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PRODUCTION OF BULKY PRODUCTS OF ACRYLIC COMPOSITE FIBERS

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ABSTRACT OF THE DISCLOSURE

The invention is directed to a method of making bulky yarn goods using a mixed spun yarn in which one portion of the fibers is made of an acrylic composite fiber having latent heat-developable coil crimps and another portion is a fiber made of a single highly shrinkable acrylic polymer or copolymer. Upon heating the mixed yarn under conditions tending to prevent the development of the coil crimps of the composite yarn, the single polymer fiber shrinks and affords protection for the composite fibers thus permitting the composite fibers to fully develop their latent crimps.

This invention relates to a method of manufacturing bulky yarns and fabrics from acrylic composite fibers having latent coil crimps.

A composite fiber composed of two or more polymers which would exhibit different thermal behaviors and arranged eccentrically along the entire length of the fiber would give rise to three-dimensional or coily crimps upon heating due to the differential thermal shrinkage of said component polymers. The yarns made by mix-spinning such as acrylic composite fiber with another fiber, or knit or woven fabrics of such yarn may be expected to have an improved bulk and hand as compared with the comparable products manufactured by using the conventional acrylic fiber.

It has been found, however, that a composite fiber which has already had its coil crimps developed in the course of its manufacture would not only be difficult to spin because of its tendency to wind round the card cylinder due to said three-dimensional crimps but would lose a portion of its crimps during the processes of spinning, weaving or knitting and finishing, so that the resultant goods have no satisfactory bulk. For this reason, it has been considered highly desirable to inhibit the development of such coil crimps during the fiber production process and, only after spinning into yarns, to heat-treat the same to develop said coil crimps.

However in respect of a composite fiber composed of acrylic polymers, the shrinking power or shrinkability of the fiber in the formation of coil crimps due to a difference in thermal shrinkage between the component polymers is very small. Therefore, if such a fiber could be heated in a relaxed state in which it has a freedom of movement it would have coil crimps completely developed, but when a product made from such a fiber is to be processed in large quantities on a commercial scale, it is subjected to various restrictive forces such as the gravitational load due to its own weight, the restrictions imposed by its own texture, and the tension forces arising from the movement of the fluids used in dyeing and finishing. Such restrictive forces are obviously not conducive to the free movement of the fiber, and the formation of coil crimps is thereby hindered. Under such conditions it is difficult to obtain sufficiently bulky products.

This invention provides a method of manufacturing

products having a satisfactory bulk, which comprises mix-spinning (blending) an acrylic composite fiber having latent coil crimps, i.e. crimps that could be developed upon heating, with a thermally shrinkable acrylic fiber having a high shrinking characteristic so that the spun yarn may have an additional shrinking capacity which is sufficient to cope with the above-mentioned restrictive forces and, accordingly, the latent coil crimps may be brought into complete development.

In carrying this invention into practice, the thermally shrinkable acrylic fiber to be mix-spun or blended with an acrylic composite fiber should have a shrinkage of at least 5% and a shrinking power of at least 30 mg./d. in hot water at 98° C.

The mixing proportions should satisfy the following formulas:

$$0.8>Y>0.2$$

$$15<X\cdot Y<100$$

wherein X represents the shrinking power in mg./d. of said thermally shrinkable acrylic fiber in hot water at 98° C. and Y represents the relative amount of the thermally shrinkable acrylic fiber in the blend spun yarn composed of the acrylic composite fibers having latent coil crimps and the thermally shrinkable fiber.

The above-mentioned shrinking power and shrinkage are determined as follows.

SHRINKING POWER

The tension that is induced in a shrinkable fiber when it is immersed in hot water in a state in which it is secured at the non-shrunk length is measured with a strain meter. Each sample consists of 100 monofilaments aligned side by side, both ends of which are fixed to give a 30 mm. length. After the sample is secured to a length under an initial tension of 10 mg./d., it is immersed in hot water at 98° C. The tension that arises in the sample is recorded and plotted against time. The tension reaches its maximum value in 1–2 seconds, and, from then on, it falls off as the stress is relieved. The maximum tension is defined as the shrinking power of the fiber in hot water.

SHRINKAGE

A similar sample is treated with hot water at 98° C. for 10 minutes while it is held in a relaxed state. The shrunk length is measured under the tension of 10 mg./d.

In carrying out the present invention any composite acrylic fiber which can develop coil crimps when heat treated may be used. Thus the composite fiber may be composed of polyacrylonitrile and an acrylonitrile copolymer, or may be composed of an acrylonitrile copolymer and another acrylonitrile copolymer. In any case the different polymers composing the composite fiber must be different in thermal shrinkage, due to which the said fiber develops coil crimps upon being heated. When a copolymer is used it is preferable that the copolymer comprises at least 50% by weight of acrylonitrile. The production of such composite acrylic fiber is well known in the art and does not constitute the feature of the invention.

This invention will be further described in detail by reference to the following examples.

EXAMPLE 1

Two dissimilar spinning solutions (polymer concentration: 10%) were prepared by dissolving a copolymer composed of 90% acrylonitrile and 10% methyl acrylate on the one hand and a copolymer composed of 88% acrylonitrile and 12% methyl acrylate on the other hand in a 50% aqueous solution of sodium thiocyanate, respectively. Equal amounts of said spining solutions were extruded into an 8% aqueous solution of sodium thiocyanate through a spinning nozzle having 500 orifices (each 0.08 mm. in diameter). After washing with water, the tow was stretched in boiling water 8 times its initial length. Then the resulting fiber was dried in a highly humid atmosphere at a dry-bulb temperature of 105° C. and a wet bulb temperature of 70° C. until it had a water content of less than 3%. The fiber was further treated in boiling water for 10 minutes, during which time it was held in a relaxed state. The fiber was then mechanically crimped, oiled and dried to prepare a 6-denier composite fiber (this fiber will be referred to as (A) hereinafter).

On the other hand, another spinning solution (polymer concentration 10%) was prepared by dissolving a copolymer of 90% acrylonitrile and 10% methyl acrylate in a 50% aqueous solution of sodium thiocyanate. This spinning solution was extruded and formed into filaments in a conventional manner, and the resulting filaments were washed with water and, then, stretched in boiling water to 8 times its initial length. The spinnerette nozzle used had 500 orifiices (each 0.08 mm. in diameter). The fiber was dried in a highly humid atmosphere at a dry-bulb temperature of 105° C. and a wet-bulb temperature of 70° C. until it had a water content of less than 3%. The fiber was then treated in saturated water vapor at 120° C. for 10 minutes, during which time it was held in a relaxed state. Then the fiber was subjected to mechanical crimping, oiling, and drying. Thereafter the fibers were divided into three groups, which were guided through a space defined by two hot plates while being stretched 1.07, 1.15 and 1.22 times, respectively. The fibers were mechanically crimped to prepare shrinkable filaments (B), (C) and (D). The shrinkage values of the above filaments in hot water at 98° C. were 7%, 13% and 18%, respectively, while their shrinking power values were found to be 32 mg./d., 49 mg./d. and 74 mg./d., respectively.

Then, the four kinds of filaments prepared above were cut into staples and spun yarns (4/22) were manufactured by mix-spinning (A) with (B), (C) and (D) in various combinations and ratios. The hanks of these spun yarns were dyed by means of a hank dyeing machine. The dyeing operation was carried out under the following conditions.

Composition of dye solution:

Basacryl blue GL, percent OWF	1
Levegal pan, percent OWF	1
Na_2SO_4, percent OWF	10
H_2SO_4	pH 2
Liquor ratio	1:100

Dye bath temperature.—The dye solution was heated to 98% at the rate of 1° C. per minute, and after being held at 98° C. for 60 minutes, it was gradually cooled to 60° C.

The shrinking power of each fiber and the characteristic of the resulting spun yarns are summarized in table.

TABLE 1

Composition of yarn	X·Y	Spun yarn	
		Bulkiness	Hand
A 100%	0	x	x
A 80%, B 20%	6.4	x	x
A 80%, C 20%	9.8	x	x
A 80%, D 20%	14.8	Δ	Δ
A 60%, B 40%	12.8	x	x
A 60%, C 40%	19.6	o	o
A 60%, D 40%	29.6	o	o
A 40%, B 60%	19.2	o	o
A 40%, C 60%	29.4	o	o
A 40%, D 60%	44.4	o	o
A 20%, B 80%	25.6	o	o
A 20%, C 80%	39.2	Δ	Δ
A 20%, D 80%	59.2	x	x

X—Shrinking capacity of thermally shrinkable acrylic fiber in hot water at 98° C. as expressed in mg./d.

Y—Relative amount of thermally shrinkable acrylic fiber.

In the above table *x* represent a bad result, Δ a fair one and *o* a good or excellent one.

In this example, the yarns were thermally shrunken simultaneously with dyeing, but a satisfactory bulk may likewise be produced by treating them under dry hot or wet hot conditions, independently of the dyeing operation.

What we claim is:

1. A method of manufacturing bulky yarn or fabric containing acrylic composite fibers and thermally shrinkable acrylic fiber characterized by blending an acrylic composite fiber having latent coil crimps that would be developed upon heating and which are produced by composite spinning two or more dissimilar acrylic polymers different in thermal shrinkage value, with a thermally shrinkable acrylic fiber having a shrinkage value of at least 5 percent and a shrinking power of at least 30 mg./d. as measured in hot water at 98° C. in such a proportion as would satisfy the following formulas:

$$0.8>Y>0.2$$
$$15<XY<100$$

wherein X is the shrinking power in mg./d. of said thermally shrinkable acrylic fiber as measured in hot water at 98° C. and Y is the relative amount by weight of said thermally shrinkable fiber in the said blended yarn, and heating the resulting spun yarn or fabric made thereof at temperatures over 90° C. to produce a bulk therein.

2. A method as claimed in claim **1** wherein the acrylic composite fiber contains at least 50% by weight of acrylonitrile and the thermally shrinkable acrylic fiber contains at least 70% by weight of acrylonitrile.

3. A blended yarn composed of acrylic composite fibers of two or more dissimilar acrylic polymers different in thermal shrinkage and thermally shrinkable acrylic fibers having a shrinkage value of at least 5 percent and a shrinking power of at least 30 mg./d. as measured in 98° C. hot water in such a proportion as would satisfy the following formulas:

$$0.8>Y>0.2$$
$$15<XY<100$$

wherein X is the shrinking power in mg./d. of said thermally shrinkable fiber as measured in hot water at 98° C. and Y is the relative amount of said thermally shrinkable fiber in the blend spun yarn composed of said composite fibers and thermally shrinkable acrylic fibers.

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