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3,220,085

TEXTILE PROCESS FOR FORMING STRETCHING YARN

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2 Claims. (Cl. 28—72)

This application is a division of our copending application Serial No. 131,119, filed August 14, 1961, now Patent No. 3,146,575.

This invention relates to a method for making an elastic yarn.

In recent years there has arisen a demand for stretch yarns, i.e. yarns which, without any elastomeric component, have a high degree of recoverable stretch. Such yarns are normally multi-ply yarns in which the stretchiness is obtained by controlling the twist given to the various component yarns.

It has also been proposed to make bulky yarns by blending thermoplastic and non-thermoplastic fibers and then heating the blend. On heating, the thermoplastic fibers shrink, causing the yarn to be shortened in length and the non-thermoplastic fibers to be folded upon themselves. Although such yarns are bulky, i.e., of increased diameter, they are not stretchy; that is to say, when pulled out, they recover their original length only to a very limited extent.

The present invention provides a method for making a new type of yarn which is both bulky and stretchy. Yarns made in accordance with the invention comprise thermoplastic fibers and cross linked cellulosic filamentary material in which at least a major portion of said cross linked cellulosic fibers have a memory, rendered permanent by the cross linking, for a physical position in which the individual filaments are buckled or folded under themselves. Such composite yarns are made, in accordance with the invention, by blending thermoplastic filamentary material with cellulosic filamentary material, heating the resulting yarn to shrink the thermoplastic filamentary material, thus folding the cellulosic material upon itself, and cross linking the cellulosic material.

The thermoplastic filamentary material used in the present invention may be any thermoplastic filaments which shrink when heated. Polyolefin fibers such as polyethylene or polypropylene fibers are particularly suitable but other similar materials can be used such as nylons, polyesters, e.g., polyethylene terephthalate, vinyl chloride, vinyl acetate, acrylonitrile, acrylic ester and cellulose ester, e.g., cellulose acetate fibers. Preferably the thermoplastic filamentary material is present in the yarn as staple fiber. The denier of the thermoplastic filaments is not critical and will, of course, vary with the composition of the filaments, but will usually be from about 1.5 to about 15.

The cellulosic filamentary material may be natural cellulosic fiber such as cotton, linen, jute, sisal and hemp, or it may be regenerated cellulose in which case it may be made by any desired process, e.g. by the viscose, cuprammonium, nitrate processes or by the saponification of cellulose esters such as cellulose acetate. Preferably staple fiber is used. The denier of the filaments may again vary widely but will usually be from about 1.5 to about 15.

The cellulosic filamentary material may be cross linked by any of the reagents known to the art. These include formaldehyde, dialdehydes such as glutaraldehyde and adipaldehyde, hydroxy aldehydes such as hydroxyadipaldehyde, mixed aldehydes such as acrolein, glycidyl aldehydes; the so-called reactant type resins, for example modi-

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fied urea resins, i.e., methylol compounds such as methylated methylol urea, partially polymerized methylated methylol urea, methylated and unmethylated methylol ethylene ureas, such as dimethylol ethylene urea, and methylated and unmethylated methylol 1,2-propylene ureas, as well as dimethylol triazines, triazones, and the like; polyacetals (including diacetals) of polyhydroxy compounds, for example, the products described in Patent No., 2,786,081; divinyl sulfone; dihalohydrines, for example, dichlorohydrin; and di- and tri-aziridinyl phosphine oxides and sulfides as described in Patent No. 2,859,124.

Still other cross linking agents in common use and which may be employed in the present invention are the heat hardenable resins. These include the aminoplasts which may be defined as heat hardenable condensation products of compounds having at least two amino hydrogens, with methylol forming compounds. Typical aminoplasts are urea-formaldehyde, melamine formaldehyde, dicyandiamide formaldehyde, guanadine formaldehyde and combinations of these. The term is also used to include the methylol-amino-epihalohydrin compounds described in Daul Patent No. 2,960,484. Other resinous cross linking agents include those formed by the reaction of formaldehyde and acrolein as described in Patent No. 2,696,477; resins formed by the reaction of acetone and formaldehyde as described, for example, in United States Patents Nos. 2,504,835 and 2,711,971; and polyepoxy resins, e.g., polyfunctional compounds having at least two epoxy groups linked through a hydrocarbon, a polyhydric phenol or a polyhydric alcohol group, such as the resins formed from saturated polyglycidyl ethers of polyhydric alcohols as described in Patent No. 2,752,269. Particularly interesting compounds of this last named group are the condensation products of epichlorohydrin with ethylene glycols.

It will be clear that the precise nature of the cross linking agent is not a part of the invention. Of the various agents listed above, formaldehyde and dimethylol ethylene urea will be found especially useful.

In practicing the invention, various manipulative sequences can be used. Where both the thermoplastic and the cellulose filamentary materials are staple fiber they may be blended before spinning on conventional textile machinery. For example, both cotton and rayon yarns are conventionally made using the well known cotton system of spinning. In this the fiber is taken from the bale, and run through a picker to form a lap. The lap is delivered to a carder. The carded fibers may be combed and are then drawn, slubbed, and spun. In making yarns according to the invention the blending is preferably carried out in the picker, i.e. by adding the thermoplastic fibers to the cellulosic fibers as the latter are being processed in the picker. This insures maximum dispersion. However, the mixing can take place at any convenient place prior to spinning. Moreover, it is obvious that other systems than the cotton system may be employed.

The proportions of the thermoplastic and cellulosic yarns which are blended are open to considerable variation, and depend on the type of fibers being used and on the relative denier of the two fibers. An overall range (percent by weight) would be from about 25% cellulose and about 75% thermoplastic to about 95% cellulose and about 5% thermoplastic. Preferably the blends will contain (by weight) from about 5% thermoplastic and 95% cellulose to about 35% thermoplastic and about 65% cellulose.

The cross linking agent may be present in the cellulose fiber at the time of blending. However, cross linking of the cellulose must not take place until after the fibers have assumed their folded positions. Hence care must be taken that the combination of cross linking agent and

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curing agent used is such that premature curing does not take place. In most cases it is preferable to impregnate the blended yarn with curing agent and since in most cases shrinking of the yarn will require a temperature at least equal to the curing temperature of the cross linking agent, it is preferred to impregnate the yarn after it has been shrunk.

Shrinking of the yarn is carried out by simply heating the yarn in a relaxed condition. The temperature required will of course depend on the nature of the thermoplastic fiber and can range from say 70 to 250° C. Any suitable heating apparatus may be employed.

In impregnating the yarn, various manipulative procedures may be used. Conveniently, the yarn may be passed through a bath of the agent or the yarn or a bundle of yarns may be laid down in a plaited pattern on a moving belt and subjected to a spray or bath of a liquor containing the reagent.

The concentration of the cross linking agent in the treating liquor will of course depend on the amount of cross linking it is desired to effect, on the composition of the yarn and on the efficiency of the cross linking agent. In general it should be such as to deposit on the yarn between about 0.1 and about 15% cross linking agent, based on the dry weight of cellulose in the yarn.

After the yarn has been impregnated, it may be dried at a temperature of say 120 to 150° C. and cured at a temperature which will depend on the cross linking agent used, but which will in general range between about 150° C. and about 190° C. If desired, drying and curing may be carried out simultaneously. The yarn should be in a relaxed condition during both drying and curing.

If desired, impregnation may be carried out before shrinking, and shrinking and curing effected simultaneously. However, in general the results are not as satisfactory as when the yarn is fully shrunk prior to curing.

The invention will be further described with reference to the following specific examples which are given for purposes of illustration only and are not to be taken as in any way limiting the invention beyond the scope of the appended claims.

Example 1

A yarn containing 25% by weight 2 inch, 3 denier polypropylene staple fiber and 75% 2 inch, 3 denier viscose rayon staple fiber is prepared using the cotton system, by adding both the polypropylene staple and the rayon to the picker. The yarn is then treated with an aqueous solution containing, by weight, 10% dimethylol ethylene urea and 3% MgCl₂·6H₂O. It is padded to 100% pickup, dried at about 80° C. and heated at 160° C. for 3 minutes to effect curing and shrinkage simultaneously. A shrinkage of 10% is observed. Samples of the yarn each ten inches long are then loaded with various weights and the stretch measured. The weights are removed and the recovery measured. The results are given in Table A below:

TABLE A

Load, grams	Percent Stretch ¹	Percent Recovery ²
10.....	4	75
20.....	7	71
40.....	12	75
60.....	14	71

¹ Percent stretch = $\frac{\text{extended length} - \text{original length}}{\text{original length}} \times 100$

² Percent recovery = $\frac{\text{recovered length} - \text{original length}}{\text{extended length} - \text{original length}} \times 100$

Example 2

The yarn used in Example 1, containing 25% by weight 2 inch, 3 denier polypropylene staple fiber and 75% by

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weight 2 inch, 3 denier viscose rayon staple fiber is heated at 160° C. without impregnation with cross linking agent. A shrinkage of 26% is observed. The bulky yarn so obtained is treated with an aqueous solution containing 10% by weight dimethylol ethylene urea and 3% MgCl₂·6H₂O, padded to 100% pickup, dried at about 800° C., and cured for three minutes at 160° C.

Samples ten inches long are again weighed, and stretch and recovery measured. The results are shown in Table B below:

TABLE B

Load, grams	Percent Stretch	Percent Recovery
20.....	11	91
40.....	16	88
60.....	24	83

It will be observed that when shrinkage is completed before cross linking, higher stretch and elastic recovery are obtained than when stretching and curing are carried out simultaneously.

Example 3

The yarn used in Examples 1 and 2 is heated to 160° C. to effect a shrinkage of 26% and then impregnated with an aqueous solution containing 3% HCHO and 3% MgCl₂·6H₂O. It is padded to 100% pickup, dried at 80° C. and heated to 160° C. for 3 minutes to effect curing. A bulk yarn having excellent elastic recovery is obtained.

Example 4

To compare yarns according to the invention with non-cross linked yarns and to illustrate the effect of cross linking in promoting elastic recovery, the same yarn used in Examples 1 and 2 is heated to 160° C. for three minutes to give 36% shrinkage and then tested, without impregnation, for stretch and recovery. As before, 10 inch samples were used. The results are listed in Table C below:

TABLE C

Load, grams	Percent Stretch	Percent Recovery
10.....	13	15
20.....	15	20
30.....	21	25
40.....	22	22
50.....	24	13
60.....	24	25

The foregoing examples show clearly that cross linking the cellulose establishes a memory in the cellulose for its folded, contracted position and greatly enhances the elastic properties of the yarn.

We claim:

1. A method for forming a stretchy yarn which comprises blending cellulosic filamentary material with thermoplastic filamentary material to form a yarn, heating said yarn to shrink said thermoplastic filamentary material and to cause the individual cellulosic filaments to be folded back upon themselves, impregnating the shrunken yarn with a cross-linking agent for the cellulose which is substantially inert to said thermoplastic material and heating the impregnated yarn in the substantial absence of tension to effect cross-linking of the cellulosic filaments in said folded position.

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2. A method for forming a stretchy yarn which comprises blending cellulosic filamentary material with thermoplastic filamentary material to form a yarn, impregnating said yarn with a cross-linking agent for the cellulose which is substantially inert with respect to said thermoplastic material and heating said impregnated material in the substantial absence of tension to shrink the thermoplastic material, thereby causing the cellulosic filaments to fold back upon themselves; said heating simultaneously causing cross-linking of the cellulosic filaments in said folded position.

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