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[54] **METHOD OF PRODUCING BUNDLED MULTIFILAMENT YARN**

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[57] **ABSTRACT**

A method of producing a bundled multifilament yarn is provided herein by fixing a rosin ester of a random copolymer of ethylene oxide and propylene oxide to an unstretched or stretched synthetic fiber multifilament yarn. The rosin ester may be applied to the yarn singly or together with such materials as an emulsifier, antistatic agent or lubricating agent.

5 Claims, No Drawings

METHOD OF PRODUCING BUNDLED MULTIFILAMENT YARN

The present invention relates to a method of producing a bundled synthetic fiber multifilament yarn, and more particularly the invention has for its object the production of a bundled multifilament yarn having excellent properties as warps for weaving.

In general, prior to the weaving step for the production of textile fabrics, a preparatory step is required wherein the warp yarn is first sized and then warped or is sized after warping.

The object of such sizing is to give bundling properties and wear resistance to the yarn, to make the adhesion between individual filaments sufficient, and to make the yarn sufficiently resistant to shock, friction and tension during weaving so that the weaving efficiency is improved.

To attain such objects, pastes (or sizing agents) are used which have film-forming ability or adhesiveness. They are, for example, polyvinyl alcohol, esters of polyacrylic acid, sodium polyacrylate, polyacrylic acid, polyacrylamide, etc.

However, sized yarn is greatly influenced by the oiling agent with which the original warp yarn has been treated, and there are various difficulties resulting therefrom.

First, upon immersing warp yarn in a paste liquid, when the compatibility between the oiling agent and the paste liquid is poor, scum is generated which floats on the surface of the paste liquid, while when the compatability is too good, the amount of the oiling agent contained in the paste liquid becomes larger with the passage of time when the liquid is used continuously for a long time, with the result that not only the performance of the paste becomes lowered but also considerable generation of foam is observed. In either case, uneven pick-up of paste is caused and thus the sized yarn becomes of inferior quality.

Secondly, there are often cases in which an oiling agent is a cause of the hindrance of adhesion between the warp yarn and the paste. If an oiling agent which may cause adhesion hindrance is fixed to the warp yarn, even though the sized yarn represents a good appearance, the paste will "fall off" under the influence of the friction at the heald or reed. Such is generally called "paste-fall." The paste made fo fall off becomes sticky by moisture absorption and causes a phenomenon called "gum-up." This worsens the shedding movement and seriously impairs the quality of the fabric thus produced. Also, the paste itself is susceptible to the influence of temperature and humidity. Therefore, under circumstances of high temperature and high humidity, the paste will "gum up" independently of the oiling agent used.

The method of the present invention obviates various such difficulties encountered in the conventional sizing step, and moreover simplifies the process by incorporating a sizing step into the yarn producing step.

The method of the present invention is characterized in that a random copolymer of ethylene oxide and propylene oxide esterified with rosin is fixed or deposited singly or together with a lubricating agent, emulsifier, antistatic agent, etc., to an unstretched or stretched synthetic fiber multifilament yarn, and particularly in that the extruded multifilament yarn is treated in the spinning step with an oiling agent containing 5 – 70 weight percent of the above-mentioned treating agent based on the total weight of the non-aqueous components.

As the random copolymers of ethylene oxide and propylene oxide esterified with rosin to be used in the method of the present invention (hereinafter referred to as the "treating agent" of the present invention), either monoester or diester may be used. As used herein, the term "rosin" refers to a natural resin mainly composed of abietic acid, which additionally contains pimaric acid, sabinic acid, etc. The average molecular weight of the random copolymers of ethylene oxide and propylene oxide is preferably within the range of 5,000 to 20,000. In the case of an average molecular weight below 5,000, it is difficult to provide a high degree of bundling properties and a high degree of wear resistance. On the other hand, with an average molecular weight above 20,000, the resulting too high viscosity makes it difficult for the treating agent to fix to the multifilament yarn. The ratio off ethylene oxide to propylene oxide is not required to be particularly limited, but 50 – 85 mol percent of ethylene oxide is preferred. When ethylene oxide is less than 50 mol percent, it is difficult to compound such a copolymer into an emulsion, and when ethylene oxide is in excess of 85 mol percent the viscosity of the resulting emulsion becomes considerably high, so that such a copolymer is not desirable.

In this connection, if, in the present invention, the random copolymer of ethylene oxide and propylene oxide is replaced with a block copolymer, the emulsifying power of the rosin ester will become poor and the kinetic friction coefficient of the yarn treated with such ester becomes high, with the smoothness of the yarn becoming bad.

In producing the treating agent of the present invention by reacting a random copolymer of ethylene oxide and propylene oxide with rosin, it is desirable to take the molar ratio of the copolymer and rosin so as to be 1:0.5 – 3.0. If rosin is less than 0.5 mol percent, the treated yarn will have seriously inferior hundling properties, and on the other hand when rosin is in excess of 3 mol percent, the obtained yarn will have good bundling properties, but its smoothness becomes remarkably poor and it is liable to generate static electricity. In the reaction product, besides the above-mentioned random copolymer rosin ester, unreacted random copolymer and rosin are present together. However, the reaction product may be used without particularly separating the unreacted materials. The unreacted rosin may be converted into an alkali metal salt thereof.

Yarns treated with such a treating agent of the present invention have a high degree of bundling properties and a high degree of wear resistance as well as a proper degree of smoothness, with the quality of the yarns being further stabilized. Therefore, the yarn obtainable by the present invention are provided with necessary characteristics as warps for weaving so that the yarn may be exempted from a separate sizing step before weaving. When the treating agent of the present invention is applied to an unstretched yarn, the treated yarn will have an extremely good stretchability so that entangling of the yarn about rollers or yarn breakage during the production step is few in comparison with the yarn treated with a conventional oiling agent, and fluff of the stretched yaarn becomes markedly reduced.

The treating agents of the present invention may be thus applied to the yarn together with an oiling agent in the spinning step or may be applied upon stretching or after stretching. However, when they are applied particularly together with an oiling agent in the spinning step, it is necessary that the ratio to other general oiling agents such as lubricating agent, emulsifier, antistatic agent, etc. be suitably adjusted, taking the operation efficiency in spinning and stretching into consideration, so that the treating agent of the present invention occupies 5 – 70 weight percent, preferably 10 – 50 weight percent, of the total weight of the nonaqueous components. Where the treating agent is applied after stretching, since an oiling agent has been already applied in the spinning step, it is preferably that the ratio of the treating agent of the present invention to the general oiling agent be set within the range of 10:0 – 5:5. In either case where the treating agent of the present invention is applied to an unstretched filament yarn or to stretched filament yarn, it is desirable that the treating agent be fixed to the yarn in an amount of more than 0.1 weight percent based on the fiber weight. Additionally, to prevent "paste-fall" and "gum-up" and to improve spinnability and stretchability, the total fixed amount of the oiling agent and the treating agent of the present invention is desirable to be small such that it is less than 2 weight percent based on the fiber weight. With an ordinary paste, a fixed amount of less than 2 weight percent based on the fiber is not sufficient for the sized yarn to have an effect as sized yarn. But with the use of the treating agent of the present invention, and a small amount is able to give sufficient bandling properties and wear resistance to the yarn.

The multifilament yarn obtainable by the method of the present invention is most suitable as warps for weaving. In addition to its having bundling properties, wear resistance, anad smoothness comparable to those seen in usual sized yarn, it is removed from the defects of the conventional sized yarn, such as "paste-fall" and "gum-up." Thus, by the method of the present invention, the sizing step can be omitted. In spite of this, the method of the present invention results in good weaving efficiency, few flufff generation during wearing, and improvement in shedding movement. Also, the small fixed amount of the treating agent contributes to the prevention of paste-fall and gum-up and to the quality improvement of the resulting fabrics.

EXAMPLE 1

An unstretched multifilament yarn of nylon-6 obtained by melt-spinning, after being unwound from a pirn and prior to entering the stretching zone, was applied with the treating agents Nos. 1 – 4 shown in Table 1 according to the method of the present invention. Immediately after this treatment, the yarn was stretched to obtain a nylon-6 multifilament yarn of 70 denier/14 filaments.

Each of the treating agents was used as an aqueous emulsion in concentration of 10 % which contained 80 % of a treating agent of the present invention, 10 % of a mineral oil, 5 % of a higher fatty acid ester, and 5 % of a polyoxyethylene nonionic surface active agent, and as an antistatic agent an alkyl phosphate metal salt was added in an amount of 8 % based on the non-aqueous components.

Table 1

No.	Treating agent	Fixed amount of treating agent (*nonaqueous components) on the fiber
1.	Ethylene oxide (75 mol %)-propylene oxide (25 mol %) random copolymer (mol. wt. 12,000) rosin diester	1.10 wt. %
2.	Ethylene oxide (75 mol %)-propylene oxide (25 mol %) random copolymer (mol. wt. 12,000) rosin monoester	1.12 wt. %
3.	Ethylene oxide (85 mol %)-propylene oxide (15 mol %) random copolymer (mol. wt. 12,000) rosin diester	1.07 wt. %

*Including a 0.6 wt. % fixed amount of a spinning oil.

Characteristic properties of the yarns thus obtained are shown in Table 2 together with those of Comparative Example 1 wherein the yarn was treated with a PVA type paste in place of the treating agent of the present invention (*fixed amount on the fiber = 1.12 wt. %), and Comparative Example 2 wherein only a spinning oil was applied.

Table 2

No.	Bundling properties	Wear resistance	Smoothness	Number of fluffs generated (per million meters)	Weaving efficiency (%)
1	A	A	Good	0.07	97
2	A	A	Good	0.06	97
3	A	A	Good	0.12	95
4	A	A	Good	0.04	97
Comp. Ex. 1	B	B	Good	0.20	90
Comp. Ex. 2	B	C	Good	0.04	90

Bundling properties

One end of a test sample, 30 cm. in length, is fixed and a weight of 25 grams is suspended at the other end. The sample is cut with a sharp knife at a point of 20 cm. from the fixed end. The number of divided filaments, the height and width of the divided portion are measured and ranked in A, B, and C. The rank A represents a sample having a number of divided filaments less than 5, a divided height less than 50 mm., and a divided width less than 5 mm. The rank B represents a sample having a number of divided filaments from 6 to 9, a divided height from 50 to 100 mm., and a divided width from 5 to 10 mm., and the rank C represents a sample having a number of divided filaments more than **10,** a divided height more than 100 mm., and a divided width more than 10 mm.

Wear resistance

A test sample, 50 cm. in length, is fixed at one end, and a weight of 50 grams is suspended at the other end. The sample is rubbed at the middle point with a blade traversing horizontally. The rank C is the case where fluff is generated within 5 minutes. The rank B is the case where fluff is generated in 5 – 10 minutes, and the rank A is the case where no fluff is generated after 10 minutes.

Table 3

No.	Rosin ester content (wt. %)	Fixed amount of treating agent (wt. %)	Spinnability	*Stretchability (%)	Bundling properties	Wear resistance	Smoothness	Fluffs per million meters	Weaving efficiency (%)
5	100	0.43	Dirt generated on guides	75	A	A	Bad	2.0	90
6	70	0.52	Good	95	A	A	Good	0.33	95
7	40	0.75	Good	97	A	A	Good	0.15	97
8	10	1.60	Good	98	A	A	Good	0.06	97

*Stretchability: Percentage perfect full pirns to the total pirns operated.

Smoothness

The yarn is made to travel over a rubbing rod at a contact angle of 90°. The travelling tension of the yarn before passing the rubbing means at a travelling speed of 100 m/min. is fixed constant at 10 grams, and the tension after passing the rubbing means is measured. When this value is less than 1.2, it is ranked as "Good," when that of Comparative Example 2 is taken as 1.

Weaving efficiency

This is expressed by the percentage operation of the weaving machine.

As apparent from Table 2, the yarn obtained by the method of the present invention represents a high degree of bundling properties and a high degree of wear resistance as well as a proper degree of smoothness, while the conventional PVA type sizing agent does not show any effect as a bundling agent at the same fixed amount as the treating agent of the present invention, the effect obtained being substantially equal to that obtained in the case of using a spinning oil only.

EXAMPLE 2

In the spinning step of a nylon-6 multifilament yarn of 70 d/14 f., oiling agents each containing 100 weight percent, 70 weight percent, 40 weight percent and 10 weight percent of the ethylene oxide (75 mol %)-propylene oxide (25 mol %) random copolymer rosin diester were respectively applied to the extruded yarn as an aqueous emulsion in concentration of 15 % by means of oiling rollers. The oiling agent components other than the rosin ester were 50 weight percent of a mineral oil, 20 weight percent of a higher fatty acid ester, and 30 weight percent of a polyoxyethylene type nonionic surface active agent, to which, as an antistatic agent, the same one as used in Example 1 was added in an amount of 7 % based on the nonaqueous components.

The spinnability and stretchability of the thus obtained yarn are shown in Table 3 together with other characteristic properties.

The fixed amount was controlled such that the amount of the rosin ester was more than 0.1 weight percent. Too high a total fixed amount generated dirt on drawtwisters. Also, as seen in the above table, too large an amount of the rosin ester in the treating agent lowered the smoothness and increased generation of fluffs. Accordingly, when the treating agent of the present invention is applied together with an oiling agent in the spinning step, it is necessary that the ratio of the treating agent to the oiling agent be adjusted to 5/**95** – 70/**30**, preferably 10/**90** – 50/**50**.

What we claim is:

1. A method of producing bundled multifilament yarn which comprises depositing a rosin ester of a random copolymer of ethylene oxide and propylene oxide on the surface of a synthetic fiber multifilament yarn in an amount of more than 0.1% by weight based on the weight of the yarn, said random copolymer having an average molecular weight of 5,000 to 20,000 and wherein the ratio of ethylene oxide to propylene oxide in the copolymer is 50–85 mol % of ethylene oxide to 15–50 mol % of propylene oxide.

2. A method according to claim **1**, wherein a lubricating agent, an antistatic agent or an emulsifier is co-deposited on the synthetic fiber multifilament yarn along with the rosin ester of the random copolymer.

3. A method according to claim **1**, wherein the rosin ester of the random copolymer is deposited on the synthetic fiber multifilament yarn while in an unstretched state.

4. A method according to claim **1**, wherein the rosin ester of the random copolymer is deposited on a stretched synthetic fiber multifilament yarn.

5. A method of producing bundled mutifilament yarn which comprises melt-spinning the yarn and then treating the yarn with an aqueous emulsion of an oily agent in combination with a rosin ester of a random copolymer of ethylene oxide and propylene oxide in an amount of 5–70% based on the weight of non-aqueous components, said rosin ester being used in an amount of more than 0.1% based on the weight of the yarn; and wherein the average molecular weight of the random copolymer is 5000 to 20,000 and the ratio of ethylene oxide to propylene oxide in the copolymer is 50–85 mol % of ethylene oxide to 15–50 mol % of propylene oxide.

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