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TEXTILE TREATING PROCESS AND PRODUCT OBTAINED THEREBY

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ABSTRACT OF THE DISCLOSURE

Process for improving the wash and wear properties of cellulosic fabrics by applying thermosetting resin to the cellulosic fabric followed by drying and curing; then subjecting the fabric to a caustic soda treatment whereby the fabric is mercerized or causticized, neutralizing and drying; thereafter applying a thermoplastic resin to the fabric; and then applying additional thermosetting resin to the fabric followed by drying and curing.

The present invention relates to a textile finishing process and the resulting product. More particularly, the invention is concerned with increasing the wash and wear properties of cellulosic fabrics including those fabrics where cellulosic fibers are used in conjunction with other textile fibers, e.g. polyesters.

In addition to wash and wear properties, the present process increases the potential of the treated fabric for making permanent creases, pleats, embosses or the like in the fabric prior to finishing and/or after said fabric is made into a garment.

Broadly stated, the present process comprises applying thermosetting resin to the cellulosic fabric followed by drying and curing; then subjecting the fabric to a caustic soda treatment whereby the fabric is mercerized or causticized, neutralizing and drying; thereafter applying a thermosplastic resin to the fabric; and then applying additional thermosetting resin to the fabric followed by drying and curing.

The treatment of cellulosic fabric by means of the above-described process results in fabric containing high crease angles (wet and dry), good tensile strength, excellent wash and wear properties and a high degree of resiliency. Fabric processed in this manner is highly suitable for use in making garments of any desired shape which can be indefinitely maintained by curing, ironing or pressing. For example, permanently pleated crease-free garments may be made by processing fabric through the steps outlined with no curing or, at most, only a partial cure, followed by garment manufacture and then simultaneously pressing and curing the garment or first pressing and then curing.

One particularly unique advantage of the present process is that for all-cotton fabrics, physical properties such as tear and tensile strengths are kept at higher levels than with other permanent crease type processes. Wear tests of garments made with 100% cotton fabrics treated by the present process have shown that after many launderings (25–30), the garments have retained their shape and demonstrate a high degree of wash and wear appearance, while at the same time retaining the physical properties normally found on all-cotton fabric. This represents a very substantial advantage over prior procedures.

With prior procedures, it is a known fact that in order to obtain excellent wash and wear appearance or a high degree of resiliency in 100% cotton fabrics, a large amount of a thermosetting resin must be applied to the fabric. However, it has also been recognized that this addition of high quantities of thermosetting resin to develop the desired degree of wrinkle resistance or resiliency significantly hinders the physical properties of an all-cotton fabric. For example, the tensile, tear and abrasion properties of all-cotton fabrics are markedly affected by the application of high concentrations of thermosetting resins. Similarly, it is known that the addition of high amounts of other cellulosic reactants used to obtain desirable cross-linking for wash and wear properties also degrades the physical properties of treated fibers, yarns and fabrics. The present invention obviates these prior art problems while at the same time offering maximum wash and wear properties and resiliency.

While the reasons for the success of the invention are not fully understood, it appears that one important feature of the invention is to form cross-links in the cellulose in the wet state followed by additional cross-linking in the dry state. Another important feature is mercerization or causticization (or swelling) when the fabric is treated with caustic soda. Additionally, it appears to be important to the results herein to add only a part of the thermosetting resin to be used before causticizing or mercerizing (e.g. from 5 to 95% by weight of the total add-on) with the rest of the resin being added after the caustic soda treatment. Apparently, when part of the thermosetting resin is applied to the prepared cellulosic fabric followed by drying and curing and subsequent swelling of this fabric in caustic or mercerization under normal conditions, the cross-links formed by the application of the resin are reoriented and possibly in some instances broken by the nature of the swelling means. Accordingly, when this fabric is thereafter subjected to a second application of a thermosetting resin, additional cross-links are formed at new sites due to the swelling of the cellulose and they are located in more effective or desirable positions. Additionally, when the fabric is cured, available reactant sites are finally cross-linked thereby resulting in the high degree of resiliency and/or wash and wear characteristics observed for the invention.

In comparison, the addition of all of the thermosetting resin in one application as generally considered necessary in the past to achieve a high degree of resiliency and which markedly impairs the tensile, tear, and abrasion resistance of cotton fabrics, apparently results in an excessive amount of cross-linking, which in turn deteriorates the physical properties of an all-cotton fabric.

Addition of the first reactant resin in a small amount according to the invention herein seems to cover the minimum amount of usable and accessible sites for producing wash and wear characteristics. When this fabric is mercerized or otherwise swollen, other sites which are needed to give a high degree of resiliency are exposed and consequently become more reactive for the second addition of thermosetting resin. Under these conditions, it appears that more of the sites which are needed for the wash and wear characteristics are crosslinked thus minimizing the cross-linking of those sites which could markedly affect the tensile, abrasion and tear strength of the fabric. Whatever the explanation, it is clear that the present process gives a product having outstanding wash and wear and resiliency characteristics without undesirably affecting the other physical or aesthetic qualities of the fiber. This is in marked contrast to normal finishing procedures which have been considered acceptable in the trade where resin application for improved resiliency and wash and wear properties effects a drastic reduction in abrasion, tear and tensile strength.

Another important feature of the present process is the application of thermoplastic resin (preferably an acrylic polymer) or the like to the fabric between the caustic soda treatment and the final application of the thermosetting resin. An unsual advantage of this feature is the fact that the product thus obtained demonstrates

increased crease angle and abrasion resistance while maintaining or increasing tensile strength. This is highly unusual because conventional applications of acrylic polymer or like resin to cellulosic fabrics for the purpose of improving the crease angle reduce the tensile strength.

The various steps of the present process are described in detail below:

(a) Fabric preparation.—The cellulosic fabric (which may be 100% cellulose or a blend with other fibers) is suitably prepared for the finishing operations. The preparation steps depend on the condition of the fabric involved. Usually, however, this will include such operations as singeing, desizing, washing, mercerizing, neutralizing and drying. Cleaned, mercerized goods are preferred for the operations outlined hereinafter but there may be variations if this is desired. For example, mercerizing may be omitted in the preparation of the fabric.

(b) First thermosetting resin application.—A small amount of thermosetting resin is applied to the fabric. The amount of resin added can be varied depending on the nature and construction of the fabric. However, as an example, the amount of resin added at this stage may be in the range of 1–20% based on the weight of fabric. Usually, the resin application is carried out using an aqueous resin solution containing a suitable catalyst followed by drying and curing. Drying may be carried out at, for example, 250 to 350° F., followed by curing at 300 to 375° F. for 1.5 to 0.5 minutes.

Resins which may be used for this treatment are those capable of crosslinking and reacting with the cellulosic fabric. This includes any resin from the following well-known classes: triazones such as dimethylol triazone precondensate, triazines, urons, urea formaldehyde precondensates, melamine formaldehyde precondensates, other aminoplast materials. The catalysts which may be used are, for example, zinc nitrate, magnesium chloride, amine hydrochloride, etc.

Typical conditions for this initial thermosetting resin application include the following:

(1) Pad the fabric with aqueous resin solution containing 2–40% resin, catalyst and, if desired, a wetting agent, to obtain a 40–80% wet pick-up;

(2) Tenter dry, using heat sufficient to dry fabric. The temperature used depends on fabric speed and weight but usually will be in the range of 250 to 350° F.;

(3) Cure. The curing temperature also depends on weight of the fabric and the length of time the fabric is to be exposed to heat. Typical conditions include 300°–375° F. for 1.5 to 0.5 minutes;

(4) A typical resin formulation used for this treatment is: 6.0% methylolated triazine resin (such as Aerotex Resin 23 special), 1.85% magnesium chloride, 0.15% alkyl aryl polyether alcohol (namely, Triton X–155), balance: water.

(c) Caustic soda treatment.—The caustic soda treatment, involving causticization or mercerization of the fabric obtained from (b), may be carried out in either of two ways. According to one method, the fabric is mercerized under tension using aqueous caustic soda not exceeding 45° TW (15–20% NaOH). The duration of this treatment depends on various factors including fabric construction and weight. In a typical example, however, a medium weight cotton fabric is treated for about 0.5 to 1 minute using 42–43° TW sodium hydroxide. During the mercerization, the fabric should be pulled wider than the desired finishing width (e.g. 2% wider although it will be recognized that this will be varied depending on other factors).

In lieu of mercerizing the fabric as described above, the causticization may be carried out in the relaxed state in a conventional wash box or J box. For this alternative, the caustic concentration may vary from 23 to 46° TW (10–20% sodium hydroxide) using a treating time of 15–5 minutes before washing.

After mercerizing or causticizing, the fabric is neutralized, washed and dried. Neutralization may be effected by means of a suitable acid, e.g. acetic acid or SO_2 gas (sulphurous acid). Drying is usually carried out at about 300–350° F. using a tenter frame.

(d) Thermoplastic resin application.—After the caustic soda treatment, the fabric is given a so-called "pretreatment" with an acrylic copolymer or equivalent thermoplastic textile finishing resin or chemical agent. As noted above, this treatment aids in obtaining greater tensile strength retention, improved abrasion resistance and higher crease angles. While organic solvent systems may be used, the acrylic polymer or the like is preferably applied from an aqueous system after which the fabric is dried, usually by slack drying. The amount of resin thus applied can be widely varied but usually falls in the range of 1–10% based on the fabric weight.

Acrylic polymers are preferred for this step of the process and particularly advantageous results are obtained using Rhoplex HA–8 acrylic polymer. However, other thermoplastic resins may be used in lieu of, or in addition to, the acrylics such as butadiene/acrylonitrile copolymers (e.g. the Hycar type polymers), chlorinated polyolefins, polyvinyl acetate and the like.

(e) Further thermosetting resin addition and finishing.—Following application of the acrylic or the like, the fabric is finished by a further addition of thermosetting resin (e.g. 1 to 20% add-on based on fabric weight). Other auxiliaries that may be desired for specific effects such as oil and/or water repellency, hand, softness abrasion resistance, tear and tensile strength, etc., may be added at this point. Partial curing (equivalent, for example, to 30–45% fixed resin solids) may occur during subsequent drying of the fabric and the dried fabric may also be calendered, sanforized and/or otherwise mechanically processed depending on the desired end use of the fabric. The fabric may be fully cured at this stage or it may be left in an uncured or partially cured condition which is susceptible to undergo further cross-linking or curing at a later stage. If the fabric is not fully cured, it can be made into garments that can be fashioned into specific shapes and then cured, ironed, or pressed to preserve the desired condition of fabrication indefinitely.

Typical conditions for this further resin application and subsequent processing of the fabric may include padding the fabric with an aqueous finishing formulation containing 2–40% of the thermosetting resin, catalyst and modifiers, if desired, to obtain a 40–80% wet pick-up followed by drying, e.g., tenter drying, using sufficient heat to dry to the desired moisture level (normally 5–8% by weight of the fabric). Drying temperatures depend on various operating conditions such as the fabric weight and construction. However, a typical drying temperature is 290° F. for 0.5 minute. This may cause partial curing of the fabric and, if desired, the fabric may be fully cured at this stage or it may be calendered and/or sanforized, fabricated into garments and cured by baking in a press, oven or combination of these two, as mentioned above.

A typical resin formulation for this finishing step (e) comprises the following where percentages are by weight:

	Percent
Methylolated triazine/cyclic ethylene urea resin	10.0
Alkyl aryl polyether alcohol (namely, Triton X–155)	0.15
High density polyethylene (namely, Aqualene N)	0.5
Magnesium chloride	2.5
Balance: water.	

The invention is further illustrated by the following additional examples:

EXAMPLE 1

The data set forth below gives a comparison of the physical properties of two identical pieces of a light

weight gingham (comprising 78 ends and 56 picks). One piece of the gingham fabric was treated according to the present process while the other was treated by a conventional finishing process. In both instances the same percent of total resin solids add-on was employed.

TABLE I

	Present process	Conventional process
Tensile	54 x 31	44 x 27
Dry wrinkle recovery (degrees Monsanto)	130 x 133	124 x 135
Warp abrasion	689	286
Tear, grams	1,365 x 545	1,090 x 500

It can be seen from the above data that fabric treated by the present process demonstrates substantially better tensile, tear and abrasion properties.

In the conventional process referred to above, a total of 16% methylolated triazine resin was applied from aqueous solution by padding, drying to a moisture content of 6% by heating at 290° F. for 20 seconds followed by curing at 350° F. for 5 minutes. In the process illustrative of the present invention used in this example, 6% of the same triazine resin was applied from aqueous solution, followed by drying at 290° F., then curing at 350° F. for about 1.0 minute, mercerizing with caustic soda (13–19%) for about 50 seconds, application of about 8% Rhoplex HA–8 acrylic followed by drying at 325° F. for 20 seconds, adding 10% of the same triazine resin as before and drying. Both samples were cured after the final dry for five minutes at 350° F. The fabrics subjected to the treatments indicated were prepared for processing by singeing, desizing, washing and mercerizing in caustic soda (30–43° TW) for about 30 seconds before the first resin application.

EXAMPLE II

The following data shows the effects of various steps of the present process on the physical properties of an all-cotton woven fabric. This fabric was processed in the manner shown in Example I with the intention of curing after the fabric was made into a garment. Data is given for tensile strength, abrasion resistance, dry and wet wrinkle recovery and tear strength after each of steps (a) to (e) referred to above.

It should be noted that the sample which was processed with step (d), i.e. pre-treated with the acrylic polymer (HA–8) prior to finishing demonstrated much greater abrasion retention and increased wet and dry wrinkle recovery when compared with the sample finished without this pre-treatment but otherwise similarly processed.

The data in this example also shows that after the first resin application, step (b), both the dry and wet wrinkle recovery were improved and the tensile strength lowered. After the caustic treatment step (c), the dry wrinkle recovery was reduced to the original dry recovery of the prepared fabric although the wet wrinkle recovery was not affected. On the application of the final finish, a significant increase in dry recovery was achieved. The tensile strength of the fabric was well within commercial acceptance, the abrasion, tear strength and stabilization were outstanding and an excellent wash and wear appearance rating (indicated by the reference standard 5) was achieved.

TABLE II

	Tensile	Abrasion	Dry wrinkle recovery, degrees	Wet wrinkle recovery, degrees	Trapezoid tear, lbs.
After step (a)	54 x 60	3,353	65 x 71	93 x 93	6.2 x 7.4
After step (b)	55 x 63	1,199	94 x 104	95 x 95	4.0 x 6.0
After step (c)	59 x 70	697	80 x 72	98 x 102	4.2 x 7.4
After step (d)	64 x 73	754	95 x 93	103 x 106	5.3 x 7.2
After step (e)	47 x 43	813	148 x 145	137 x 133	2.9 x 3.2
Processed without step (d)	45 x 43	261	122 x 130	111 x 117	3.0 x 3.2

EXAMPLE III

This example shows the effects of the present process as carried out in Example I on the physical properties and durable crease for several different polyester/cotton blend fabrics.

TABLE III

	Dacron polyester/ cotton 65/35	Dacron polyester/ cotton 50/50	Fortrel polyester/ cotton 50/50	Blue C polyester/ cotton 50/50
Tensile	265 x 141	173 x 87	59 x 83	41 x 33
Dry wrinkle recovery (Monsanto degrees)	136 x 136	135 x 135	144 x 143	138 x 139
Tear, grams	3,392 x 1,856	2,752 x 2,432	1,856 x 1,344	
Warp abrasion	2,000+	2,000+	2,000+	1,390+
Wash/wear appearance	Excellent	Excellent	Excellent	Excellent
Crease appearance	Excellent	Excellent	Excellent	Excellent
Shrinkage (after 5 launderings)	.83 x 0	.83 x 0	0 x .83	.72 x .83

As can be seen from this data, the physical properties, as well as the wash and wear and crease appearance characteristics of each of the indicated blend fabrics, were excellent.

EXAMPLE IV

The following data summarizes the results of a series of trials on the same fabric using the process of the present invention as described in Example I. The fabric used in all instances was an all-cotton woven fabric having a construction of 86 picks x 56 ends. The tabulated data shows the reproducibility of the results obtained with the present process.

TABLE IV

	Tensile strength	Monsanto crease recovery angle	Fabric W/W appearance
	62 x 38	139 x 134	5.0
	73 x 46	132 x 129	5.0
	71 x 44	131 x 134	5.0
	73 x 39	131 x 127	5.0
	56 x 39	135 x 133	5.0
	57 x 36	145 x 145	5.0
	63 x 38	137 x 135	5.0
	63 x 37	141 x 137	5.0
	67 x 38	147 x 140	5.0
	68 x 40	149 x 142	5.0
Average	65.30 x 39.50	139 x 136	5.0

EXAMPLE V

The following data summarizes the results of a series of trials on the same fabric using the present process as described in Example I. The fabric used in all instances was an all-cotton fabric having a construction of 68 picks x 40 ends.

TABLE V

	Tensile strength	Monsanto crease recovery angle	Fabric W&W appearance
	46 x 35	144 x 134	5.0
	38 x 38	138 x 138	5.0
	41 x 35	140 x 136	5.0
	37 x 35	143 x 138	5.0
	38 x 31	134 x 138	5.0
	37 x 33	145 x 143	5.0
	38 x 36	137 x 140	5.0
	44 x 38	141 x 139	5.0
	43 x 34	139 x 136	5.0
	38 x 33	136 x 143	5.0
Average	40.00 x 34.80	140 x 139	5.0

EXAMPLE VI

The following example shows a further novel effect of this process. A conventional wash and wear finished all-cotton fabric (i.e. fabric treated with melamine resin, dried, cured, washed, dried and sanforized), was mercerized, neutralized, washed and dried at 325° F., followed by the application of 12% resin (namely methylolated triazine/cyclic ethylene urea resin) and catalyst (magnesium chloride) followed by drying at 290° F., sanforizing, and finally curing for eighteen minutes at 325° F., to give a fabric having excellent wash and wear characteristics and permanent creasing properties as follows:

TABLE VI

	Trial I	Trial II
Construction	114 x 68	114 x 68
Tensile	140 x 112	150 x 118
Crease angle	124 x 146	148 x 131
Tear	2,850 x 2,752	2,368 x 2,688
Abrasion	2,000+	2,000+
Shrinkage in curing (no wash)	.28 x .00	1.11 x .56
Shrinkage after curing (5 washes)	.00 x .00	.56 x .00
Trouser appearance (5 washes)	Excellent	Excellent
Crease appearance (5 washes)	Excellent	Excellent

Various modifications may be made in the invention described herein. For example, as indicated, the invention is applicable to 100% cotton fabric or fabric blends of cotton or other cellulosic fibers, with polyester or other synthetic fibers. Usually, the blends will contain at least about 20–25% cellulosic fiber. By the reference to blends, it is intended to cover the case where the cellulosic fiber is intimately blended with the other fiber to make a composite spun yarn and also the case where separate cellulosic and synthetic yarns are used. Other variations will also be apparent. Hence, the scope of the invention is defined in the following claims.

We claim:

1. In a process for finishing a cellulosic fabric by the application of a textile finishing thermosetting resin, followed by drying and curing, the improvement which comprises first applying only part of the thermosetting resin to the fabric, drying and curing; thereafter treating the fabric with caustic whereby said fabric is mercerized or causticized, neutralizing and drying said fabric; then applying a thermoplastic resin to said fabric and thereafter applying the rest of the thermosetting resin to the fabric and drying.

2. The process of claim 1 wherein the fabric as subjected to said first thermosetting resin application has been previously mercerized.

3. The process of claim 2 wherein said fabric is 100% cotton.

4. The process of claim 2 wherein said fabric comprises a blend of polyester and cotton fibers.

5. The process of claim 1 wherein from 5–95% of the total thermosetting resin added to the fabric is applied in the first resin application.

6. The process of claim 1 wherein after the second resin application and drying, the resin is cured.

7. The process of claim 6 wherein a garment is formed from said fabric and a crease is pressed therein between drying after the second resin application and said curing.

8. The process of claim 1 wherein the thermosetting resin in each application is partially cured during drying.

9. The process of claim 1 wherein the fabric is prepared, before the first resin application, by desizing, washing and mercerizing.

10. The process of claim 1 wherein the thermosetting resin is a water-soluble methylolated textile finishing resin applied from aqueous solution and the thermoplastic resin is an acrylic polymer.

11. The fabric obtained by the process of claim 1.

12. The process of claim 1 wherein drying is carried out at a temperature between 250° F. and 350° F. until the fabric is dry and curing is carried out at a temperature of 300° F. to 375° F. for from 1.5 to 0.5 minutes, the textile finishing thermosetting resin being selected from the group consisting of methylol triazones, triazines, urons, urea formaldehyde precondensates and melamine formaldehyde precondensates.

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