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TREATMENT OF TEXTILE MATERIALS WITH ALDEHYDES

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This invention relates to the treatment of textile materials (containing either natural cellulosic fibers such as cotton, linen, hemp, jute or regenerated cellulose, or keratinous fibers such as wool or mixtures of these in various proportions), to reduce their shrinkage and fulling tendencies; and in the case of keratinous and other protein, or modified protein fibers it also relates to their treatment to confer non-felting properties. It also relates to conferring other desirable qualities to textile materials.

The treatment may take place at any stage of the fabric manufacture, namely in the raw stock, skein or in the woven or the knitted piece, provided said fabrics are free or substantially free from all sizing materials such as starch, glue, gums, natural resin compounds, etc.

The normal fabrics made from the aforesaid fibers and mixtures containing the same have a marked yet normal tendency after successive washing and cleaning to shrink in different degrees; this affects the wearability of the fabric. Wool fabrics, upon repeated washings at temperatures of 100° F. to 120° F. shrink sometimes until the fabric felts and becomes unable to be used further.

The shrinkage of natural cellulose fibers may be overcome mechanically, by some such treatment as compressive shrinkage, provided that the fabrics so treated are not subsequently subjected to any tension or stretching process, which would nullify the desired effect. The loss of yardage of materials finished by this compressive shrinkage is considerable. This varies according to the construction of the fabric and also according to the method and mechanics of the different manufacturing plants.

Fabrics containing rayon or wool do not lend themselves to treatment by compressive shrinkage, or other mechanical shrinkage treatment, as these fabrics show a tendency to shrink after each and every washing operation, especially if the operation takes place at temperatures over 100° F.

The most widely employed chemical processes for shrinkage control of cellulosic and protein textile materials are more or less based on the formation within the fiber of an insoluble resin, which may be either urea-formaldehyde resin or melamine-formaldehyde resins type. While certain benefits are derived from such processes there are accompanying disadvantages, which detract from the processes. These are herewith summarized.

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By the use of the hitherto known resin treatment processes, said processes cause a loss in tensile strength, varying from 20% to 50% and a loss of 50% in abrasion resistance, in the case of cotton. This, of course, means that the wearing qualities of the fabric so treated are seriously impaired. Rayons also are affected. While the tensile strength of regenerated cellulosic fibers is not affected by hitherto known resin treatment processes, the abrasion resistance is decreased to an amount of approximately 50%. The wearing qualities of the fabric are therefore seriously impaired. In mixtures of cotton and rayon, the abrasion resistance and tensile strength of the fabrics, woven or knitted of mixtures of the two fibers, are each affected in the same manner as in comparable fabrics made of the individual fiber.

In addition to the aforesaid disadvantages, there is still another important disadvantage, which has not been mentioned.

Inasmuch as the ordinary commercial laundry uses sodium hypochlorite solution in their washing operation, any fabric which has been treated with resins under known processes would be tendered after a few such washes. This is attributable to the fact that the resin picks up and retains the chlorine, thus ultimately decomposing the fabric.

Therefore, many attempts have been made to develop and perfect processes which stabilize fabrics without the use of resins. For this purpose, fabrics have been treated with formaldehyde, or compounds which split off formaldehyde, in the presence of an acid or in the presence of a salt which is acid-reacting per se or becomes acidic during processing.

The established practice has been to impregnate the goods with a solution of from 2%–10% of formaldehyde calculated on the anhydrous basis in the presence of a catalyst, such as citric acid, tartaric acid, aluminum sulfate or stannous chloride, etc. After impregnation, the goods are squeezed and dried at about 140° F. to 160° F. This is an unpleasant operation at all times, even when the utmost precautions are exercised to

take care of the formaldehyde fumes liberated in the drying process. The next step, which is the most important and critical step of that process, is the baking or curing operation of the impregnated and dried goods. By the term "curing" or "baking" is understood the exposure of the impregnated and dried fabric for a definite period of time to a dry, high temperature. During this operation, the reaction of the formaldehyde with the fabric takes place. The normal curing-baking temperature is from 250°–300° F. The time of curing depends upon the temperature used. However, the actual length of time of the curing or baking operation is one of vital importance. There is very little margin of error allowable in the curing. Too short a time does not give the desired effect on shrinkage control, while only a short period of overbaking causes a very serious loss in tensile strength. Nevertheless even when the process is under the most rigid control, the results are not satisfactory, as the hand, resulting from the process, is much too "raggy," and demands further building up, with consequent ill effects on the stabilizing of the treated goods. However, apart from the appearance and hand of the finished piece, the worst feature is the high loss in abrasion resistance.

In an attempt to make the aforesaid process workable, and obtain better results, in British Patent #565,337, it was suggested that the formaldehyde solution, in addition to the catalyst, should contain a stiffening or loading agent. This would consist of vegetable or animal colloids, or conversion products of these, which are capable of reacting with formaldehyde to form condensation products which swell sparingly or are insoluble in water. None of the suggestions, however, caused the ill effects to disappear although they much improved the results to a certain degree.

According to our invention, by which the aforesaid disadvantages are eliminated, textile materials are impregnated, in the substantial absence of an acid catalyst, with an aqueous solution of a water-soluble aliphatic aldehyde such as formaldehyde or glyoxal or compounds thereof which yield such water-soluble aliphatic aldehydes by a subsequent steaming step such as hexamethylenetetramine, paraformaldehyde, paraldehyde, polyglyoxal, etc., squeezed or otherwise put under pressure, then dried, then exposed to steaming in a suitable vessel, e. g. a steam chamber or acid ager, cottage steamer, etc., in the presence of an acid during the said steaming operation. The textile materials which may be employed contain fibers of natural or regenerated cellulose, fibers of natural or modified protein which fibers contain chemical groups capable of reacting with these aldehydes. Mixtures of said fibers may be employed as well as mixtures of these various aliphatic aldehyde or aldehyde-compounds.

It is preferred to use a volatile organic acid in this steaming step, because some of the volatile inorganic acids tend to damage some fibers. The volatile acids can be suitably introduced into the steaming chamber by injection or other suitable means. The acids may also be sprayed on the dried goods or applied by means of a padding arrangement, then the steaming carried out as mentioned supra. By the use of the latter method, non-volatile organic or inorganic acids, such as lactic acid and phosphoric acid may also be used. When a chemical compound is used which splits off an aliphatic aldehyde by the steaming step, such as glyoxal a stoichiometric excess of

the volatile or non-volatile, organic or inorganic acid must be used in conjunction with the steaming. This excess of acid is based on the quantity of the chemical compound originally used to impregnate the fabric. In this acidic atmosphere, or in the presence of a liquid acid on the goods and in the presence of moisture of the steaming step, the aldehyde is the reagent which reacts with the cellulosic or protein fibers comprising the fabric, whereby the desired improvement in properties is effected.

Hexamethylene-tetramine is the preferred impregnating agent, because there is no loss of volatile reagent during the drying process, better shrinkage results are obtained and the use of this agent entails no discomfort to the operator during the impregnating and drying steps. There is no upper limit as to the drying temperature other than that imposed by the nature of the fiber per se. When this chemical is used, therefore, production is only limited by the capacity of the machines used to impregnate and dry the fabric.

The organic acids are not limited as to type and embrace the aliphatic, aromatic, alkyl-aryl acids and derivatives which yield acids upon steaming. Examples thereof are: formic, acetic, propionic, butyric, diethylacetic, benzoic, toluic, lactic and oxalic acids, etc. When an inorganic acid is used, whether volatile or non-volatile, care must be used to select an acid which will have no ultimate ill-effect on the fabric, such as tendering, yellowing, etc.

When hexamethylenetetramine is employed ammonia is split off. And enough acid should be present during the steaming operation to neutralize the ammonia liberated. However, when formaldehyde or paraformaldehyde is employed it is not essential to use an excess of acidic catalyst, since there is no neutralization of the catalyst, or consumption of same.

The temperature of steaming is substantially 212° F. or above. The preferred range is 212–220° F. Temperatures of 250° F. and even as high as 300° F. can be used, but protein fibers do not lend themselves well to this higher range. The period of time corresponding to the preferred range is 3 to 8 minutes.

While of course a minimum period of time is required for the reaction, no harm will accrue to the fabric even if it is exposed to the acid steaming step for a much longer period. In other words there is a time-margin when the steaming operation is used which eliminates all the critical features of the curing-baking step used in the orthodox or conventional formaldehyde process of shrinkage control.

After the steaming step, the goods should be washed and soaped, rinsed, and finally dried. Rinsing can be in warm, then cold water.

As mentioned supra, the application of the aliphatic aldehyde may take place at any time subsequent to the desizing of the fabric which is to be treated. This is a unique property, as thereby we are enabled to obviate the change in shade which occurs when the impregnation and heat-curing, etc. in the orthodox formaldehyde method takes place after dyeing. Hitherto, this resin treatment to reduce has invariably been the last operation in finishing, other than the final framing of the fabric. The process herein represents an important improvement as thereby the dyer can obtain his shade, and be sure that there will be no alteration due to a subsequent chemical operation.

If desired, the "hand" or "body" of the goods treated can be modified in the direction of either more softness or more crispness at will by the introduction to the impregnating bath of suitable agents, such as cation softeners, glues, gelatins, starch, modified starches, poly-vinyl acetate emulsions, methacrylate emulsions or other water-insoluble resin emulsions the resins of which do not react substantially with the aldehyde in the steaming step, or modified cellulose compounds such as methyl cellulose, hydroxy cellulose or cellulose glycollates, etc. Shrinkage-control is not dependent in any way on these compounds; they are added only to influence the "hand," whereas the shrinkage-control is obtained whether they are applied as an after-treatment or in the same bath or omitted entirely.

Fabrics treated by our process have a soft, full hand and are without the "raggy" hand usually associated with the conventional formaldehyde setting process. As pointed out supra at the very outset, all kinds of fabric containing fibers which contain chemical groups capable of reacting with the aldehydes become shrink-proof. Moreover, there is no loss in tensile strength or in abrasion resistance, as proven by reference to figures below. In fact, an increase in the resistance to abrasion takes place. There is another advantage to our process in that fabrics treated by the method do not absorb or retain chlorine from chlorine compounds commonly used in the commercial laundries, such as sodium hypochlorite. This is a result long sought and a matter of the greatest importance. In the treatment of wool by our method, it is well to observe that the presence of small amounts of oil or grease in the fabric to be treated is in no way a hindrance to the process. It is the presence of this grease or oil in woolen fabrics which makes the usual resin treatment for shrinkage control very difficult and unreliable.

The following specific examples serve to illustrate the results obtained by our process:

Example 1

Cotton treated

The goods were 100% cotton warp and filling.

Tests on the above cloth were conducted with the following solutions:

(1) 100 c. c. of technical 36% formaldehyde (solution) diluted to 1 liter with water.
(2) 30 g. of hexamethylene-tetramine diluted to 1 liter with water.

The swatches were impregnated with solutions (1) and (2), squeezed, allowing a pick-up of 100% on the dry weight of the goods, dried at substantially 120° F., then steamed through a steam chamber in the presence of an excess of acetic acid for 5 minutes, at a temperature of 212° F. to 220° F., soaped and washed for 5 minutes at 120° F., rinsed in warm and cold water, then dried.

After drying the swatches were marked in order to measure the shrinkage resulting from consecutive washes.

After each wash, carried out in a laundry tumbler machine, at a temperature of 120° F. for 10 minutes, the swatches were rinsed for 5 minutes in warm and cold water, removed from the machine, packed between towels for a period of 10 minutes, then pressed in a laundry machine till dry.

The swatches were allowed to condition, after which they were measured. The results were as follows:

	Original (Untreated Goods)	Sample No. 1 (Formaldehyde)	Sample No. 2 (Hexamethylenetetramine)
Shrinkage Results:			
1st Wash ..... per cent	5.0	zero	0.4
2nd Wash ..... do	5.2	0.4	0.4
3rd Wash ..... do	5.4	0.6	0.4
4th Wash ..... do	5.5	0.8	0.4
5th Wash ..... do	5.6	0.8	0.4
6th Wash ..... do	6.2	0.85	0.4
7th Wash ..... do	7.7	1.0	0.4
Tensile Strength:			
Warp	46	40	
Filling	32	30	46
Abrasion ..... cycles	150	230	31.5
			2.0

The abrasion figures were obtained on the Taber machine, as is likewise true for the values in all examples herein.

Example 2

Rayon treated

The goods were 100% spun rayon, warp and filling.

Tests on the above cloth were conducted with the following solutions:

(1) 100 c. c. of formaldehyde (commercial 40%) diluted to 1 liter with water.
(2) 30 g. of hexamethylenetetramine diluted to 1 liter with water.

The patches were impregnated with solutions (1) and (2), squeezed, allowing a pick-up of 100% on the dry weight of the goods, dried at substantially 120° F., then steamed through a steam chamber in the presence of an excess of acetic acid for 5 minutes, at a temperature of 212° F. to 220° F., soaped and washed for 5 minutes at 120° F., rinsed in warm water then cold water, and dried.

After drying the swatches were marked in order to measure the shrinkage resulting from consecutive washes.

After each wash, carried out in a laundry tumbler machine, at a temperature of 120° F. for a period of 10 minutes, the swatches were rinsed at 120° F. for 5 minutes, then rinsed in cold water for 5 minutes. The patches were removed from the machine, wrapped in towels for 10 minutes, then pressed in a laundry pressing machine till dry.

The swatches were allowed to condition, after which they were measured.

The results were as follows:

	Original (Untreated)	No. 1 Sample (Formaldehyde)	No. 2 Sample (Hexamethylene-tetramine)
Shrinkage Results:			
1st Wash ..... per cent	5.1	0.5	zero
2nd Wash ..... do	5.2	0.7	zero
3rd Wash ..... do	5.3	0.9	zero
4th Wash ..... do	5.4	1.2	zero
5th Wash ..... do	5.5	1.4	zero
6th Wash ..... do	5.4	1.5	zero
7th Wash ..... do	5.6	1.5	zero
8th Wash ..... do	5.7	1.6	zero
9th Wash ..... do	5.8	1.6	zero
10th Wash ..... do	5.9	1.6	zero
Tensile Strength:			
Warp	49.5	45	49
Filling	59	55	58
Abrasion ..... cycles	300	380	490

Example 3

Wool treated

The samples were 100% wool flannel.

Tests on the above cloth were conducted with the following solutions:

(1) 100 c. c. of technical 36% formaldehyde (solution) diluted to 1 liter with water.
(2) 30 g. of hexamethylenetetramine diluted to 1 liter with water.

The swatches were impregnated with solutions (1) and (2), squeezed, allowing a pick-up of 100% on the dry weight of the goods, dried at substantially 120° F., then steamed through a steam chamber in the presence of an excess of formic acid for 5 minutes at a temperature of 212° F. to 220° F., soaped and washed for 5 minutes at 120° F., rinsed in warm then cold water, then dried.

After drying, the swatches were marked in order to measure the shrinkage resulting from consecutive washings.

After each wash, carried out in a laundry tumbler machine, at a temperature of 120° F., for 10 minutes, the swatches were rinsed in water at 120° F. for 5 minutes, then in cold water for 5 minutes. The patches were then removed from the machine, wrapped in towels for 10 minutes, then pressed in a laundry pressing machine till dry.

The swatches were allowed to condition, after which they were measured.

The results were as follows:

	Original (Untreated)	No. 1 Sample (Formaldehyde)	No. 2 Sample (Hexamethylene-tetramine)
Shrinkage Results:			
1st Wash ... per cent	8.37	0.8	0.4
2nd Wash ... do	8.8	0.8	0.4
3rd Wash ... do	13	1.7	0.6
4th Wash ... do	14	1.9	0.8
5th Wash ... do	15	4.5	0.9
Tensile Strength:			
Warp	40	35	38
Filling	32	29	31.5
Abrasion ... cycles	650	750	825

Example 4

Cotton treated

The goods were 100% cotton, warp and filling.

Tests on the above cloth were conducted with the following solution:

100 c. c. of technical glyoxal (30%) solution diluted to 1 liter with water.

The swatch was impregnated with the solution, squeezed, allowing a pick-up of 100% on the dry weight of the goods, dried at substantially 120° F., then steamed through a steam chamber in the presence of an excess of formic acid for 5 minutes, at a temperature of 212° F., soaped and washed for 5 minutes at 120° F., rinsed in warm and cold water, then dried. After drying the swatches were marked in order to measure the shrinkage resulting from consecutive washes.

After each wash, carried out in a laundry tumbler machine, at a temperature of 120° F. for 10 minutes, the swatches were rinsed for 5 minutes in warm then cold water, removed from the machine, packed between towels for a period of 10 minutes, then pressed in a laundry machine till dry.

The swatches were allowed to condition, after which they were measured.

The results were as follows:

	Original (Untreated goods)	Sample treated with Glyoxal
Shrinkage Results:		
1st Wash ... per cent	5.0	0.3
2nd Wash ... do	5.2	0.3
3rd Wash ... do	5.4	0.3
4th Wash ... do	5.5	0.4
5th Wash ... do	5.6	0.4
6th Wash ... do	6.2	0.3
7th Wash ... do	7.4	0.4
Tensile Strength:		
Warp	46	45
Filling	32	32
Abrasion ... cycles	150	250

Example 5

Rayon treated

The goods were 100% spun rayon, warp and filling.

Tests on the above cloth were conducted with the following solution:

30 g. of hexamethylenetetramine dissolved in water and diluted to 1 liter with water.

The patches were impregnated with the above solution, squeezed, allowing a pick-up of 100% on the dry weight of the goods, dried at substantially 120° F.

The goods are sprayed evenly with a water solution of 50% lactic acid, allowing such quantity of the lactic acid as will be a calculated excess of acid to split the hexamethylenetetramine. The calculated amount of lactic acid is based on the amount of hexamethylenetretramine absorbed by the treated fabric.

After spraying the lactic acid, the goods are steamed in the steam chamber for 8 minutes, at a temperature of 212° F. to 220° F., soaped and washed for 5 minutes at 120° F., rinsed in warm then cold water, and dried. After drying the swatches were marked in order to measure the shrinkage resulting from consecutive washes.

After each wash, carried out in a laundry tumbler machine at a temperature of 120° F., for a period of 10 minutes, the goods were rinsed for 5 minutes at 120° F., then rinsed cold for 5 minutes. The patches were removed from the machine, wrapped in towels for 10 minutes, then pressed in a laundry pressing machine till dry.

The swatches were allowed to condition, after which they were measured.

The results were as follows:

	Original (Untreated)	(Treated and Sprayed)
Shrinkage Results:		
1st Wash ... per cent	5.1	0.3
2nd Wash ... do	5.2	0.4
3rd Wash ... do	5.3	0.3
4th Wash ... do	5.4	0.2
5th Wash ... do	5.5	0.3
6th Wash ... do	5.4	0.25
7th Wash ... do	5.6	0.3
8th Wash ... do	5.7	0.2
9th Wash ... do	5.8	0.25
10th Wash ... do	5.9	0.25
Tensile Strength:		
Warp	49.5	49
Filling	59	57
Abrasion ... cycles	300	480

From the results of Example 1 supra it will be seen that as compared to the untreated goods (1) there was much less shrinkage of the cotton goods which underwent the acidic steaming after impregnation with formaldehyde and hexa-

methylenetetramine respectively, (2) there was no more shrinkage after the seventh wash with the latter agent than after the initial wash, (3) there was 0.6% greater shrinkage in the case of the formaldehyde impregnation upon a similar comparison. An inspection of the tensile strength test reveals that with both the warp and filling, the hexamethylenetetramine impregnated samples equalled the untreated samples, although the formaldehyde treated sample was very slightly less. In the abrasion tests the hexamethylenetetramine treated sample was superior to the formaldehyde treated, and both excelled the untreated sample.

An inspection of the test results of rayon (Example 2) bears out the same findings. Wool differs in only one respect, namely that repetition of washes did increase the shrinkage, but only slightly.

The results of Examples 4 and 5 are in general agreement with the results of Examples 1 and 2.

This process of ours does not confer crush-proofing or crease-proofing to the textile fabrics. Non-felting is conferred to wool, in addition to shrink-proofing which is conferred to it. If it is desired to crease-proof cotton and rayon a resin would have to be used over the formaldehyde treatment. In this case the fabric can be treated by melamine formaldehyde by present commercial processes or preferably by employing this resin precondensate or urea-formaldehyde precondensate by our processes of copending application Ser. No. 597,714.

It will be realized by those skilled in the art that changes may be made in the processes hereinbefore described without departing from the scope of this invention. We do not intend to be bound except by the scope of the appended claims. In the claims the term "aliphatic aldehyde type compound" is employed to designate simply water-soluble mono-aldehyde, poly-aldehydes and compounds of these aldehydes which yield water-soluble free aliphatic aldehydes in substantial amounts, not simply traces, by a subsequent acid-steaming. This would include polymeric aldehydes and derivatives of aliphatic aldehydes with ammonia. Thus suitable compounds would include formaldehyde, paraformaldehyde, paraldehyde ($C_2H_4O_3$) which is the polymeric form of ordinary aldehyde, and hexamethylene tetramine which is a derivative of formaldehyde and ammonia. Polyaldehyde such as glyoxal as well as polyglyoxal can be used. Where the term "formaldehyde-type compound" is employed in the claims it designates formaldehyde or its polymeric modification, paraformaldehyde, or compounds thereof which yield formaldehyde in substantial amounts, not simply traces, by a subsequent acid steaming. Such terms would exclude of course precondensates of either urea and its derivatives, or melamine and its derivatives with aldehydes because they would yield nil to mere traces of the free aldehyde by a subsequent steaming step.

We claim:

1. In the process of improving textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting textile fibers with an aqueous solution of a formaldehyde type compound, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of an acid at a temperature not below substantially 212° F. until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with formaldehyde.

2. In the process of improving textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting textile fibers with an aqueous solution of a formaldehyde type compound, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of an acid at a temperature of substantially 212–220° F. until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with formaldehyde.

3. In the process of improving textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting textile fibers with an aqueous solution of hexamethylene tetramine, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam at a temperature not below substantially 212° F. in the presence of more than sufficient acid to neutralize ammonia split off until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with formaldehyde.

4. In the process of improving textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting textile fibers with an aqueous solution of a formaldehyde type compound, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of a steam volatile organic acid at a temperature not below substantially 212° F. until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with formaldehyde.

5. In the process of improving protein textile materials the steps of wetting the protein textile fibers with an aqueous solution of a formaldehyde type compound, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of a volatile organic acid at a temperature of substantially 212–220° F. until the shrinkage tendency is substantially reduced, and non-felting properties are conferred, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers.

6. In a process of improving textile materials the steps of wetting wool containing oil or grease with an aqueous solution of a formaldehyde type compound, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of an acid at a temperature not below substantially 212° F. until the shrinkage tendency is substantially reduced,

and non-felting properties are conferred, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers.

7. In the process of improving textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting textile fibers with an aqueous solution of a formaldehyde type compound, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of a steam volatile acid at a temperature not below substantially 212° F. until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with formaldehyde.

8. In the process of improving textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting textile fibers with an aqueous solution containing hexamethylene tetramine, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in an atmosphere of an excess of steam-volatile organic acid at a temperature of substantially 212–220° F. in the presence of more than sufficient acid to neutralize ammonia split off until shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with formaldehyde.

9. In the process of improving textile materials without significant loss of tensile strength and abrasion resistanee, the steps of wetting textile fibers with an aqueous solution of glyoxal in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of a stoichiometric excess of a steam-volatile organic acid at a temperature not below substantially 212° F. until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with the aldehyde.

10. In the process of improving textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting textile fibers with an aqueous solution of glyoxal, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of a stoichiometric excess of an acid at a temperature not below substantially 212° F. until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with the aldehyde.

11. In the process of improving textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting dyed textile fibers with an aqueous solution of a formaldehyde type compound, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of an acid at a temperature of substantially 212–220° F. until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with formaldehyde.

12. In the process of improving textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting textile fibers with an aqueous solution of a water-soluble aliphatic aldehyde type compound, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of an acid at a temperature not below substantially 212° F. until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with the aliphatic aldehyde.

13. In the process of improving textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting textile fibers with an aqueous solution of a water-soluble aliphatic aldehyde type compound, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of a steam volatile acid at a temperature not below substantially 212° F. until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with the aliphatic aldehyde.

14. In the process of improving textile material without significant loss of tensile strength and abrasion resistance, the steps of wetting textile fibers with an aqueous solution of a water-soluble aliphatic aldehyde type compound, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of a steam volatile organic acid at a temperature not below substantially 212° F. until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers, and the composition of the textile fibers treated containing groups capable of reacting with the aliphatic aldehyde.

15. In the process of improving cotton textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting the cotton textile fibers with an aqueous solution of hexamethylene tetramine, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in an atmosphere of steam-volatile organic acid at a temperature of substantially 212–220° F. wherein there is more than sufficient acid to neutralize ammonia split off, until shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial

absence of other type additives which chemically modify the textile fibers.

16. In the process of improving regenerated cellulose textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting the regenerated cellulose textile fibers with an aqueous solution of hexamethylene tetramine, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in an atmosphere of steam-volatile organic acid at a temperature of substantially 212–220° F. wherein there is more than sufficient acid to neutralize ammonia split off, until shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers.

17. In the process of improving protein textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting the protein textile fibers with an aqueous solution of hexamethylene tetramine, in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in an atmosphere of steam-volatile organic acid at a temperature of substantially 212–220° F. wherein there is more than sufficient acid to neutralize ammonia split off, until shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers.

18. In the process of improving textile materials without significant loss of tensile strength and abrasion resistance, the steps of wetting cotton textile fibers with an aqueous solution of glyoxal in the substantial absence of an acidic catalyst, removing the surplus liquid from the fibers, drying the fibers, thereafter exposing them to steam in the presence of an excess of a steam-volatile organic acid at a temperature not below substantially 212° F. until the shrinkage tendency is substantially reduced, these aforesaid steps being characterized by the substantial absence of other type additives which chemically modify the textile fibers.

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