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STABILIZATION OF KNIT FABRICS

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This invention relates to the stabilization of knitted cellulose fabrics against excessive or marked change in dimensions and against distortion without embrittlement of the yarns and with retention of the soft hand, freeness, and elasticity which are required for knit goods.

No practical method for controlling the shrinkage of knit fabrics has heretofore been developed, primarily because of difficulties resulting from the peculiar construction of knit goods as compared to woven fabrics. These difficulties are founded on a lack of rigid construction and a lack of selvaige by which woven fabrics are readily handled. Knit goods depend for their value upon loose, free chains which permit stretching and impart elasticity. For this reason the knitted stitches must be free to slide over each other. The construction and the properties required of knitted fabrics render them especially susceptible to large changes in dimensions in both length and width and to distortion of the shape of the stitches.

While it is possible to impart an apparent shrinkage to knit fabric by purely mechanical treatment, the resulting fabric is seldom completely shrunk even though an exorbitant loss of yardage may have occurred. Furthermore, mechanical shrinking leaves knit fabrics susceptible and sensitive to stretching and distortion. However successful mechanical shrinkage of woven fabrics may have been, such a method has not been directly applicable to knit fabrics.

Another method that has been proposed for reducing shrinkage of woven fabric is based on impregnating with a considerable amount of a heat-hardenable resin or resin-forming material, such as methylol urea, and forming the hardened resin within the fibers. In order to control the shrinkage, the cloth, after impregnation with the resinous material, is dried under tension at the desired marketable dimensions and the resin is cured while these dimensions are maintained. Such methods are not applicable to knit fabrics, not only because of the differences in construction already mentioned but also because of undesirable effects imparted by such procedure and by the resins heretofore used. The resins which have been applied to woven fabrics and the amounts of resin generally required to fix the dimensions of woven fabrics are not suitable for knit fabrics. With a hard resin and an appreciable amount of resin deposited on the fabric a hard, boardy hand results which cannot be tolerated in knit garments. But of more serious consequence is the ensuing embrittlement which causes yarns to be broken or cut by needles in fabrication of garments. While this is of little consequence with woven fabrics, it is disastrous for knit materials as it causes "runs" and other defects.

It is an object of this invention to provide a method whereby knitted cellulose fabrics are stabilized against marked changes in dimensions and against distortion. It is an object to accomplish these results without loss of fullness, softness, and required handle and with retention of elasticity, resilience, and normal freeness.

These objects are accomplished by impregnating a knitted cellulose fabric with an aqueous solution containing 8 to 15% of a water-soluble condensate of urea, formaldehyde, and an alcohol, removing excess solution from the fabric to leave 5% to 12% of said condensate in the fabric based on dry weights, spreading the fabric to approximately the desired finished width, drying the spread fabric without tension and heat-hardening the condensate in the fabric.

The condensates which have been found effective for this process are formed by reacting urea, formaldehyde, and one of the mono- or poly-hydric alcohols which in the presence of an acid catalyst react therewith to form water-soluble condensates. The alcohols which yield water-soluble condensates include methyl alcohol, ethyl alcohol, propyl or isopropyl alcohol, ethylene glycol, diethylene glycol, glycerine, dextrose, etc., the polyhydric alcohols yielding particularly effective condensates. If desired, a simple condensate of urea and formaldehyde may first be prepared and then reacted with the hydroxyl-bearing compound. Alternatively the reactants may be directly combined. The reaction is carried out in an anhydrous system and water of reaction removed as it is formed. In place of part of the urea there may be used another carbamide, such as thiourea, or a triazine, such as melamine.

Before applying the solution of the urea-formaldehyde-alcohol condensate to the knit goods a small amount of a strong acid-type catalyst, such as ammonium chloride, ammonium thiocyanate, ammonium sulfate, methylamine hydrochloride, etc., should be added. The preferred catalysts are the ammonium salts of strong acids. The concentration of catalyst may be 1 to 4% of the weight of the solid condensate, 2% being a particularly suitable amount for the preferred ammonium salts.

There may also be added to the solutions of the above condensates a small amount of a wetting or penetrating agent. The presence of $\frac{1}{20}$ to $\frac{1}{4}\%$ of such an agent as octylphenoxyethyl sodium sulfate is, for example, particularly effective in securing thorough penetration of yarns and fibers.

The solution of condensate may be applied to the knitted fabric by dipping, spraying, or other means suitable for saturating it with the solution. The wet fabric is then opened out and spread flat preferably, in the case of the usual

tubular knit fabric, by running it over an internal device or shoe which is set to spread the fabric to approximately the finished width which is desired or a slightly wider width. It is then passed between squeeze rolls which express excess solution and which are adjusted to leave only 50% to 80% solution in the fabric. These percentages are based on dry weight of the fabric.

When treating cotton fabrics, it is preferable to adjust the concentration of the impregnating solution to between about 8% and 12% of condensate solids and to leave in the cotton only enough condensate to yield from about 5% to about 8% resin after the subsequent treatments, although slightly higher resin contents are sometimes permissible. In the case of knit goods made from rayon or mixtures of cotton and rayon, however, there may be used solutions with as much as 15% condensate solids and the amount of solution retained may desirably be increased somewhat over that in a cotton fabric, an amount of resin in the final fabric between 6% and 12% being particularly satisfactory.

The spread fabric, free from excess solution, is then fed into a drier, where it is dried under no tension. A conveyor drier or loop drier is satisfactory for this purpose. Drier temperatures up to 280° F. are usual practice. The dried fabric is then passed into an oven or drier having a temperature of 290° F. to 320° F., where the condensate is hardened. The fabric may now be finished as desired.

Since the cured fabric is generally acid, it is desirable to wash it in a bath having a mild alkalinity, as from soda ash. When desired, a little sodium perborate or hydrogen peroxide may be used in this bath.

Details of typical procedures are shown in the following examples.

Example 1

A 16" tubular knit, 5½ yd./lb., 30's yarn, cotton fabric, peroxide-bleached, soap-washed, and dried to width, was dipped into a resin solution containing 12% urea-formaldehyde-glycol condensate, 0.3% of ammonium chloride, and 0.1% of the sodium salt of octylphenoxyethyl sulfate. The solution was maintained at a temperature of 100° F. The wet fabric was spread to a 17-inch width over a flat internal shoe before passing through a pair of squeeze rolls, which removed excess solution from between the fibers and left 60% solution in the fabric. The fabric was then passed without tension through a carrier drier, operating at about 260° F. The dry fabric was heated in an oven of the carrier drier type which operated at 300° F. to 310° F., approximately five minutes being required for the fabric to pass through this oven. The cured fabric was washed in a bath containing 0.1% built soap and 0.1% sodium perborate, rinsed, squeezed, spread and dried in a carrier drier.

This fabric was made into garments which were subjected to wash tests in order to determine the shrinkage of the resin-containing knit fabric compared to the shrinkage of the usual untreated knit fabric. Garments washed in a domestic type washing machine with a 0.2% soap solution at 160° F. and air-dried on a clothes line were found to have shrunk as follows:

	Percent in length
Untreated garments.....	9
Treated garments.....	1.5

When other sets of garments were washed in a

commercial washing machine and dried in a rotating drum-type drier, the shrinkage of the garments was as follows:

	Percent
Untreated.....	20
Treated.....	6

Example 2

A 17½" tubular knit, 5 yd./lb. all-spun viscose rayon fabric, peroxide-bleached, scoured, dyed, and dried, was dipped into a solution containing 15% of a urea-formaldehyde-glycol condensate, 0.3% of ammonium thiocyanate and 0.05% sodium octylphenoxyethyl sulfate. The wet fabric was spread to a width of 18½ inches with a flat shoe operating within the tubular fabric, squeezed through a pair of rolls to leave an 80% gain in weight, based on the dry fabric, and batch-rolled. The fabric was then fed into a carrier drier operating at 250° F. to 260° F. and then into a similar drier operating at 300° F. to heat-harden the condensate.

The resulting fabric exhibited comparatively a small degree of shrinkage, whether tested by home washing methods or in commercial laundry units. The fabric possessed a full hand and resilience without raginess, and yet was soft and pleasing to the hand.

Example 3

A 17½" tubular knit, spun cuprammonium rayon and cotton mixed fabric, 5 yds./lb., peroxide-bleached, soap-washed, and dried, was sprayed with a solution containing 10% of a urea-formaldehyde-glycol condensate, 0.2% of ammonium sulfate, and 0.07% of sodium octylphenoxyethoxyethyl sulfonate. The fabric was passed through two sets of rubber brass squeeze rolls, with the final set adjusted to leave an 80% pick-up of solution. After the squeezing operation, the fabric was spread with an internal shoe to a width of 18½" and passed through a carrier drier at a temperature of about 260° F. The dry fabric was passed into a loop drier operating at 310° F. where the condensate was cured.

As in the previous examples, the properties of stability and resistance to change in dimensions of the processed fabric were markedly superior to those of untreated fabric. There was a decreased tendency for stretching and distortion. The hand was greatly improved, the fabric being full and bulky without boardiness. The draping qualities were excellent. Since the sleaziness of the untreated cloth had been eliminated, fabrication of garments was facilitated. There was a decrease in the tendency of "runs" to occur.

Example 4

A 27" tubular knit, 3 yds./lb., cotton fabric, peroxide-bleached, dyed with direct dyestuff, soap-washed and dried to width, was spread to a width of 28 inches over a flat internal shoe immediately before being wet out on a slop padder with a solution containing 10% of a water-soluble urea-formaldehyde-ethyl alcohol condensate, 0.2% of ammonium chloride, and 0.1% of the sodium salt of octylphenoxyethyl sulfate. The temperature of the solution was maintained between 90° and 100° F. The wet fabric was then passed through a set of squeeze rolls, which removed excess solution leaving 80% solution in the goods, based on the dry weight of the fabric. The cloth was then dried at 260° F. by running it through a tensionless drier. After drying, the

fabric was passed for seven minutes through a curing box, which operated at a temperature of 310° F. The cured fabric was then dipped in a solution containing 0.1% of the sodium salt of octylphenoxyethyl sulfate and 0.1% of sodium perborate, spread, squeezed and dried in a carrier-type drier.

The resin-containing fabric when cut into garments, exhibited considerably less shrinkage than untreated fabric in garments, whether tested by a commercial laundry procedure or by a home washing procedure. The treated fabric possessed the soft, full hand required for knit goods. There was, furthermore, a marked increase in the wash-fastness of the direct dyestuff in the treated fabrics.

Heavier fabrics than shown in the above examples may be successfully stabilized by the same general procedure, but with an increase in the time allowed for the steps of penetrating, drying, and curing. When desired, the stabilized fabrics may be treated with softeners, such as sulfonated olive oil, tea-seed oil, castor oil, tallow, etc., or a sulfated long chain aliphatic alcohol, etc., with water-proofing agents, sizing agents or both permanent and non-permanent types, etc. The stabilized fabrics, furthermore, may be subjected to mechanical treatments, such as preshrinking, with a far greater degree of success than has heretofore been possible.

The process herein described may be successfully applied to knit cellulose fabrics, composed of cotton, or regenerated cellulose, including both viscose and cuprammonia fibers as filaments or staple fibers, or mixtures of these various materials.

We claim:

1. A process for stabilizing knitted cellulose fabric against marked change in dimensions and against distortion of the construction with retention of elasticity, resilience, and freeness of construction which comprises impregnating said fabric with an aqueous solution containing 8 to 15% of a water-soluble condensate of urea, formaldehyde, and an alcohol and a small amount of a strong acid-type catalyst, removing excess solution from the fabric to leave 5% to 12% of said condensate in the fabric, based on dry weights, spreading the fabric to approximately the desired finished width, drying the spread fabric without tension, and heat-hardening the condensate in the fabric.

2. A process for stabilizing knitted cellulose fabric against marked change in dimensions and against distortion of the construction with retention of elasticity, resilience, and freeness of construction which comprises impregnating said fabric with an aqueous solution containing 8 to 15% of a water-soluble condensate of urea, formaldehyde, and ethylene glycol together with a small amount of a strong acid-type catalyst, spreading the impregnated fabric to approximately the desired finished width, squeezing it to leave therein a condensate content of 5% to 12% based on the weight of the dry fabric, drying the spread fabric without tension, and heat-hardening the condensate in the fabric.

3. A process for stabilizing knitted cellulose fabric against marked change in dimensions and against distortion of the construction with retention of elasticity, resilience, and freeness of construction which comprises impregnating said

5 fabric with an aqueous solution containing 8 to 15% of a water-soluble condensate of urea, formaldehyde and ethylene glycol together with a small amount of an ammonium salt of a strong acid, spreading the impregnated fabric to approximately the desired finished width, squeezing it to leave therein a condensate content of 5% to 12% based on the weight of the dry fabric, drying the spread fabric without tension, and heat-hardening the condensate in the fabric.

10 4. A process for stabilizing knitted cotton fabric against marked change in dimensions and against distortion of the construction with retention of elasticity, resilience, and freeness of construction which comprises impregnating said fabric with an aqueous solution containing 8 to 12% of a water-soluble condensate of urea, formaldehyde, and ethylene glycol together with a small amount of a strong acid-type catalyst, spreading the impregnated fabric to approximately the desired finished width, squeezing it to leave therein a condensate content of 5 to 8% based on the weight of the dry fabric, drying the spread fabric without tension, and heat-hardening the condensate in the fabric.

20 5. A process for stabilizing knitted cotton fabric against marked change in dimensions and against distortion of the construction with retention of elasticity, resilience, and freeness of construction which comprises impregnating said fabric with an aqueous solution containing 8 to 12% of a water-soluble condensate of urea, formaldehyde, and a polyhydric alcohol together with a small amount of a strong acid-type catalyst, spreading the impregnated fabric to approximately the desired finished width, squeezing it to leave therein a condensate content of 5 to 8% based on the weight of the dry fabric, drying the spread fabric without tension, and heat-hardening the condensate in the fabric.

30 6. A process for stabilizing knitted regenerated cellulose fabric against marked change in dimensions and against distortion of the construction with retention of elasticity, resilience, and freeness of construction which comprises impregnating said fabric with an aqueous solution containing 8 to 15% of a water-soluble condensate of urea, formaldehyde, and ethylene glycol together with a small amount of a strong acid-type catalyst, spreading the impregnated fabric to approximately the desired finished width, squeezing it to leave therein a condensate content of 6 to 12% based on the weight of the dry fabric, drying the spread fabric without tension, and heat-hardening the condensate in the fabric.

45 7. A process for stabilizing knitted regenerated cellulose fabric against marked change in dimensions and against distortion of the construction with retention of elasticity, resilience, and freeness of construction which comprises impregnating said fabric with an aqueous solution containing 8 to 15% of a water-soluble condensate of urea, formaldehyde, and a polyhydric alcohol together with a small amount of a strong acid-type catalyst, spreading the impregnated fabric to approximately the desired finished width, squeezing it to leave therein a condensate content of 6 to 12% based on the weight of the dry fabric, drying the spread fabric without tension, and heat-hardening the condensate in the fabric.

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