a biocide as described herein and/or a pH adjusting agent as described herein; and
v) water up to 100 wt-%.

The water-repellent finishing composition exhibits excellent water-repellence, storage stability and wash durability. The water-repellent composition contains preferably from about 0.2 wt-% to about 1.0 wt-% of a thickening agent, such as carob (also known as locust bean gum or carob gum containing at least 75% galactomannan). Preferably, the wax of

vegetal origin is candelilla wax and/or the wax extender is an urethane or an emulsion of Carnauba wax in 1,2,3-propanetriol, and/or the surfactant is Surfinol® PSA 336.

[0038] A further textile finishing composition suitable to be used in the process claimed and described herein comprises

i) from about 12.0 wt-% to about 20.0 wt-% 1,2,3-propanetriol, preferably of vegetal origin;
ii) from about 0.5 wt-% to about 2.5 wt-% of a surfactant as described herein;
iii-3) from about 4.0 wt-% to about 7.5 wt-% of an esterquat as described herein, wherein preferably the esterquat is a compound of formula (I)



(I)

wherein

R-C(O) represents the residue of a fatty acid having from about 12 to about 24, preferably from about 14 to about 22, more preferably from about 16 to 20 carbon atoms;
R^1 is an alkyl group of 1 to 4 carbon atoms,
R^2 is an alkyl group of 1 to 4 carbon atoms or a hydroxyalkyl group of 1 to 4 carbon atoms,
-L- is an alkylene of 1 to 4 carbon atoms, and
X^- is a salt forming anion;

iv) optionally a thickening agent as described herein and/or a biocide as described herein and/or a pH adjusting agent as described herein; and
v) water up to 100 wt-%.

The combination of 1,2,3-propanetriol, surfactant and esterquat in the specific amounts provides softness, improved wicking properties and wash durability to the textile, and confers stability to the textile finishing composition under storage conditions. In the present finishing composition it is preferred that

- the surfactant is selected from Span® 80, Tween® 80, Surfinol® PSA 336, and mixtures thereof; and/or
- the esterquat is bis-(oleic isopropyl ester) dimethyl ammonium methosulfate (supplier: Evonik; commercial name: REWOQUAT® CR 3099); and/or
- the composition contains from about 0.05 wt-% to about 2.00 wt-%, preferably from about 0.05 wt-% to about 1.00 wt-%, more preferably from about 0.05 wt-% to about 0.5 wt-% of a pH adjusting agent, such as citric acid or acetic acid; and/or
- the compositions does not contain a thickening agent.

[0039] Another textile finishing composition suitable to be used in the process according to the present invention comprises

i) from about 15.0 wt-% to about 30.0 wt-% 1,2,3-propanetriol, preferably of vegetal origin;
ii) from about 0.05 wt-% to about 10.0 wt-% of a surfactant as described herein;
iii-1) from about 1.0 wt-% to about 6.0 wt-% of an oil of vegetal origin as described herein;
iv) optionally a thickening agent as described herein and/or a biocide as described herein and/or a pH adjusting agent as described herein; and
v) water up to 100 wt-%. The present finishing composition provides improved softness and/or wicking properties

to the textile, is stable under storage conditions and is wash durable. The finishing composition may be a textile softening composition preferably comprising:
i) from about 17.0 wt-% to about 30.0 wt-% 1,2,3-propanetriol, preferably of vegetal origin;
ii) from about 0.05 wt-% to about 0.8 wt-% of a surfactant as described herein;
iii-1) from about 1.0 wt-% to about 3.0 wt-% of an oil of vegetal origin as described herein;
iv) optionally a thickening agent as described herein and/or a biocide as described herein and/or a pH adjusting agent as described herein ; and
v) water up to 100 wt-%. In the present textile softening composition it is further preferred that:

- the oil of vegetal origin is hydrogenated rapeseed; and/or
- the surfactant is Surfinol® PSA 336; and/or
- the composition contains from about 0.1 wt-% to about 0.6 wt-% of a thickening agent, such as carob (also known as locust bean gum or carob gum containing at least 75% galactomannan); and/or
- the composition contains from about 0.05 wt-% to about 2.00 wt-%, preferably from about 0.05 wt-% to about 1.00 wt-%, more preferably from about 0.05 wt-% to about 0.5 wt-% of a pH adjusting agent, such as citric acid or acetic acid.

[0040] The textile finishing composition may be a textile composition for improving the wicking properties of a textile preferably comprising:

i) from about 15.0 wt-% to about 25.0 wt-% 1,2,3-propanetriol, preferably of vegetal origin;
ii) from about 4.5 wt-% to about 10.0 wt-% of a surfactant as described herein;
iii-1) from about 2.0 wt-% to about 6.0 wt-% of an oil of vegetal origin as described herein;
iv) optionally a thickening agent as described herein and/or a biocide as described herein and/or a pH adjusting agent as described herein; and
v) water up to 100 wt-%. In the present composition it is further preferred that:

- the oil of vegetal origin is selected from linseed oil, algae oil, and mixtures thereof; and/or
- the surfactant is selected from Span® 80, Tween® 80, Surfinol® PSA 336,and mixtures thereof; and/or
- the composition contains from about 0.1 wt-% to about 1.0 wt-%, preferably from about 0.1 wt-% to about 0.5 wt-% of a thickening agent, such as carob (also known as locust bean gum or carob gum containing at least 75% galactomannan.

[0041] A second aspect according to the present invention is directed to a finished textile obtained by the inventive process claimed and described herein. The low drop volume ejected by and the precise deposit achieved with a piezo-electric drop-on-demand inkjet printhead combined with the drying and fixation step provides the textile with a uniform (constant wet deposit on the entire treated surface of the textile) and wash-durable finishing.
[0042] A third aspect according to the present invention relates to a garment comprising the finished textile claimed and described herein.
[0043] To further illustrate the invention, the following **examples** are provided. These examples are provided with no intend to limit the scope of the invention.
RT: 20 °C - 25 °C;

I. Preparation of textile finishing compositions

[0044] The following textile finishing compositions have been prepared as follows

Example 1: Water-repellent finishing composition

[0045] A 1000 kg batch textile water-repellent finishing composition having the composition depicted in the table below was prepared as follows:
In a first step, an emulsion was obtained by introducing the following ingredients in a high energy dispenser (2000 L capacity) and stirring at the indicated speed and temperature for the indicated time period:

1) vegetal 1,2,3-propanetriol (107.28 kg) - stirring for about 30 min at 2 m/s and RT;
2) Candelilla wax (86.4 kg) - stirring for about 90 min at 5 m/s and RT;
3) Candelilla wax extender (21.6 kg) - stirring for about 90 min at 5 m/s and RT;
4) Proxel™ GXL (0.72 kg) - stirring for about 15 min at 5 m/s and RT;

5) water (504 kg) - stirring for about 45 min at 5 m/s and RT.

[0046] In a second step, the following ingredients were added stepwise to the emulsion obtained in the first step and the stirring was continued for the indicated time to provide the textile finishing composition printable by piezo inkjet.
1) vegetal 1,2,3-propanetriol (150 kg) - stirring for about 30 min at 5 m/s and RT;
2) carob thickening agent, 20 wt-% dispersion in water (20 kg) - stirring for about 45 min at 5 m/s and RT;
3) Proxel™ GXL (1 kg)- stirring for about 30 min at 10 m/s and RT;
4) Surfinol® PSA 336 (5 kg) - stirring for about 30 min at 10 m/s and RT;
5) water (104 kg) - stirring for about 60 min at 10 m/s and RT.

Ingredient	Commercial name/Supplier	Wt-%
Vegetal 1,2, 3-propanetriol (CAS Nr. 56-81-5)	Pricerine™ 9091 (Croda)	25.7
Candelilla wax (CAS Nr. 8006-44-8)		8.6
Candelilla wax extender: aliphatic blocked isocynate		2.2
Blend of sodium dioctylsulfo succinate and ethoxylated 2,4,7,9-tetramethyl-5-decyne-4,7-diol surfactants	Surfinol® PSA 336 (Evonik)	0.5
Carob thickening agent	Carob EXC 25 - HEIQ - Switzerland	0.4
20% aqueous dipropylene glycol solution of 1,2-benzisothiazolin-3-one (biocide)	Proxel™ GXL	0.1
water		62.5

Example 2: Textile softening finishing composition

[0047] A 1000 kg batch textile softening composition having the composition depicted in the table below was prepared as follows:
In a first step, an emulsion was obtained by introducing the following ingredients in a high energy dispenser (2000 L capacity) and stirring at the indicated speed and temperature for the indicated time period:

1) vegetal 1,2,3-propanetriol (86.4 kg) - stirring for about 30 min at 2 m/s and RT;
2) citric acid (1.44 kg) - stirring for about 30 min at 2 m/s and RT;
3) carob thickening agent (1.44 kg) - stirring for about 45 min at 5 m/s and RT;
4) Proxel™ GXL (0.72 kg) - stirring for about 30 min at 5 m/s and RT;
5) hydrogenated rapeseed oil (14.4 kg)- stirring for about 60 min at 5 m/s and RT;
6) water (615.6 kg) - stirring for about 45 min at 5 m/s and RT.

[0048] In a second step, the following ingredients were added stepwise to the emulsion obtained in the first step and the stirring was continued for the indicated time to provide the textile finishing composition printable by piezo inkjet.
1) vegetal 1,2,3-propanetriol (150 kg) - stirring for about 30 min at 5 m/s and RT;
2) carob thickening agent, 20 wt-% dispersion in water (1 kg) - stirring for about 45 min at 5 m/s and RT;
3) Proxel™ GXL (1 kg)- stirring for about 15 min at 5 m/s and RT;
4) Surfinol® PSA 336 (5 kg) - stirring for about 15 min at 5 m/s and RT;
5) water (123 kg) - stirring for about 45 min at 10 m/s and RT.

Ingredient	Commercial name/Supplier	Wt-%
Vegetal 1,2, 3-propanetriol (CAS Nr. 56-81-5)	Pricerine™ 9091 (Croda)	23.6
Hydrogenated rapeseed oil		1.4
Blend of sodium dioctylsulfo succinate and ethoxylated 2,4,7,9-tetramethyl-5-decyne-4,7-diol surfactants	Surfinol® PSA 336 (Evonik)	0.5

(continued)

Ingredient	Commercial name/Supplier	Wt-%
Carob thickening agent	Carob EXC 25 (HEIQ - Switzerland)	0.2
20% aqueous dipropylene glycol solution of 1,2-benzisothiazolin-3-one (biocide)	Proxel™ GXL	0.1
Citric acid (CAS Nr.: 77-92-9; pH adjusting agent)		0.1
water		74.1

Example 3: Textile finishing composition for improved softening and wicking properties

[0049] A 1000 kg batch textile softening composition having the composition depicted in the table below was prepared as follows: In a first step, an emulsion was obtained by introducing the following ingredients in a high energy dispenser (2000 L capacity) and stirring at the indicated speed and temperature for the indicated time period:

1) REWOQUAT® CR 3099 (54.29 kg) - stirring for about 30 min at 2 m/s and RT;
2) Span® 80 (1.10 kg) - stirring for about 30 min at 2 m/s and RT;
3) Tween® 80 (4.35 kg) - stirring for about 30 min at 2 m/s and RT;
4) water having a temperature of 35 °C (490.30 kg) - stirring for about 60 min at 2 m/s and 35 °C.

[0050] In a second step, the following ingredients were added stepwise to the emulsion obtained in the first step and the stirring was continued for the indicated time to provide the textile finishing composition printable by piezo inkjet.
1) vegetal 1,2,3-propanetriol (150 kg) - stirring for about 30 min at 5 m/s and RT;
2) Surfinol® PSA 336 (5 kg)- stirring for about 10 min at 5 m/s and RT;
3) Proxel™ GXL (1 kg)- stirring for about 10 min at 5 m/s and RT;
4) water (294 kg) - stirring for about 45 min at 10 m/s and RT.

Ingredient	Commercial name/Supplier	Wt-%
Vegetal 1,2, 3-propanetriol (CAS Nr. 56-81-5)	Pricerine™ 9091 (Croda)	15.0
bis- (oleic isopropyl ester) dimethyl ammonium methosulfate (esterquat)	REWOQUAT® CR 3099 (Evonik)	5.4
(Z)-Sorbitan-mono-9-octadecenoat (CAS NR.: 1338-43-8)	Span® 80 (Sigma Aldrich)	0.1
Polyoxyethylen-Sorbitan-Monooleat (9005-65-6)	Tween® 80 (Sigma Aldrich)	0.4
Blend of sodium dioctylsulfo succinate and ethoxylated 2,4,7,9-tetramethyl-5-decyne-4,7-diol surfactants	Surfinol® PSA 336 (Evonik)	0.5
20% aqueous dipropylene glycol solution of 1,2-benzisothiazolin-3-one (biocide)	Proxel™ GXL	0.1
water		78.5

Example 4: Textile finishing composition for improved wicking properties

[0051] A 1000 kg batch textile softening composition having the composition depicted in the table below was prepared as follows:
In a first step, an emulsion was obtained by introducing the following ingredients in a high energy dispenser (2000 L capacity) and stirring at the indicated speed and temperature for the indicated time period:

1) vegetal 1,2,3-propanetriol (62.62 kg) - stirring for about 15 min at 2 m/s and RT;
2) BST-001 (6.18 kg) - stirring for about 20 min at 2 m/s and 45 °C;
3) BST-020 (35.02 kg) - stirring for about 15 min at 2 m/s and RT;

4) Span® 80 (15.70 kg) - stirring for about 30 min at 5 m/s rpm and RT;
5) Tween® 80 (40.33 kg)- stirring for about 30 min at 5 m/s and RT;
6) water (664.14 kg) - stirring for about 90 min at 10 m/s and RT.

[0052] In a second step, the following ingredients were added stepwise to the emulsion obtained in the first step and the stirring was continued for the indicated time to provide the textile finishing composition printable by piezo inkjet.
1) vegetal 1,2,3-propanetriol (150 kg) - stirring for about 15 min at 5 m/s and RT;
2) carob thickening agent, 20 wt-% dispersion in water (20 kg) - stirring for about 45 min at 5 m/s and RT;
3) Proxel™ GXL (1 kg)- stirring for about 10 min at 5 m/s and RT;
4) Surfinol® PSA 336 (5 kg) - stirring for about 30 min at 5 m/s and RT.

Ingredient	Commercial name/Supplier	Wt-%
Vegetal 1,2, 3-propanetriol (CAS Nr. 56-81-5)	Pricerine™ 9091 (Croda)	21.3
Linseed oil	BST-001 (Beyond Surface Technologies - Muttenz)	0.6
Algae oil	BST-020 (Beyond Surface Technologies - Muttenz)	3.5
(Z)-Sorbitan-mono-9-octadecenoat (CAS NR.: 1338-43-8)	Span® 80 (Sigma Aldrich)	1.6
Polyoxyethylen-Sorbitan-Monooleat (9005-65-6)	Tween® 80 (Sigma Aldrich)	4.0
Blend of sodium dioctylsulfo succinate and ethoxylated 2,4,7,9-tetramethyl-5-decyne-4,7-diol surfactants	Surfinol® PSA 336 (Evonik)	0.5
Carob thickening agent	Carob EXC 25 (HEIQ - Switzerland)	0.4
20% aqueous dipropylene glycol solution of 1,2-benzisothiazolin-3-one (biocide)	Proxel™ GXL	0.1
water		68.0

II. Manufacturing of textiles with textile finishing process according to the invention

[0053] The finishing process was performed using a commercially available industrial textile printer Panthera D8 (Supplier: Swiss Performance Chemicals) and subsequent calendar roll to roll (Model RTR-2760-H, Supplier: Eastsign). The Panthera D8 printer is equipped with 8 water-based Kyocera KJ4B-0300, DOD IJ Piezo Print heads.

1. Manufacturing of a textile with improved wicking properties

[0054] The textile finishing composition according to example 4 was printed by piezoelectric drop-on-demand ink jet (printing resolution 600x600dpi, 2 passes; printing speed 250 m^2/h; wet deposit: 15 g/m^2) on a surface of a white color textile (Reference number: W-2017-992; 100 % PES; knitted) and of a pink color textile (Reference number: W-2017-993; 100 % PES; knitted). The printed textiles were dried by exposure to hot air (120 °C) for 90 seconds. Subsequently, the dried textiles were calendared for 35 sec at 205 °C to provide the finished textiles T1 and T2 according to the present invention (T1 - white color, T2 - pink color).

[0055] For comparative purposes,

- a sample of the white color textile and of the pink color textile was printed as described above. To dry and fix the finishing composition to the textiles, said printed textile were kept in an oven at 100 °C for 1 minute. Comparative finished textiles C1 and C2 (C1 - white color, C2 - pink color) were obtained;
- a sample of the white color textile (the sample was not treated with a finishing composition) was finished by drying in an oven at 100 °C for 1 minute to provide the comparative textile C3;
- a sample of the white textile was finished using a standard finishing composition for improving the wicking properties of textiles and a finishing process including a padding step, a drying step by exposure to IR, and a fixation step by using a high temperature fixation frame. Comparative sample C4 was obtained.

[0056] The wicking properties of the finished textiles T1, T2, C1 - C4 were evaluated in the water drop test method

AATCC 79, where the absorption time in seconds was measured prior to washing, and after 1, 5 and 10 washings (laundering test ISO 5077/3759/6330; Detergent ECE 98 -20 g), respectively.

[0057] The water drop test method AATTCC79, also known as absorption time - dropping test, is conventionally used in the textile industry to measure the absorption time of a drop of water by the textile fabric. To measure the absorption time, the textile fabric is held in a mandrel and a drop of water (0.1 mL) is deposited with a micropipette on the surface of the fabric. The time required by the textile fabric to absorb the drop (absorption time) is measured. The absorption time is a measure of the wicking propeties of the textile fabric.

The measured absorption time (seconds) is presented in the Table below:

	Finished textile					
	T1	**T2**	C1	C2	C3	C4
Prior to washing	<1	<1	6.78	3.08	33.67	1.7
After 1st washing	<1	<1	6.85	3.15	34.77	1.7
After 5th washing	<1	<1	7.34	3.45	34.85	1.9
After 10th washing	<1	<1	10.90	4.86	35.60	2.01

[0058] The two finished textile fabrics T1 and T2 according to the present invention present better wicking properties and wash durability (absorption time lower than 1 second even after 10 washings) than the finished textile fabric C4 finished by padding with a standard padding composition. The comparable properties of the finished textile fabrics T1 and T2 show the versatility of the textile finishing composition and the textile finishing process. Comparison of the adsorption time measured for the finished textiles C1 and C2 and the finished textiles T1 and T2 demonstrates that the calendaring step is essential for fixing the finishing composition to the textile fabric. Comparative finished textile C3 that was not printed with a textile finishing composition presents poor wicking properties as evidenced by the absorption time superior to 30 seconds.

2. Manufacturing of a textile with improved wicking properties

[0059] The textile finishing composition according to example 3 was printed by piezoelectric drop-on-demand ink jet (printing resolution 600×600dpi, 2 passes; printing speed 250 m^2/h; wet deposit: 15 g/m^2) on a surface of the three different textile fabrics indicated below. The printed textiles were dried by exposure to hot air (120 °C) for 90 seconds. Subsequently, the dried textiles were calendared for 35 sec at 205 °C to provide the finished textiles **T3 - T5** (T3 - finished 1st fabric, T4 - finished 2nd fabric, and T5 - finished 3rd fabric) .

1st fabric	Single Jersey, 245 g/m^2	87% cotton and 13% spandex
2nd fabric	Single Jersey plated,140 g/m^2	61% cotton and 39% POLYESTER
3rd fabric	Single Jersey, 125 g/m^2	60% cotton and 40% POLYESTER

[0060] The wicking properties of the finished textiles T4 - T5 were evaluated in the above-described water drop test method AATCC 79, and in the test method for vertical wicking rate of textiles AATCC 197 (effects were measured at 30 minutes).

[0061] Test method AATCC 197 is generally used in textile industry to evaluate the ability of fabric specimens to transport liquid vertically when a cut edge is submerged. The determined vertical wicking rate represents a measure of the textile wicking properties. Cut edges of samples of the finished textiles T3 - T5 (14.0 × 2.5 cm) were submerged in water for 30 minutes. The samples were submerged both in the warp and in the weft direction. The height of the water absorbed by the samples (wicking distance) after 30 min was measured. Wicking distances at 30 minutes superior to 13 cm are indicative of textile fabrics having excellent absorbency and wicking behavior.

The results of the tests are summarized in the Table below:

	Absorption time measured in test method AATCC 79 (seconds)	Wicking distance (cm) measured at 30 minutes in test method AATCC 197	
		Warp	Weft
Finished 1st fabric **T3**	< 1	15.3	17.1
Finished 2nd fabric **T4**	< 1	17.0	14.3
Finished 3rd fabric **T5**	< 1	17.0	16.3

[0062] Finished textile fabrics T3 - T5 according to the present invention show excellent absorbency (AATCC 79, absorption time < 1 second). Finished textile fabrics T3 - T5 also show excellent wicking behavior (AATCC 197) and meet the absorbency requirements of at least 13 cm for the wicking height at 30 minutes. The tests conducted in two directions of the fabric in warp and weft illustrate the excellent wicking behavior of the finished textile fabric according to the present invention. The wicking properties of the three tested textile fabrics are comparable, showing the versatility of the textile finishing composition and of the finishing process.

3. Manufacturing of a textile with softness properties

[0063] The textile finishing composition according to example 2 was printed by piezoelectric drop-on-demand ink jet printing resolution 600×600dpi, 2 passes; printing speed 250 m^2/h; wet deposit: 15 g/m^2) on a surface of a variety of different textile fabrics including 100% cotton twill at a density of 160 g/m^2 and a fabric garment blend 70% cotton/30% polyester at a density of 110 g/m^2. The printed textile fabrics were dried by exposure to hot air (120 °C) for 90 seconds and subsequently, calendared for 35 sec at 205 °C to provide the finished textile.

[0064] Following finishing, the softness of the finished fabric was evaluated by an expert by hand touch prior to washing and after 5, 10 and 20 washings, respectively. Compared to the untreated textile, the finished textile exhibit an excellent softness. The softness is maintained after 5, 10 and 20 washings.

4. Manufacturing of a textile with water-repellence properties

[0065] The textile finishing composition according to example 1 was printed by piezoelectric drop-on-demand ink jet (printing resolution 600×600dpi, 2 passes; printing speed 250 m^2/h; wet deposit: 15 g/m^2) on a surface of the three different textile fabrics indicated below. The printed textiles were dried by exposure to hot air (120 °C) for 1 minute. Subsequently, the dried textiles were calendared for 3 minutes at 205 °C to provide the finished textiles **T6 - T8** according to the present invention (T6 - finished textile fabric A, T7 - finished textile fabric B, T8 - finished textile fabric C.

Textile fabric	Color	Composition		Density g/m^2
A	light grey	88% polyamide/12% elastane	woven	180
B	kaki	72% polyamide/20% wool/8% elastane	woven	200
C	medium grey	94% polyamide/6 % elastane	woven	180

[0066] The water repellence of the finished textiles T6 - T8 and of the corresponding untreated textile A-C was evaluated in the AATCC 22 test method using the commercially available spray rating tester TF160 (supplier: Testex). Three samples were evaluated for each of the textile fabrics A, B and C. During the experiment, the sample of finished fabric held in a mandrel is sprayed with water. The sample is oriented at 45° with respect to the nozzle head of the spray rating tester and positioned at a distance of 150 mm under the nozzle. At the end of the experiment, the appearance of the sprayed finished fabric is compared with the appearance of the finished fabric (not sprayed) by an expert and based on visual standards, a visual rating is given to the finished fabric. A visual rating of 100 indicates that the textile fabric preserves its initial aspect (i.e. no visually detectable difference between the appearance of the textile fabric prior and after the spraying) and no water was absorbed by the textile fabric during the experiment i.e. the textile fabric has excellent water repellence. The results of the visual rating are summarized in the table below:

Textile fabric A	Sample 1	Sample 2	Sample 3
Untreated fabric	95	90	85
Finished fabric prior to washing	100	100	100
After 1st wash	100	100	100
After 5th wash	100	100	100
After 10th wash	100	100	90
After 20th wash	100	100	90

Textile fabric B	Sample 1	Sample 2	Sample 3
Untreated fabric	95	95	90
Finished fabric prior to washing	100	100	100
After 1st wash	100	100	100
After 5th wash	100	100	100
After 10th wash	100	100	100
After 20th wash	100	100	100

Textile fabric C	Sample 1	Sample 2	Sample 3
Untreated fabric	100	95	90
Finished fabric prior to washing	100	100	100
After 1st wash	100	100	100
After 5th wash	100	100	100
After 10th wash	100	100	100
After 20th wash	100	95	90

[0067] As shown by the above table, the finished textiles according to the present invention provide excellent water repellency even after 20 washings. The rating of "100" indicates no absorption of water by the tested fabric. The water repellency does not decrease after 1 wash, 5x washes, 10x washes and 20x washes, which confirms the excellent wash durability of the finishing obtained with the inventive finishing process. Comparable results were obtained for the three fabrics attesting the versatility of the water-repellent finishing composition and the finishing process according to the present invention.

5. Evaluation of the reliability of the finishing process

[0068] The reliability of the textile finishing compositions according to examples 1 to 4 and of the textile finishing process was tested on a piezoelectric drop-on-demand inkjet printer Panthera S4 (supplier: Swiss Performance Chemicals) equipped with 4 water-based DOD IJ Piezo Kyocera KJ4B-0300 printheads and on a piezoelectric drop-on-demand inkjet printer Panthera D8 (supplier: Swiss Performance Chemicals) equipped with 8 water-based DOD IJ Piezo Kyocera KJ4B-0300 printheads.

[0069] To visualize the quality of the printing, a magenta sublimation ink (SwissJet SP7 from Swiss Perfomance Chemicals, Switzerland) was added to each of the textile finishing compositions according to examples 1 to 4 (99 wt-% textile finishing composition; 1 wt-% magenta sublimation ink).

[0070] The so obtained finishing compositions were printed bidirectionally at 240 m^2/h on a white color textile fabric (Natt6 2/1, 100% PES, 218 g/m^2) without using automatic cleaning up program. Different lengths (20 m, 100 m, 200 m,

and 500 m) of textile were printed and the quality of the printing was visually checked. A prime test was conducted prior to printing each of the desired lengths (20 m, 100 m, 200 m and 500 m) to check whether all nozzles are correctly ejecting, as well as after printing each of the desired lengths to detect potential nozzles clogging.

[0071] The above-summarized printing procedure was repeated after leaving the finishing compositions in the printer for 3 days.

[0072] After exposure to hot air (120 °C) for 90 seconds and subsequent calendaring for 35 sec at 205 °C, the printed textile was examined. No errors were detected on the printed textile. Moreover, no nozzles clogging occurred.

6. Evaluation of drying temperature

[0073] The textile finishing composition according to example 4 was printed by piezoelectric drop-on-demand ink jet (Panthera D8, printing speed 240 m^2/h; wet deposit: 20 g/m^2) on a surface of a white color textile fabric (Natt6 2/1, 100% PES, 218 g/m^2), and subsequently dried by exposure for 90 seconds to hot air of different temperatures. The residual water was determined. The results are depicted in the table below.

Hot Air Temperature	Initial Fabric Weight (g)	Printed Fabric Wet Weight (g)	Dried Fabric Weight (g)	Residual water after drying	
				9	wt-%
100°C	180	196	185.5	5.5	3.06
110°C	210	230.20	213.5	3.5	1.67
120°C	225	245.90	225.4	0.4	0.18
130°C	217	237.2	217.5	0.25	0.15
140°C	226	247.15	226.4	0.24	0.11

[0074] The residual water content inferior to 0.2 % reached by exposure for 90 seconds to a hot air temperature from 120 °C to 140 °C for 90 seconds confirms the complete evaporation of the water contained by the finishing composition. Use of hot air temperatures lower than 120 °C will require longer drying times for achieving the same level of dryness.

7. Evaluation of calendaring temperature

[0075] To evaluate the influence of the calendarimg temperature on the properties of finished textile, the textile finishing composition according to example 4 was printed by piezoelectric drop-on-demand ink jet (Panthera D8, printing speed 240 m^2/h; wet deposit: 20 g/m^2) on a surface of a white color textile fabric (Natt6 2/1, 100% PES, 218 g/m^2), dried by exposure for 90 seconds to hot air (120 °C), and subsequently calendared at different temperatures to provide finished textiles T9 - T11 according to the present invention and textiles C5 and C6 for comparative purposes. The wicking properties of the finished textiles were evaluated using the method test AATCC 79 described above. The measured absorption times are depicted in the table below.

Finished textile	Calendaring temperature	Absorption time measured according to AATCC 79 (seconds)
C5	140°C	2.45
C6	160°C	1.83
T9	180°C	1.15
T10	200°C	<1
T11	210°C	< 1

[0076] Finished textiles T9 - T11 finished by a finishing process according to the present invention exhibit better properties that textiles C5 and C6 that were subjected to a calendaring step of 140 °C and 160 °C, respectively.

Claims

1. A textile finishing process comprising the following steps:

   a) providing a continuous supply of a textile;
   b) piezoelectric drop-on-demand ink jet printing one or more textile finishing compositions on a side of the textile, or on one or more regions of a side of the textile;
   c) drying the textile by exposure to an air having a temperature from about 120 °C to about 140 °C to provide a dried textile; and
   d) calendaring the dried textile for at least 10 seconds at a temperature from about 180 °C to about 220 °C to provide a finished textile.

2. The textile finishing process according to claim 1, wherein steps a), b), c) and d) are carried out continuously.

3. The textile finishing process according to claim 1 or 2, wherein at step b) a wet deposit from 10 g/m^2 to 30 g/m^2, preferably from 10 g/m^2 to 25 g/m^2, of the one or more finishing compositions is deposited on the side of the textile, or on the one or more regions of the side of the textile.

4. The textile finishing process according to any one of claims 1 to 3, wherein at step b) at least two, preferably at least three, more preferably at least four textile finishing compositions, are applied with a single piezoelectric drop-on-demand ink jet printhead.

5. The textile finishing process according to claim 4, wherein at step b) a different wet deposit is printed for each of the at least two, preferably at least three, more preferably at least four textile finishing compositions.

6. The textile finishing process according to any one of claims 1 to 5, wherein at step c) the textile is dried for less than 3 minutes, preferably for less than 2 minutes.

7. The textile finishing process according to any one of claims 1 to 6, wherein at step d), the dried textile is calendared for less than 60 seconds.

8. The textile finishing process according to any one of claims 1 to 7, wherein the one or more finishing compositions are selected from water-repellent finishing compositions, softening compositions, flame retardant treatment compositions, antimicrobial treatment compositions, wrinkle-resistant treatment compositions, UV-enhancing finishing compositions, finishing compositions for moisture management, and finishing compositions for improving the wicking properties.

9. The textile finishing process according to any one of claims 1 to 8, wherein the one or more finishing compositions do not contain silicone or fluorinated compounds.

10. The textile finishing process according to any one of claims 1 to 9, wherein the one or more finishing compositions comprise:

    i) from about 10.0 wt-% to about 30.0 wt-% 1,2,3-propanetriol;
    ii) from about 0.05 wt-% to about 10.0 wt-% of a surfactant;
    iii) from about 1.0 wt-% to about 10 wt-% of a fatty acid ester containing finishing agent selected from an oil of vegetal origin, a wax of vegetal origin, a beeswax, and an esterquat, with the proviso that if the fatty acid ester containing finishing agent is a wax of vegetal origin or a beeswax, the composition further comprises a wax extender;
    iv) optionally a thickening agent and/or a biocide and/or a pH adjusting agent; and
    v) water up to 100 wt-%;

    wherein the wt-% are based on the total weight of the composition.

11. The textile finishing process according to any one of claims 1 to 10, wherein the one or more finishing compositions have a viscosity from 5 cP to 9 cP, more preferably from 6 to 7 cP, at 25 °C and a shear rate 200-400 s^{-1}.

12. The textile finishing process according to any one of claims 1 to 11, wherein the textile is a woven, knitted or

nonwoven fabric.

13. The textile finishing process according to claim 12, wherein the fabric contains synthetic and/or natural fibers, preferably selected from cellulose fibers, elastane fibers, polyamide fibers and polyester fibers.

14. A finished textile obtained by the process according to any one of the claims 1 to 13.

15. A garment comprising the finished textile according to claim 14.

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EUROPEAN SEARCH REPORT

Application Number
EP 23 15 1887

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The Hague	25 April 2023	Barathe, Rainier

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