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[54] **TEXTILE FINISHING PROCESS AND PRODUCTS PRODUCED THEREBY**

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[58] **Field of Search**.....117/135.5, 143 R, 161 KP, 76 T, 117/161 ZA, 161 UC, 62; 260/86.7, 87.3, 33.8 UR, 33.6 PQ

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[57] **ABSTRACT**

Process, and the resulting products, for producing water-resistant textile fabrics having excellent breathability and aesthetics which adapt the fabrics for use in rainwear products, and wherein a textile fabric is coated with an aqueous dispersion containing one or more water-insoluble, film-forming, solvent-swellable polymers and a sufficient amount of a water-immiscible organic solvent to swell the polymer and increase the viscosity of the dispersion. The coated fabric is dried, impregnated with a water-repellent compound, and treated to cure the coating and the impregnant on the fabric.

15 Claims, No Drawings

TEXTILE FINISHING PROCESS AND PRODUCTS PRODUCED THEREBY

This invention relates to a process for finishing textile materials and, more specifically, to a process for treating textile fabrics to provide water-resistant textile products having excellent breathability and aesthetic appearance suitable for use as rainwear and the like. The invention also relates to novel products produced by the above process.

Extensive efforts are presently being made in the industry to produce a lightweight rainwear fabric which has exceptional water resistance, breathability, i.e., air and vapor permeability, and durability, without appreciable loss in aesthetic properties, such as hand and drape, necessary to the wearability and use of the fabric in production of garments. It is a current practice to apply a polymeric or resinous coating to textile fabrics to provide them with water-resistant capabilities, and various chemical compounds, such as vinyl, acrylic, and urethane polymers, as well as fluorocarbon and silicone chemicals, have been employed for this purpose.

In the finishing of such textile fabrics to impart water-resistant characteristics thereto, it has heretofore been difficult to impart the desired degree of durable water resistance to the fabrics, while still retaining the necessary breathability, hand, and aesthetic appearance in the fabric to provide an attractive garment product. Generally, when such polymeric materials are applied to textile fabrics in amounts sufficient to provide the degree of water resistance required, they tend to make the fabrics stiff and boardy and provide an undesirable slick, waxy feel, or they are of such poor durability as to be easily washed out of the fabrics during cleaning.

The particular location and formation of the water-resistant film or coating on the fabric surface greatly influences the breathability and comfort of the fabric during wear. If the coating is not maintained sufficiently porous, the breathability of the fabric will be poor, even though the water resistance of the fabric may be high. Also, if the coating is not maintained on or near the surface of the fabric during curing but is permitted to migrate into the interstices of the fabric, it will substantially close the interstices of the fabric during curing to greatly reduce breathability of the fabric during use. Certain prior art processes have employed thickening agents, such as carboxy-methycellulose, to provide the high viscosity necessary to maintain the coating on the surface of the fabric during cure; however, these thickening agents remain on the fabric product and appreciably detract from the aesthetics and wearability of the fabrics in subsequent use. Other prior art processes employ a leaching operation to form the necessary porosity in the coating wherein starch or salt is incorporated into coating and subsequently leached out with various chemicals to obtain the porosity required for proper breathability. This, of course, requires additional chemicals and involves more processing steps which adds appreciably to the cost of producing the fabrics.

U.S. Pat. No. 3,326,713 discloses a process for waterproofing fabrics wherein the textile fabric is impregnated with a particular type fluorochemical compound which is cured in the fabric, after which the fabric is coated with a solvent solution of a waterproofing resin which is cured thereon to provide a water-resistant product. The cured fluorochemical compound serves to resist migration of the resin coating into the interior portions of the fabric before it is cured, thereby preventing the coating from closing the pores of the fabric and also retaining a degree of breathability in the product. In this disclosed process it is essential that the fluoro-chemical compound be cured on the fabric before application of the coating resin for proper positioning of the coating on the fabric surface. The process consequently requires two curing operations which appreciably increase the production costs.

It is an object of the present invention to provide a novel and economical process for finishing textile fabrics to provide highly durable, water resistant fabrics having excellent breathability and aesthetic characteristics which make them readily adaptable for use in rainwear products.

It is another object to provide a novel water resistant fabric having excellent water resistance with greatly improved breathability and aesthetics which make it readily adaptable for use in rainwear products.

The above as well as other objects of the invention are accomplished by employing as the water-resistant coating composition for the textile fabrics an aqueous dispersion of one or more organic solvent-swellable, film-forming polymers which polymer or polymers, with the addition of a suitable organic solvent to the dispersion, increase in size in the dispersion to form a highly viscous composition which can be readily applied to and retained on the surface portion of the fabric during the coating operation. Upon drying and curing of the coating composition, the polymer particles coalesce and harden while the evaporable liquids are removed to form a thin, porous polymeric coating on the fabric possessing excellent water resistance and exceptional breathability. Without intending to be limited thereby, it is believed that the minute droplets of organic solvent which are dispersed across the surface of the fabric flash off to leave minute voids in the coating which permit the passage of air and vapor therethrough for breathability, but are small enough to create sufficient surface tension to resist the passage of liquids through the fabric.

By employing an organic solvent-swelling agent which readily evaporates with the water from the coating during heat curing thereof, the coating is in a much purer state than would be the case if cellulose or other polymeric thickeners were employed to provide the high viscosity necessary for proper placement of the coating on the fabric. Further, by being able to increase the viscosity of the dispersion-coating composition with a liquid solvent, relatively small amounts of film-forming polymeric material can be applied to and retained on the surface portion of the fabric product. This high viscosity with low solids content in the coating composition is a feature which cannot be achieved with the aforementioned polymeric thickeners, and it also permits formation of a thin coating of the polymer on the fabric surface without having to employ a prior fluorocarbon barrier in the fabric to prevent migration of the coating. In addition, the physical coating step itself is greatly facilitated in that larger amounts of the coating composition may be applied to the fabric without fear of appreciably reducing the breathability and aesthetic characteristics of the fabric due to the presence of large amounts of solids thereon. Thus, relatively small amounts of water-insoluble film-forming polymeric material can be easily and properly positioned on the surface of the fabric to provide excellent water resistance without appreciable loss in breathability and aesthetic properties of the fabric, and with appreciable reduction in the cost of the finishing operation.

The finishing operation of the present invention, as used in the production of apparel fabrics, preferably includes a subsequent impregnation of the polymer-coated fabric with a typical water repellent chemical, such as a fluorocarbon compound, which provides additional water and oil repellency to the finished product. Varying amounts of the water-repellent chemical may be employed, with amounts from about 0.1 to 5 percent by weight on the fabric weight being preferred. In such cases, the coating composition and water repellent compound may be conveniently cured on the fabric in a single heating step, thereby improving the economics of the process considerably.

As solvent-swellable, film-forming polymers of the aqueous dispersion coating composition, there may be employed any water-insoluble film-forming polymers, e.g., acrylics, vinyls, urethanes, silicones, natural and synthetic rubbers, and copolymers and mixtures of the foregoing, which have the capability of swelling in the aqueous dispersion with the addition of an organic solvent. The term "film-forming polymer," as used herein, is intended to cover film-forming compounds, whether applied in monomeric or partially polymerized, e.g., prepolymer, form to the surface of the fabric, so long as they can be reacted to form a water-resistant coating on the fabric. In a preferred embodiment of the process, the coating com-

position is composed of an aqueous dispersion containing a mixture of an ethylene/vinyl acetate copolymer and an acrylic polymer.

The viscosity of the coating composition applied to the fabrics may be varied, depending upon the particular structure and porosity of the fabric to be treated. For most textile woven fabrics to be used in rainwear, dispersions having a viscosity of between about 50,000 to 500,000 centipoise have been found quite suitable for coating the fabrics, with those having viscosities of about 100,000 centipoise being preferred.

To achieve the desired coating viscosity of the dispersion, varying amounts of organic solvents may be added to the aqueous dispersion to swell the polymer therein. Typical of such organic solvents which may be employed are xylene, toluene, perchloroethylene, and trichloroethylene.

The amount of the film-forming composition applied to the fabrics may also be varied, depending upon the particular construction and weight of the fabric. Generally excellent results in water resistance and breathability without appreciable loss in aesthetic characteristics of the fabrics can be obtained when as little as 5 percent polymer solids, based on the weight of the fabric, are cured thereon. In light weight or loosely woven textile fabrics about 15 percent polymer solids are preferred, while with medium to heavy weight fabrics, or tightly woven fabrics, about 10 percent is preferred.

In a typical treating process employing the process of the present invention, a textile fabric of woven, knit, or nonwoven construction is suitably coated, as by roller or knife coating, with the aqueous dispersion containing the solvent-swellable polymer and a sufficient amount of organic solvent to obtain the desired viscosity to retain the coating composition in the fabric surface. After coating, the fabric is dried and preferably impregnated with a water repellent chemical, such as a fluorocarbon compound. The fabric is thereafter dried and cured to provide a durable, water resistant fabric product having exceptional breathability, particularly water vapor transmission characteristics, without appreciable loss of aesthetic properties such as hand drape, feel, etc., of the fabric. As fabrics which may be treated in accordance with the present invention there may be employed any woven, knitted or nonwoven fabrics composed of natural and/or synthetic fibers, including blends thereof.

In preparing the highly viscous coating composition for application to the fabrics, one or more water-insoluble, solvent-swellable, film-forming polymers are dispersed in an aqueous medium to form a discontinuous phase therein. A water-immiscible organic solvent is then added to the dispersion to combine with and swell the film-forming polymer or polymers therein, thereby increasing the viscosity of the dispersion while correspondingly decreasing the percent solids content thereof. The amount of solvent added to the dispersion may be varied, depending on the particular viscosity desired in the coating operation. The term "dispersion," as used herein, is intended to be taken in its broadest sense and to include any heterogenous mixture of the polymer in an aqueous medium, whether the polymer be in solid, liquid, or gaseous form, or a combination thereof, in the composition.

By increasing the viscosity of the dispersion coating in this manner, it has been found that viscosities of greater than about 50,000 centipoise may be easily obtained while the percentage solids in the coating composition can be retained at or below about 25 percent by weight. For fabrics to be used in rainwear garments, it has been found that best results are obtained when the viscosity of the coating composition is maintained between about 50,000 to 500,000 centipoise, while the percentage solids in the composition are maintained between about 10 to 25 percent by weight of the composition.

After the desired viscosity is obtained, the coating composition may be applied to the surface of the fabric in suitable manner, such as by knife coating, roller coating or the like. Generally, it has been found that the viscosity of the aqueous dispersion decreases upon pumping to the coating apparatus; therefore, it may be desirable, if pumping apparatus or the like is employed, to adjust the viscosity in the initial mixing stages so as to obtain the desired viscosity at the coating site. The fabric is dried to remove excess liquids from the coating composition, and heated to cure the coating, either with or without subsequent impregnation of the fabric with a water repellent chemical, thereby forming on the fabric a porous, highly breathable coating having excellent water resistance.

The following examples illustrate a manner in which the present invention may be practiced, and parts and percentages therein are by weight unless otherwise indicated. The examples are in no way intended to limit the scope of the invention, but are presented for purposes of illustration only.

EXAMPLE I

Typical coating formulations are prepared as follows:

a. Composition A

Ingredients:

5.0 parts SM-2013 (40 percent solids reactive dimethyl polysiloxane in aqueous emulsion, from General Electric)

1.0 part SM-2014 C catalyst (50 percent solids dibutyl tin dilaurate in aqueous emulsion, from General Electric)

13.0 parts Aircoflex 500 (55 percent solids ethylene/vinyl acetate copolymer in aqueous emulsion, from Airco Chemicals)

13.0 parts Aircoflex 46-3 (55 percent solids reactive carboxylated vinyl acetate/ethylene copolymer in aqueous emulsion, from Airco Chemicals)

0.1 part diammonium phosphate catalyst

52.5 parts of trichloroethylene solvent

Mixing Procedure:

All ingredients except the trichloroethylene are added to a suitable container and stirred vigorously with a propeller stirrer for about 30 seconds. Then the trichloroethylene is added thereto while still stirring. The total emulsified composition, which contains about 20 percent water, is stirred for an additional 2–4 minutes, or until no movement can be detected on the surface of the mixture. The emulsion, after standing about 2 hours, has a viscosity of around 450,000–500,000 cps.; however, when applied to the fabric by pumping apparatus, the viscosity drops to about 100,000–150,000 cps.

b. Composition B

Ingredients:

31.0 parts Aircoflex 500

42.0 parts trichloroethylene

10.6 parts water

Mixing Procedure:

Same as Composition A, above, except the viscosity decreases from an initial viscosity of about 123,000 cps. to about 75,000 cps. upon pumping to the coating apparatus.

c. Composition C.

Ingredients:

5.0 parts SM-2013

1.0 part SM-2014C catalyst

13.0 parts Aircoflex 500

13.0 parts Aircoflex 46-3

36.0 parts toluene

Mixing Procedure:

All the above ingredients except the toluene are added to a suitable container. Then the toluene is added to the emulsion while stirring with a high shear Eppenbach mixer. The mixing is stopped as soon as there is no movement on the surface of the composition. The viscosity at this point is approximately 500,000 cps., and 400,000 cps. upon pumping to the coating apparatus.

d. Composition D

Ingredients:

31.0 parts by weight of Rhoplex K14 (46 percent solids self cross-linking acrylic polymer in aqueous emulsion, from Rohm & Haas)

63.0 parts trichloroethylene

Mixing Procedure:

Add the trichloroethylene to the acrylic emulsion while stirring vigorously with a propeller stirrer for 1–4 minutes or until no movement can be detected on the surface. After standing for 2 hours, the viscosity of the composition is about 675,000 cps., and when the composition is applied to the fabric after pumping, the viscosity is about 400,000 cps.

e. Composition E

Ingredients:

25.0 parts Rhoplex K14

6.2 parts Aircoflex 500

2.8 parts water

52.5 parts trichloroethylene

Mixing Procedure:

Same as Composition D above, but the viscosity is about 300,000 cps. after standing 2 hours, and about 150,000 cps. after pumping.

f. Composition F

Ingredients:

31.0 parts Wyandotte urethane latex prepolymer emulsion X 1015

(47.8% solids)

42.0 parts trichloroethylene

Mixing Procedure:

Same as Composition D, above, but the initial viscosity is about 50,000 cps. and, after pumping, about 25,000 cps.

EXAMPLE II

Composition A of Example I, above, is applied to a relatively heavy 5 oz. per sq. yd. polyester/cotton poplin fabric by pumping the composition onto the fabric surface and then passing the fabric through a knife-over-roll coating apparatus with the blade set 0.002 inches from the fabric. The coated fabric is dried at 250° F. The solids pick up on the fabric is approximately 9.0 percent. The coated fabric is then impregnated with a water repellent composition consisting of

15.0% Rhonite R1 (a dimethylol cyclic ethylene urea wash & wear resin from Rohm & Haas)

3.0% Catalyst X 4 (Zinc nitrate from Sun Chemical Co.)

3.5% FC-208 (a fluorocarbon water repellent from Minn. Mining & Mfg. Co.)

5.0% Nalan W (water repellent extender from DuPont)

4.0% Sapamine NP (polyethylene softener from Ciba)

0.2% Synthrapol KB (wetting agent from ICI)

by padding onto the fabric to obtain a fluorocarbon solids pick up of approximately 0.5 percent on the dry weight of the fabric. The thus coated and impregnated fabric is dried and the water repellent and polymer coating compositions cured thereon at 330° F. for 3 minutes.

The resultant fabric possesses an air permeability of 12 seconds per 100 c.c. as measured on a Gurley Densiometer (ASTM:D726-58, Method A) with a water vapor transmission of approximately 600 grams per sq. meter per 24 hrs. as measured by the ASTM E-96 Method. The fabric allows less than 1.0 gram of water through the fabric when tested with a rain tester at 2 ft. head for 2 minutes (AATCC 35-1967) initially, as well as after six machine washes (normal setting, 120° F., with detergent).

EXAMPLE III

The procedure of Example II is followed employing a lightweight relatively tightly woven polyester/cotton fabric (4 oz. per sq. yd.). The solids pickup on the weight of fabric is 9.0 percent for the coating composition, and 0.5 percent for the fluorocarbon solids impregnant. The air permeability is 32 seconds per 100 cc., with a water vapor transmission of approximately 600 grams per sq. meter per 24 hrs. The rain resistance is less than 1.0 gram of water penetration initially and after six washes.

EXAMPLE IV

The procedure of Example II is followed employing a medium weight relatively open weave polyester/cotton fabric. The solids pickup on the weight of fabric is 15.0 percent for the coating composition, and 0.5 percent for the fluorocarbon impregnant. The air permeability is 20 seconds per 100 c.c., with a water vapor transmission of approximately 600 grams per sq. meter per 24 hrs. The rain resistance is less than 1.0 gram of water penetration initially and after six washes.

EXAMPLE V

The procedure of Example II is followed employing a medium weight polyester/cotton fabric and utilizing a floating knife-coating apparatus instead of the knife-over-roll apparatus. The solids pickup on the weight of fabric is 11.5 percent for the coating composition, and 0.5 percent for the fluorocarbon impregnant. The air permeability of the treated fabric is 26 seconds per 100 c.c., with a rain resistance of less than 1.0 gram of water penetration initially and after 6 machine washes.

EXAMPLE VI

The procedure is the same as in Example II, but coating Composition B is used to coat the fabric, instead of Composition A. The solids pickup on the weight of fabric is 10.0 percent for the coating composition and 0.5 percent for the fluorocarbon impregnant. The air permeability of the treated fabric is 10.0 seconds per 100 c.c., with a rain resistance of less than 1.0 gram of water penetration initially and after six machine washes. The oil repellency rating is 5.0 before and after three machine washes, as measured by AATCC Method 118-1966T.

EXAMPLE VII

The procedure is the same as Example III, but with a coating viscosity of about 375,000 cps. due to the changes in pumping conditions. The solids pick up on the weight of fabric is 9.7 percent for the coating composition, and 0.5 percent for the fluorocarbon impregnant. The air permeability of the treated fabric is 40 seconds per 100 c.c. with less than 1.0 gram of water penetration initially and after six machine washes.

EXAMPLE VIII

The procedure is the same as Example IV, but Composition C is applied to the fabric instead of Composition A. The solids pickup on the weight of fabric is 13.0 percent.

The air permeability is 30 seconds per 100 c.c. with a rain resistance of less than 1.0 gram penetration initially and after 10 machine washes.

EXAMPLE IX

The procedure is the same as Example II, except the fabric is coated with coating Composition D. The solids pickup on the weight of the fabric is 7.6 percent for the coating composition, and 0.5 percent for the fluorocarbon impregnant.

The air permeability is 5.0 seconds per 100 c.c., with a rain resistance of less than 1.0 gram of water penetration initially and after three machine washes. The oil repellency rating is 5.0 before and after three machine washes.

EXAMPLE X

The procedure of Example II is followed, but the coating Composition E is applied to the fabric instead of Composition A. The total solids pickup on the weight of fabric is 6.3 percent for the coating composition, and 0.5 percent for the fluorocarbon impregnant. The air permeability of the treated fabric is 13.0 seconds per 100 c.c., with a rain resistance of less than 1.0 gram of water penetration initially and after six machine washes. The oil repellency is 5.0 initially and after three washes.

EXAMPLE XI

The procedure is the same as Example II, but the coating Composition F is applied to the fabric instead of Composition

A. The total solids pick up on the weight of Fabric is 10.0 percent for the coating composition and 0.5 percent for the fluorocarbon impregnant. The air permeability of the treated fabric is 12 seconds per 100 c.c., with a rain resistance of less than 1.0 gram of water penetration initially and after six machine washes. The oil repellency is 5.0 initially and after three washes.

The foregoing specification has set forth preferred embodiments of the invention and, although specific terms have been employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being limited only by the extent of the following claims.

That which is claimed is:

1. A process for producing water-resistant textile fabrics having improved breathability, durability and aesthetics adapted for use in rainwear products, comprising the steps of coating at least one side of a textile fabric with a mixture of a relatively low viscosity aqueous dispersion of one or more water-insoluble, film-forming, solvent-swellable polymers and a water immiscible organic solvent in a sufficient amount to swell the polymeric material and provide a relatively high viscosity mixture, removing excess liquid from the coated fabric, and treating the fabric to cure the coating thereon.

2. A process as defined in claim 1 including impregnating the coated fabric with a water-repellent compound and treating the fabric to cure the impregnant thereon.

3. A process as defined in claim 2 wherein the water-repellent compound is a fluorocarbon compound.

4. A process as defined in claim 1 wherein the dispersion coating is applied to the fabric in an amount sufficient to obtain between about 5 to 20 percent by weight polymer solids thereon, based on the weight of the fabric.

5. A process as defined in claim 1 wherein the solvent-swellable polymeric material of the dispersion is selected from the group consisting of vinyl, urethane, and silicone compounds, and copolymers or mixtures of the same.

6. A process as defined in claim 5 wherein the solvent-swellable polymeric material is a mixture of an ethylene/vinyl acetate copolymer and an acrylic polymer.

7. A process as defined in claim 6 wherein the organic, water-immiscible solvent employed in the dispersion is selected from the group consisting of xylene, toluene, perchloroethylene and trichloroethylene.

8. The product produced by the process of claim 1.

9. A process as defined in claim 1 wherein said aqueous dispersion has an initial relatively low viscosity, and wherein said mixture has a relatively high viscosity of from about 50,000 to 500,000 centipoise.

10. A process as defined in claim 9 wherein the viscosity is about 100,000 centipoise.

11. A process for producing a water-repellent textile fabric having improved breathability, durability, and aesthetic characteristics suitable for use in rainwear products, comprising the steps of

a. preparing an aqueous dispersion containing a discontinuous phase having one or more water-insoluble, solvent-swellable, film-forming polymers therein,
b. adding to the dispersion a water-immiscible organic solvent to swell the film-forming polymeric material therein and increase the viscosity of the dispersion,
c. coating the surface of the textile fabric with the dispersion,
d. drying the coated fabric to remove excess liquids therefrom,
e. impregnating the coated fabric with a water-repellent fluorochemical compound, and
f. heating the thus coated and impregnated fabric to cure the components thereon.

12. A process as defined in claim 11 wherein the solvent is added to the dispersion in an mount sufficient to obtain a coating viscosity of at least about 50,000 centipoise, while maintaining a total solids content in the dispersion coating of at or below about 25 percent by weight of the dispersion.

13. A process as defined in claim 12 wherein the coating viscosity is from about 50,000 to 500,000 centipoise, while the solids content of the coating dispersion is from about 10 to 25 percent by weight of the dispersion.

14. The product produced by the process of claim 11.

15. A process for producing water resistant textile fabrics comprising the steps of

a. preparing an aqueous dispersion of relatively low viscosity and containing a discontinuous phase having a water-insoluble, solvent-swellable, film-forming polymeric material comprising a mixture of an ethylene vinyl acetate copolymer and an acrylic polymer,
b. adding to the dispersion a water-immiscible organic solvent selected from the group consisting of xylene, toluene, perchloroethylene, and trichloroethylene in a sufficient amount to swell the film-forming polymeric material and increase the viscosity of the dispersion to between about 50,000 to 500,000 centipoise,
c. coating the surface of a textile fabric to obtain a pickup of from about 5 to 20 percent by weight polymer solids thereon,
d. drying the coated fabric to remove excess liquids therefrom,
e. impregnating the coated fabric with a water-repellent fluorochemical compound, and
f. heating the thus coated and impregnated fabric to cure the components thereon.

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