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PROCESS FOR IMPARTING WASH AND WEAR PROPERTIES TO CELLULOSE-CONTAINING TEXTILE FABRIC AND RESULTING PRODUCT

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This invention relates, in general, to textile fabrics possessing wash and wear properties. More particularly, this invention relates to a process for treating cellulose and cellulose-containing textile fabrics with textile treating solutions comprising polyepoxides and certain aldehyde-reactive compounds, whereby the said textile fabrics are rendered crease resistant with a minimum loss of strength and abrasion resistance, and to the textile products produced thereby.

The more recent developments of new finishes for imparting wash and wear characteristics to cellulose and cellulose-containing fabrics have been directed to the polyepoxides which can be applied to the fabrics in various aqueous or emulsified forms and thereafter cured within the fibers by means of an epoxy curing catalyst. Fabrics which have been so treated exhibit a high level of crease recovery as well as other wash and wear properties. Although these new finishes are an improvement over the more commonly used nitrogen-containing finishes, certain of the deficiencies remain. It has been noted that while these finishes impart excellent shape-holding properties to the fabric, their application, in common with the conventional nitrogen-containing finishes, is accompanied by a decrease in the strength of the treated fabric to a point substantially below that of the untreated fabric. It is not uncommon, in some instances, for a loss in fabric strength of as high as 60 percent, or more, to accompany the application of the finish. Inasmuch as the strength of the treated fabric is less than its untreated counterpart, it is usually necessary, in certain applications, to employ a stronger fabric to compensate for the anticipated loss. This not only results in a heavier, more expensive and less attractive material but prevents the use of the lighter weight and more fashionable fabrics frequently in demand.

It is an object of this invention to provide an improved process for the treatment of cellulose and cellulose-containing textile fabrics wherein the disadvantages previously indicated are substantially eliminated. Another object is to provide wash and wear fabrics having improved breaking strengths. A further object of the present invention is to provide an improved process for rendering textile fabrics crease resistant with a minimum loss of strength. A still further object of this invention is to provide an improved process for rendering textile fabrics crease resistant with a minimum loss of abrasion resistance. Yet another object is to provide textile fabrics having wash and wear characteristics which are durable to conventional laundering techniques and having improved tensile strength, tear strength, and abrasion resistance. Other objects and advantages of the invention will be apparent from the following detailed description and appended claims.

It has now been discovered that the loss in strength and abrasion resistance that cellulose and cellulose-containing textile fabrics undergo when subjected, for the purpose of imparting wash and wear properties thereto, to the conventional process of impregnation with a textile treating solution containing a polyepoxide can be markedly decreased by incorporating in the textile treating solution a

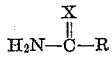
minor amount of an aldehyde-reactive compound of the group hereinafter disclosed. Accordingly, the present invention provides an improved process, whereby wash and wear properties can be imparted to cellulose and cellulose-containing textile fabrics with a minimum loss of strength and abrasion resistance, which comprises impregnating the textile fabric with a polyepoxide, an epoxy curing catalyst, and a minor amount, sufficient to enhance the strength and abrasion resistance of the treated fabric, of an aldehyde-reactive compound, and thereafter heating the textile fabric to cure the polyepoxide within the fibers thereof and thereby impart the wash and wear properties.

The term "cellulose and cellulose-containing textile fabrics" as used throughout the specification and claims is intended to include fabrics, whether woven or knitted, and garments or other articles made from such fabrics. Fabrics containing cellulose, regenerated cellulose, and mixtures of the two are intended to be within the scope of the present invention. Illustrative of the textile fabrics to which this invention relates are cotton fabrics, linen fabrics, rayon fabrics, fabrics consisting of blends of cotton, linen or rayon fibers, and fabrics consisting of blends of cellulosic fibers and non-cellulosic fibers, such as, for example, the ethylene glycol terephthalic acid polyester fibers, wherein the cellulosic fibers comprise the major portion of the fabric.

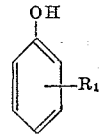
The textile treating solution that is employed in the process of this invention contains as the essential components thereof a polyepoxide, or mixture of polyepoxides, that imparts the desired wash and wear properties to the textile fabric, an epoxy curing catalyst, and an aldehyde-reactive compound, or mixture of such compounds, that minimizes the detrimental effect of the polyepoxide upon the strength and abrasion resistance of the textile fabric. The polyepoxides that are employed in the treatment of textile fabrics are well known to the art; they can be monomeric or polymeric materials, of aliphatic, cycloaliphatic, aromatic or heterocyclic type. Polyepoxides composed solely of carbon, hydrogen and oxygen are most commonly employed, but polyepoxides substituted with non-interfering substituents such as chlorine atoms can also be used. Typical of the many polyepoxides that are capable of imparting wash and wear properties to cellulose and cellulose-containing textile fabrics, and are thus of utility in the process of this invention, are, among others, the polyepoxy-substituted hydrocarbons such as vinylcyclohexene dioxide, butadiene dioxide, 2,3,5,6-diepoxyoctane, 2,3,6,7-diepoxydodecane, 2,2-bis(epoxycyclohexyl)propane, and the like; the ethers of polyepoxy-substituted alkanols and cycloalkanols such as bis(2,3-epoxycyclopentyl)ether, glycidyl ether of 2,3-epoxycyclohexanol, epoxybutyl ether of 2,3-epoxycyclohexanol 1,4-bis(2,3 - epoxypropoxy)benzene, 1,3 - bis(2,3 - epoxypropoxy)benzene, 1,3-bis(4,5-epoxypentoxy) - 5 - chlorobenzene, 1,4 - bis(2,3 - epoxypropoxy)butane, 1,1,3-tris(2,3-epoxypropoxy)butane, 1,4,bis(3,4 - epoxypropoxy)cyclohexane, diglycidyl ether of glycerol, diglycidyl ether of ethylene glycol, diglycidyl ether of diethylene glycol, bis-(2,3-epoxy-2-methylpropyl)ether, ethylene glycol bis(2,3-epoxy-2-methylpropyl)ether, diethylene glycol bis(2,3-epoxy-2-methylpropyl)ether, propylene glycol bis(2,3-epoxy-2-methylpropyl)ether, trimethylene glycol bis(2,3-epoxy - 2 - methylpropyl)ether, 1,4 - butanediol bis(2,3-epoxy - 2 - methylpropyl)ether, 1,5-pentanediol bis(2,3-epoxy-2-methylpropyl)ether, and the like; and the bis-(epoxyalkoxy)dioxanes such as 2,3-bis(2,3-epoxypropoxy)-1,4-dioxane, 2,5-bis(2,3-epoxypropoxy)1,4 - dioxane, 2,3-bis(2-methyl-2,3-epoxypropoxy) - 1,4 - dioxane, 2,5-bis(2-methyl-2,3-epoxypropoxy)-1,4-dioxane, 2,3-bis-(3,4-epoxybutoxy)-1,4-dioxane, 2,5-bis(3,4-epoxybutoxy)-1,4-dioxane, 2,3-bis(3-methyl-3,4-epoxybutoxy)-1,4-diox-

ane, 2,5-bis(3-methyl-3,4-epoxybutoxy)-1,4-dioxane, 2,3-bis(4,5-epoxypentoxy)-1,4-dioxane, 2,5-bis(4,5-epoxypentoxy)-1,4-dioxane, 2,3-bis(4-methyl-4,5 - epoxypentoxy)-1,4-dioxane, and the like.

The aldehyde-reactive compounds that are added to the textile treating solution in accordance with this invention are compounds that are capable of reacting with the carbonyl group of aldehydes. The aldehyde-reactive compounds that have been found to be of utility in the present invention are compound selected from the group consisting of: (1) primary amides of the formula:



wherein X is independently selected from the group consisting of an oxygen atom and a sulfur atom and R is independently selected from the group consisting of an amino group, a lower alkylamino group (preferably of 1 to 4 carbon atoms), a lower dialkylamino group (preferably of 1 to 4 carbon atoms in each alkyl radical), a lower alkoxy group (1 to 8 carbon atoms), and a phenoxy group, such as, for example, urea, thiourea, methylurea, 1,1 - dimethylurea, 1 - methyl-1-butylurea, 1,1 - diethylthiourea, methyl carbamate, ethyl carbamate, isopropyl carbamate, n-butyl carbamate, 2-ethylhexyl carbamate, phenyl carbamate, and the like; (2) alkali metal bisulfites such as lithium bisulfite, sodium bisulfite and potassium bisulfite; (3) phenols of the formula:



wherein R_1 is selected from the group consisting of a hydrogen atom, a methyl group and a hydroxyl group, such as, for example, phenol, o-cresol, p-cresol, catechol, resorcinal, and the like; (4) dihydric alcohols of the formula:

$$HO—(C_nH_{2n}—O)_m—H$$

wherein m is an integer having a value of 1 to 4 and n is an integer having a value of 2 to 6, such as, for example, ethylene glycol, propylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, trimethylene glycol, tetramethylene glycol, pentamethylene glycol, hexamethylene glycol, and the like; (5) guanidine; (6) dicyandiamide; (7) hydroxylamine; and (8) hexamethylene tetramine.

Addition of one or more of the above-described aldehyde-reactive compounds to the textile treating solution in the conventional process for treatment of cellulose and cellulose-containing textile fabrics with polyepoxides has been found to result in a treated fabric exhibiting marked improvement in one or more of the physical characteristics of tensile strength, tear strength and abrasion resistance, as compared with a fabric treated with a polyepoxide without the benefit of the addition of the aldehyde-reactive compound, yet to have little or no derimental effect on the wash-wear characteristics and crease recovery of the treated fabric. Furthermore, an additional benefit is realized by the use of the aldehyde-reactive compounds in the manner described herein in that, in certain instances, the undesirable odor that may be imparted to textile fabrics by the conventional polyepoxide treatment is minimized.

The amount of polyepoxide to be applied to the textile fabric will depend upon the nature of the particular fabric and its intended application, but is normally an amount sufficient to give a wash and wear rating of 3 to 5 as hereinafter indicated. The optimum amount of the aldehyde-reactive compound is dependent upon such factors as the particular compound and polyepoxide utilized, the amount of polyepoxide employed, the epoxy curing catalyst employed and the amount thereof, and the nature of the fabric being treated, and can be readily determined by one with ordinary skill in the art by means of a few routine experiments. In general, the greater the amount of aldehyde-reactive compound employed the less the loss of strength and abrasion resistance due to treatment with the polyepoxide. However, the amount of aldehyde-reactive compound should not be too large if the full effectiveness of the polyepoxide in improving the wash-wear properties and crease resistance of the fabric is to be realized. The epoxy curing catalyst can be applied to the fabric by spraying or other suitable methods after the fabric has been impregnated with the textile treating solution, but is preferably added to the textile treating solution, along with the polyepoxide and the aldehyde-reactive compound, before it is applied to the fabric.

More specifically, the process of this invention comprises impregnating a cellulose or cellulose-containing textile fabric with about 0.5 to about 30 percent, preferably about 2 to about 20 percent, based on the weight of the textile fabric, of a polyepoxide capable of imparing wash and wear properties thereto, about 0.05 to about 10 percent preferably about 0.5 to about 5 percent, based on the weight of the textile fabric, of an epoxy curing catalyst, and about 0.05 to about 1.5 percent, preferably about 0.1 to about 1 percent, based on the weight of the textile fabric of an aldehyde reactive compound as hereinbefore disclosed and thereafter heating the textile fabric to cure the polyepoxide within the fibers thereof and thereby impart the wash and wear properties.

The application of the textile treating solution to the textile fabric may be accomplished in any suitable manner as by dipping or by running the fabric through conventional-type padding rollers. Preferably, the textile treating solution is an aqueous medium. Thus, the solvent component of the textile treating solution can be water, mixtures of water and emulsifying agents, or mixtures of water and organic solvents that are miscible with water. Certain of the polyepoxides that are commonly employed in treating textile fabrics, for example, the diglycidyl ether of glycerol, are not easily dispersed in an aqueous treating bath to give a homogeneous solution because of a low degree of water solubility; while other polyepoxides, for example, 2,3-bis(2,3-epoxypropoxy)-1,4-dioxane, are almost fully miscible with water at ordinary temperatures so that organic solvents or emulsifying agents are not necessary in preparing the textile treating solution. Among the emusifying agents and organic solvents which can be employed if required are methylcellulose, hydroxyethylcellulose, carboxymethylcellulose, sodium alginate, polyvinyl alcohol, polyethylene oxide, toluene, xylene, the lower aliphatic alcohols such as ethyl alcohol, butyl alcohol, isopropyl alcohol, acetone, esters, and the like. The concentration of emulsifying agents is not necessarily critical and can vary in amount from about 0.1 to 25 percent by weight of the treating solution. In addition to the aforementioned polyepoxides, epoxy curing catalysts, aldehyde-reactive compounds, emulsifying agents, and organic solvents, the textile treating solution can contain nitrogeneous textile resins, plasticizers, natural resins, textile softening agents, stabilizers, and the like.

The textile fabric can be immersed in a treating bath containing the appropriate concentration of polyepoxide, epoxy curing catalyst, and aldehyde-reactive compound to give the concentrations in the impregnated fabric hereinbefore disclosed and then passed through a squeeze roller. A second immersion and squeezing can be effected if necessary, leaving the fabric impregnated with about 50 to about 120 percent of its own weight of treating solution, i.e., a wet pick-up of about 50 to about 120 percent. It is generally desirable where solubility limitations permit, to employ the higher concentrations of polyepoxide in the treating solution and to operate with a relatively low wet pick-up, as this means that only relatively small

amounts of water need be removed from the treated fabric in the subsequent drying and curing stages of the process and consequently speeds up the operation.

The epoxy curing catalysts employed in the process of this invention are the so called "acid-acting" epoxy curing catalysts which include not only acids but compounds capable of acting as acids, such as acidic salts, Lewis acids, and the like. Such catalysts are well known to the art and include, among others, such compounds as the fluoborates of magnesium, tin, cadmium, and sodium as well as zinc; boron trifluoride etherate, stannic chloride, boris acid, the alkane sulfonic acids, aluminum chloride, hydrochloric acid, phosphoric acid, oxalic acid, magnesium chloride, sodium sulfate, zinc sulfate, aluminum sulfate, and the like. A preferred epoxy curing catalyst in the process of this invention is zinc fluoborate.

Following the application of the textile treating solution, the fabric is usually dried at an elevated temperature to remove water. While drying can be accomplished by simply allowing the fabric to remain in contact with air at ambient temperature, it is preferred to dry the fabric at a temperature of from about 100° F. to about 325° F. for a period of about 0.2 to about 5 minutes, the higher temperatures generally being employed in conjunction with the shorter drying times.

Following drying, the fabric is "cured" by heating at a temperature sufficient to promote the reaction of the polyepoxide with the fabric so as to bind it chemically thereto, and thereby impart the wash and wear properties. The curing can be carried out at temperatures from about 150° F. to about 400° F., for periods ranging from about 15 seconds to about 15 minutes, more preferably from about 275° F. to about 350° F. for periods ranging from about 0.5 to about 2.5 minutes, with the higher temperatures generally being employed in conjunction with the shorter heating times. After the curing step, the fabric can be scoured, for example, by washing in hot water containing a small quantity of detergent, to remove unreacted material from the fabric and then dried.

Subjecting the treated textile fabric to a two-step procedure, involving a drying period at an elevated temperature followed by a curing period at a somewhat higher temperature as hereinbefore described, is preferred, but is not a critical feature of the processs of this invention. Thus, for example, both drying and curing could be accomplished in a single step wherein the fabric, following impregnation with the treating solution, is heated at 275° F. to 300° F., or thereabouts, for a period of several minutes.

Evaluation of the textile fabrics subjected to the process of this invention was made in accordance with accepted test procedures of the ASTM (American Society For Testing Materials), or the AATCC (American Association of Textile Chemists and Colorists), or by procedures that are fully described herein. The following tests were conducted:

Wash-wear rating.—Determined by AATCC Tentative Test Method 88–1960T. The rating, which is indicative of the smoothness of appearance of the fabric, ranges from 1 to 5 with intermediate ratings indicated by + and − symbols.

Crease recovery.—Measured by AATCC Tentative Test Method 66–1959T.

Tear strength.—Measured by ASTM D1424–56T.

Tensile strength.—Measured by ASTM D39–49 (Grab test).

Abrasion reisstance.—Measured by ASTM D1175–55T (b) using one-half pound head weight and two pound tension weight.

Odor.—Samples of unwashed fabric were wet with distilled water and the odor rated by a test panel employing the following ratings; none, very slight, slight, moderate, severe.

In the following illustrative examples all compositions are given in percent by weight unless specifically indicated as being otherwise.

Example 1

A sample of desized, scoured, bleached and mercerized cotton printcloth having a thread count of 80 x 80, and designated herein as sample B, was immersed in a textile treating solution consisting of 13.7 percent 2,3-bi(2,3-epoxypropoxy)-,4-dioxane, 2.5 percent zinc fluoborate, 0.3 percent urea, 0.1 percent Tergitol TMN (trademark for a trimethyl nonyl ether of polyethylene glycol), 0.3 percent zinc oxide, 1.2 percent Fabritone PE (a commercial softener composed of emulsified polyethylene wax of 30% solids content) and the remainder water, and padded on a laboratory padder using a single nip to a wet pick-up of 80 percent. The wet fabric was then placed on a pin tenter frame, dried in an oven for 1.5 minutes at 300° F., and cured for 1.25 minutes at 350° F.

Two additional samples of the same cotton fabric, designated herein as samples A and C, were subjected to an identical process except that the treating solution contained no urea and 0.6 percent urea, respectively. The properties exhibited by fabric samples A through C are summarized in Tablet I below, along with the properties of the untreated cotton printcloth for comparison purposes.

TABLE I

	Untreated Fabric	Sample A	Sample B	Sample C
Wash-Wear Rating:				
Spin Dry	1	4−	4+	4−
Tumble Dry	1	4+	5−	4+
Crease Recovery (degrees):				
Dry	178	283	286	284
Wet	----------	279	287	285
Tear Strength (grams):				
Warp	800	370	430	560
Filling	750	240	270	370
Tensile Strength (pounds):				
Filling	64	22	26	32
Abrasion Resistance (cycles):				
Warp	3,033	165	313	539
Filling	4,141	301	544	867

Consideration of the above results indicates that fabric samples B and C, which were treated with a solution containing urea, exhibited significantly higher tear strength, tensile strength, and abrasion resistance as compared to Sample A, while the wash-wear ratings and crease recovery values were comparable.

Example 2

Samples of mercerized cotton printcloth, having a thread count of 80 x 80, were immersed in textile treating solutions of the compositions set forth in Table IIA below and padded on a laboratory padder to a wet pick-up of 80 percent.

TABLE IIA

Treating Solution	Sample				
	A	B	C	D	E
Vinylcyclohexene dioxide (Percent)	12.5	12.5	12.5	12.5	12.5
Carbowax 20-M (Percent)[1]	1.25	1.25	1.25	1.25	1.25
Zinc oxide (Percent)	0.3	0.3	0.3	0.3	0.3
Zinc fluoborate (Percent)	1.88	1.88	1.88	1.88	1.88
Tergitol NPX (Percent)[2]	0.1	0.1	0.1	0.1	0.1
Fabritone PE (Percent)	1.25	1.25	1.25	1.25	1.25
Urea (Percent)	--------	0.3	0.6	1.2	1.8

[1] Trademark for a solid polyethylene glycol.
[2] Trademark for a nonyl phenyl polyethylene glycol ether.

The wet fabric samples were then placed on pin tenter frames, dried in an oven for 1.5 minutes at 300° F. and cured for 1.25 minutes at 350° F.

The properties exhibited by fabric samples A through E are summarized in Table IIB below along with the properties of the untreated printcloth for comparison purposes.

TABLE IIB

	Untreated Fabric	Sample				
		A	B	C	D	E
Wash-Wear Rating:						
Tumble Dry		4	4	4+	4−	3+
Spin Dry		3−	2+	2+	3+	2+
Crease Recovery (degrees): Dry	142	250	246	247	232	210
Tear Strength (grams):						
Warp	950	540	580	580	700	800
Filling	830	290	420	450	540	620
Tensile Strength (pounds): Filling	65	26	30	35	37	41
Odor, Dry	(1)	(2)	(2)	(3)	(1)	(3)

[1] None. [2] Moderate. [3] Slight.

Consideration of the above results indicates that samples B, C, D and E, which were treated with solutions containing urea, exhibited significantly higher tear strength and tensile strength as compared to sample A, while the wash-wear ratings and crease recovery values were generally comparable, optimum results with regard to the latter being obtained with samples B and C which utilized the lower concentrations of urea. Furthermore, the undesirable odor was, in some instances, substantially reduced by the addition of urea.

Example 3

Samples of a cotton printcloth having a thread count of 80 x 80 were immersed in textile treating solutions of the compositions set forth in Table IIIA below and padded on a laboratory padder to a wet pick-up of 80 percent.

TABLE IIIA

Treating Solution	Sample									
	A	B	C	D	E	F	G	H	I	J
Diglycidyl ether of glycerol (Percent)	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Zinc Fluoborate (Percent)	0.76	0.76	0.76	1.24	1.24	1.24	1.24	2.5	2.5	2.5
Urea (Percent)	0	0.25	0.5	0	0.3	0.6	1.2	0	0.6	1.2
Polyvinyl alcohol (Percent)	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Fabritone PE (Percent)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Tergitol TMN (Percent)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Water (Percent)	Remainder									

The wet fabric samples were then placed on pin tenter frames, dried in an oven for 1.5 minutes at 300° F., and cured for 1.25 minutes at 350° F.

The properties exhibited by fabric samples A through J are summarized in Table IIIB below, along with the properties of the untreated cotton printcloth for comparison purposes.

TABLE IIIB

Sample	Dry Crease Recovery (degrees)	Tear Strength (grams)		Tensile Strength Filling (lbs.)
		Warp	Filling	
Untreated Fabric	142	940	830	65
A	252	580		27
B	248	670	450	32
C	228	780	580	42
D	256	480	340	25
E	252	620	450	31
F	221	750	580	36
G	222	660	480	43
H	257	340	220	17
I	253	590	380	22
J	245	540	370	37

Consideration of the above results indicates that the fabric samples treated with a solution containing urea exhibited significantly higher tear strength and tensile strength as compared with fabric samples treated with a solution containing the same concentration of polyepoxide and epoxy curing agent but no urea.

Example 4

Samples of mercerized cotton printcloth were immersed in textile treating solutions of the compositions set forth in Table IVA below and padded on a laboratory padder to a wet pick-up of 75 percent.

TABLE IVA

Treating Solution	Sample				
	A	B	C	D	E
2,3-bis(2,3-epoxypropoxy)-1,4-dioxane (percent)	16.0	16.0	16.0	16.0	16.0
Carbowax 20-M (percent)	2.6	2.6	2.6	2.6	2.6
Tergitol TMN (percent)	0.3	0.3	0.3	0.3	0.3
Zinc fluoborate (percent)	2.6	2.6	2.6	2.6	2.6
Fabritone PE (percent)	1.8	1.8	1.8	1.8	1.8
Urea (percent)		0.3	0.6	1.3	2.0

The wet fabric samples were then placed on pin tenter frames, dried in an oven for 1.25 minutes at 300° F. and cured for 1.25 minutes at 320° F.

The properties exhibited by fabric samples A through E are summarized in Table IVB below along with the properties of the untreated cotton printcloth for comparison purposes.

TABLE IVB

	Untreated Fabric	Sample				
		A	B	C	D	E
Wash-Wear Rating:						
Tumble Dry		4+	4+	4+	4	3−
Spin Dry		4	4	4	3+/4−	3+/4−
Crease Recovery (degrees): Dry		285	283	285	272	217
Tear Strength (grams):						
Warp	580	360	450	500	590	640
Filling	640	360	430	460	510	620
Tensile Strength (pounds): Filling	58	21	27	31	37	45

Consideration of the above results indicates that samples B, C, D, and E, which were treated with solutions containing urea, exhibited significantly higher tear strength and tensile strength as compared to sample A, while the wash-wear ratings and crease recovery values were generally comparable, optimum results with regard to the latter being obtained with samples B and C which utilized the lower concentrations of urea.

Examples 5 to 14

Samples of cotton printcloth having a thread count of 80 x 80 were immersed in textile treating solutions containing different aldehyde-reactive compounds of the group hereinbefore disclosed and padded on a laboratory padder to a wet pick-up of 80 percent. In each case, the treating solution contained 12.5% vinylcyclohexene dioxide, 0.75% zinc fluoborate, 0.63% of the aldehyde-reactive compound, 0.38% zinc oxide, and 0.1% Tergitol NPX (trademark for a nonyl phenyl polyethylene glycol ether). The wet fabric samples were then placed on pin tenter frames, dried in an oven at 150° F. for 1.5 minutes, and cured at 175° F. for 1.25 minutes.

The properties exhibited by the fabric samples are summarized in Table V below, along with the properties of the untreated cotton printcloth, and the sample treated with the polyepoxide but without the benefit of the addition of the aldehyde-reactive compound to the treating solution for comparison purposes.

TABLE V

Example No.	Aldehyde-reactive Compound	Wash and Wear Rating		Crease Recovery, degrees	Tensile Strength (lbs.), Filling	Tearing Strengths (g.)		Odor	
		Tumble dry	Spin dry			Warp	Filling	Dry	Wet
Untreated Fabric				158	38	780	400	None	None.
Treated fabric	None	4—	3—	245	17	400	170	Moderate	Severe.
5	Urea	4—	3—	243	20	500	210	None	Moderate-Severe.
6	Sodium bisulfite	4—	3+	248	20	530	210	do	Do.
7	Hydroxylamine	4—	4—	248	18	430	210	Very Slight	Do.
8	Ethylene glycol	4—	3+	251	19	450	180	Slight	Severe.
9	Thiourea	4—	3—	242	22	510	240	Severe	Do.
10	Ethyl carbamate	4—	3+	250	21	370	180	Very Slight	Do.
11	Hexamethylene tetramine.	4—	2+	251	22	500	220	Slight-Moderate.	Do.
12	Dicyandiamide	4—	3+	241	21	450	210	Slight	Do.
13	Phenol	4—	3+	256	18	500	160	None	Moderate.
14	Guanidine	4—	2	239	18	480	210	Very Slight	Severe.

Consideration of the above results indicates that the fabric samples which were treated with a solution containing an aldehyde-reactive compound as disclosed herein exhibited tear strength and tensile strength values that were generally considerably higher than those of the fabric sample treated with the same solution except that the aldehyde-reactive compound was lacking, while the wash and wear properties were comparable.

Example 15

Samples of mercerized cotton oxford fabric, having a thread count of 88 x 59, were immersed in textile treating solutions of the compositions set forth in Table VIA below and padded on a laboratory padder to a wet pick-up to 70 percent.

TABLE VIA

Treating Solution	Sample		
	A	B	C
2, 3-bis(2, 3-epoxypropoxy)-1, 4-dioxane (percent)	4.3	4.3	4.3
Carbowax 20-M (percent)	1.0	1.0	1.0
Zinc oxide (percent)	0.3	0.3	0.3
Tergitol TMN (percent)	0.1	0.1	0.1
Zinc fluoborate (percent)	1.08	1.08	1.08
Fabritone PE (percent)	1.43	1.43	1.43
Urea (percent)		0.36	0.72

The wet fabric samples were then placed on pin tenter frames, dried in an oven for 1.5 minutes at 300° F. and cured for 1.0 minutes at 350° F.

The properties exhibited by fabric samples A through C are summarized in Table VIB below along with the properties of the untreated cotton oxford fabric for comparison purposes.

TABLE VIB

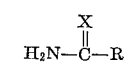
	Untreated Fabric	Sample		
		A	B	C
Crease Recovery (degrees): Dry	173	226	222	222
Tear Strength (grams):				
Warp	1,030	960	1,490	2,080
Filling	1,750			
Tensile Strength (pounds): Filling	52	26	35	41

Consideration of the above results indicates that samples B and C, which were treated with solutions containing urea, exhibited significantly higher tear strength and tensile strength as compared with sample A, with no significant difference among the three samples with respect to crease recovery.

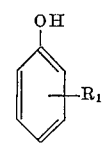
Various changes and modifications can be made in practicing the present invention without departing from it and therefor it is intended to include in the scope of the appended claims all such modifications and variations as may be apparent to those skilled in the art from the description and illustrative examples given herein.

What is claimed is:

1. A process for imparting wash and wear properties to cellulose and cellulose-containing textile fabrics with minimum loss of strength and abrasion resistance which comprises applying to the said textile fabric about 0.5 percent to about 30 percent, based on the weight of the said textile fabric, of a polyepoxide capable of imparting wash and wear properties thereto, about 0.05 percent to about 10 percent, based on the weight of the said textile fabric, of an acid-acting epoxy curing catalyst and about 0.05 percent to about 1.5 percent, based on the weight of said textile fabric, of an aldehyde-reactive compound selected from the group consisting of (1) primary amides of the formula:



wherein X is independently selected from the group consisting of an oxygen atom and a sulfur atom and R is independently selected from the group consisting of an amino group, a lower alkylamino group, a lower dialkylamino group, a lower alkoxy group, and a phenoxy group, (2) alkali metal bisulfites, (3) phenols of the formula:

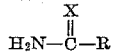


wherein R_1 is selected from the group consisting of a hydrogen atom, a methyl group, and a hydroxyl group, (4) dihydric alcohols of the formula:

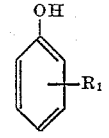
$$HO—(C_nH_{2n}—O)_m—H$$

wherein m is an integer having a value of 1 to 4 and n is an integer having a value of 2 to 6, (5) guanidine, (6) dicyandiamide, (7) hydroxylamine, and (8) hexamethylene tetramine, and thereafter heating the said textile fabric to cure the said polyepoxide within the fibers thereof and thereby impart the wash and wear properties.

2. A process for imparting wash and wear properties to cellulose and cellulose-containing textile fabrics with minimum loss of strength and abrasion resistance which comprises applying to the said textile fabric about 2 percent to about 20 percent, based on the weight of the said textile fabric, of a polyepoxide capable of imparting wash and wear properties thereto, about 0.5 percent to about 5 percent, based on the weight of the said textile fabric, of an acid-acting epoxy curing catalyst, and about 0.1 percent to about 1 percent, based on the weight of said textile fabric of an aldehyde-reactive compound selected from the group consisting of: (1) primary amides of the formula:



wherein X is independently selected from the group consisting of an oxygen atom and a sulfur atom and R is independently selected from the group consisting of an amino group, a lower alkylamino group, a lower dialkylamino group, a lower alkoxy group, and a phenoxy group, (2) alkali metal bisulfites, (3) phenols of the formula:

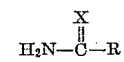


wherein R_1 is selected from the group consisting of a hydrogen atom, a methyl group, and a hydroxyl group, (4) dihydric alcohols of the formula:

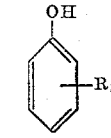
$$HO—(C_nH_{2n}—O)_m—H$$

wherein m is an integer having a value of 1 to 4 and n is an integer having a value of 2 to 6, (5) guanidine, (6) dicyandiamide, (7) hydroxylamine, and (8) hexamethylene tetramine, and thereafter heating the said textile fabric at a temperature of from about 150° F. to about 400° F. for a period of from about 15 seconds to about 15 minutes, the higher temperatures being employed in conjunction with the shorter heating times, to cure the said polyepoxide within the fibers thereof and thereby impart the wash and wear properties.

3. A process for imparting wash and wear properties to cellulose and cellulose-containing textile fabrics with minimum loss of strength and abrasion resistance which comprises impregnating the said textile fabric with an aqueous textile treating solution comprising about 2 percent to about 20 percent by weight of a polyepoxide capable of imparting wash and wear properties to the said textile fabric, about 0.5 percent to about 5 percent by weight of an acid-acting epoxy curing catalyst, and about 0.1 percent to about 1 percent by weight of an aldehyde-reactive compound selected from the group consisting of: (1) primary amides of the formula:



wherein X is independently selected from the group consisting of an oxygen atom and a sulfur atom and R is independently selected from the group consisting of an amino group, a lower alkylamino group, a lower dialkylamino group, a lower alkoxy group, and a phenoxy group, (2) alkali metal bisulfites, (3) phenols of the formula:

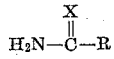


wherein R_1 is selected from the group consisting of a hydrogen atom, a methyl group, and a hydroxyl group, (4) dihydric alcohols of the formula:

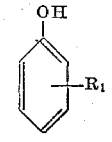
$$HO—(C_nH_{2n}—O)_m—H$$

wherein m is an integer having a value of 1 to 4 and n is an integar having a value of 2 to 6, (5) guanidine, (6) dicyandiamide, (7) hydroxylamine, and (8) hexamethylene tetramine, and thereafter heating the said textile fabric to cure the said polyepoxide within the fibers thereof and thereby impart the wash and wear properties.

4. A process for imparting wash and wear properties to cellulose and cellulose-containing textile fabrics with minimum loss of strength and abraision resistance which comprises impregnating the said textile fabric with an equeous textile treating solution comprising about 2 percent to about 20 percent by weight of a polyepoxide capable of imparting wash and wear properties to the said textile fabric, about 0.5 percent to about 5 percent by weight of an acid-acting epoxy curing catalyst, and about 0.1 percent to about 1 percent by weight of an aldehyde-reactive compound selected from the group consisting of: (1) primary amides of the formula:



wherein X is independently selected from the group consisting of an oxygen atom and a sulfur atom and R is independently selected from the group consisting of an amino group, a lower alkylamino group, a lower dialkylamino group, a lower alkoxy group, and a phenoxy group, (2) alkali metal bisulfites, (3) phenols of the formula:



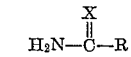
wherein R_1 is selected from the group consisting of a hydrogen atom, a methyl group, and a hydroxyl group, (4) dihydric alcohols of the formula:

$$HO—(C_nH_{2n}—O)_m—H$$

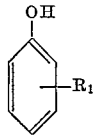
wherein m is an integar having a value of 1 to 4 and n is an integar having a value of 2 to 6, (5) guanidine, (6) dicyandiamide, (7) hydroxylamine, and (8) hexamethylene tetramine, and thereafter heating the said textile fabric at a temperature of from about 150° F. to about 400° F. for a period of from about 15 seconds to about 15 minutes, the higher temperatures being employed in conjunction with the shorter heating times, to cure the said polyepoxide within the fibers thereof and thereby impart the wash and wear properties.

5. A process for imparting wash and wear properties to cellulose and cellulose-containing textile fabrics with minimum loss of strength and abrasion resistance which comprises impregnating the said textile fabric with an aqueous textile treating solution comprising about 2 percent to about 20 percent by weight of a polyepoxide capable of imparting wash and wear properties to the said textile fabric, about 0.5 percent to about 5 percent by weight of an acid-acting epoxy curing catalyst, and about 0.1 percent to about 1 percent by weight of an

aldehyde-reactive compound selected from the group consisting of: (1) primary amides of the formula:



wherein X is independently selected from the group consisting of an oxygen atom and a sulfur atom and R is independently selected from the group consisting of an amino group, a lower alkylamino group, a lower dialkylamino group, a lower alkoxy group, and phenoxy group (2) alkali metal bisulfites, (3) phenols of the formula:



wherein R_1 is selected from the group consisting of a hydrogen atom, a methyl group, and a hydroxyl group, (4) dihydric alcohols of the formula:

$$HO—(C_nH_{2n}—O)_m—H$$

wherein *m* is an integer having a value of 1 to 4 and *n* is an integer having a value of 2 to 6, (5) guanidine, (6) dicyandiamide, (7) hydroxylamine, and (8) hexamethylene tetramine, subsequently drying the said textile fabric at a temperature of about 300° F. for a period of about 1 to 3 minutes, and thereafter heating the said textile fabric at a temperature of about 350° F. for a period of about 1 to 2 minutes to cure the said polyepoxide within the fibers thereof and thereby impart the wash and wear properties.

6. The process of claim **4** wherein the textile fabric is cotton.

7. The process of claim **4** wherein the polyepoxide is vinylcyclohexene dioxide.

8. The process of claim **4** wherein the polyepoxide is 2,3-bis(2,3-epoxypropoxy)-1,4-dioxane.

9. The process of claim **4** wherein the polyepoxide is the diglycidyl ether of glycerol.

10. The process of claim **4** wherein the epoxy curing catalyst is zinc fluoborate.

11. The process of claim **4** wherein the aldehydereactive compound is urea.

12. The process of claim **4** wherein the aldehydereactive compound is sodium bisulfite.

13. A wash and wear textile fabric prepared by the process of claim **1**.

14. A wash and wear textile fabric prepared by the process of claim **4**.

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