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[54] **PROCESS FOR PRODUCING PLY YARN FROM THREADS OF FIBERS**

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[58] **Field of Search** ..... 57/140 R, 140 BY, 157 TS, 57/157 MS

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[57] **ABSTRACT**

A process for producing a voluminous, balanced and elastic ply yarn from a mixture of non-keratinous natural fibres and discontinuous man-made fibres or only discontinuous man-made fibres. The process comprises:

a. twisting at least two single thermoset threads having a twist factor α_1 of 95–110 into ply yarn having an initial twist factor α_2 of 110–125;

b. thermosetting said initial twist of said twisted yarn;

c. overtwisting the ply yarn in the direction opposed to said initial twist with a twist factor α_3 of 275–290 while heat treating it in said overtwisted state;

d. returning the ply yarn to said initial twist, and

e. sizing the ply yarn in a relaxed state before winding the ply yarn onto a support.

16 Claims, No Drawings

PROCESS FOR PRODUCING PLY YARN FROM THREADS OF FIBERS

The present invention relates to methods for manufacturing voluminous balanced elastic ply or twisted yarns.

Hereinafter, the expression "single thread" will be employed to designate threads of discontinuous fibres and "ply yarn" to designate the twisted assembly of two or more single threads. It will be recalled that Kochlin's formula for determining the twist is:

$$T = \alpha \times \sqrt{Nm}$$

in which T is the twist in turns per metre and α is the twist factor and Nm is the metric number of the threads, i.e., the length in kilometers, of 1,000 gr of said threads.

It is known to manufacture a ply yarn having a synthetic organic continuous textile fibre obtained by twisting together two single threads of which one has a twist S and the other a twist Z, by overtwisting the ply yarn temporarily by subjecting it to a heat treatment in this state and returning it to its initial twist. This temporary high twist can be achieved by means of a twisting machine having rings or steps or by a continuous operation by means of a false twisting device.

However, this method has the drawback of producing ply yarns which are hardly suitable for knitting owing to their excessive elasticity. Furthermore, in order to obtain a balanced ply yarn which does not produce, when knitted, articles that twist or spiral, it is usual to twist together threads of opposite twist directions (S and Z). The necessity of spinning and twisting single threads having twists S and Z complicates manufacture may be the cause of errors and bad workmanship.

Consequently, it was envisaged to treat mixed yarns of natural and synthetic fibres so as to produce a ply yarn having the desired qualities.

Thus, the method has been suggested which comprises:

a. preparing single threads with a twist factor of 90 in the direction S;

b. twisting two of these single threads in the Z direction with a very high twist factor of 300 without having previously thermoset them;

c. thermosetting the ply yarns for several minutes;

d. untwisting the ply yarn and fixing it in the direction S with a twist factor of 200, and

e. effecting a foaming operation.

The last operation is essential since the ply yarn would otherwise have a dry handle as though it had no natural fibres. This handle is due to the excessive twists to which the yarn has been subjected. This ply yarn ressembles a crepe thread having a low elastic regain and a high kinking tendency.

The following has also been proposed:

a. preparing the single thread with a low twist factor of 95 in the Z direction;

b. twisting two of these single threads in the S direction with a twist factor of 135 without previously thermosetting the threads;

c. temporarily overtwisting the yarn in the S direction with a twist factor of 275, thermosetting in this state, and

d. returning to the twist indicated in paragraph b.

The ply yarn obtained lacks elasticity, evenness and bulk, and has a high tendency to kink. In the two foregoing processes the tendency to kink complicates the subsequent use of the product obtained.

An object of the invention is to provide a process whereby it is possible to obtain a ply yarn having much higher qualities than those of ply yarns known heretofore and in particular a good bulk, a suitable elasticity and an excellent evenness. Further, the ply yarn according to the invention is well balanced and enables knitted articles to be made which do not twist up.

The invention provides a process for producing elastic, voluminous and balanced ply yarn from threads of a mixture of natural non-keratinous fibres and discontinuous man-made fibres or only discontinuous man-made fibres comprising:

a. twisting at least two single thermoset threads having a twist factor α_1 of between 95–110 into a ply yarn having an initial twist factor α_2 of 110–125;

b. thermally setting the initial twist of said twisted yarn;

c. overtwisting the ply yarn in the direction opposed to its initial twist with a twist factor α_3 of 275–290 while heat treating it in this temporarily overtwisted state;

d. returning it to its initial twist, and

e. sizing it in a relaxed state before winding it onto a support.

These well-defined operations of twisting and setting effected in the indicated order result in a ply yarn having incomparable qualities.

Advantageously, the mixture comprises 30–70 and preferably 30–60 percent by weight of natural fibres and 70–30, and preferably 60–40 percent by weight of man-made fibres.

By non-keratinous natural fibres is meant in this description, by way of a non-limitative example, fibres of plant origin such as linen, cotton, hemp and jute, these fibres being replaced wholly or partly by artificial fibres if desired.

Among the man-made fibres which are suitable for the invention there may be mentioned, by way of non-limitative examples, polyester fibres such as terephthalates of polyethylene glycol, polyamide fibres, acrylic fibres, polypropylene fibres, chloralfibre fibres, polyvinyl fibres and generally any other thermoplastic fibre.

The man-made fibres and the natural fibres can have a length of about 25–200 mm.

Note that the proportions of the lengths of both the natural and man-made fibres can vary within certain limits, although the best results are substantially identical.

The sequence of operations for obtaining a ply yarn according to the invention from two single threads will be now described in more detail.

The first step of the process comprises twisting together single threads in a direction opposed to the twist of the single thread.

Each single thread is thermoset at a pressure of under roughly 70 cm of mercury and a temperature of about 80°–100°C, and preferably in the neighbourhood of 90°C, for about 15–30 minutes, and preferably about 20 minutes, with a twist factor α_1 of about 95–110, and preferably 100–105.

The single threads thus obtained can be twisted together with a twist factor of about 110–125, and preferably between 115–120.

The second step of the process comprises thermally setting the initial twist of this ply yarn. The operation

is usually carried out in the same conditions of temperature and pressure as those carried out for thermofixing the single threads. This setting can be carried out in an oven.

The third step of the process comprises untwisting the ply yarn and twisting it in a direction opposed to its initial twist with a twist factor α_3 of about 275–290, and preferably 280–285, while heat treating it in this temporarily overtwisted state. It is advisable to effect the untwisting with an elongation of the twisted yarn of about 0.1–2 percent.

The untwisting facilitates the distribution of the subsequent texturizing twisting and permits obtaining a very even texturized ply yarn.

The heat treatment is carried out at a temperature in the neighbourhood of the softening point of the man-made fibre i.e. a temperature at which the molecules of the fibre material are displaced or the fibre material is plasticized, provided that the natural fibre which is mixed with this thermoplastic fibre does not deteriorate at this temperature.

In order to alter as little as possible the natural fibre, it is well to carry out the heat treatment on a very damp ply yarn having for example a moisture content by weight exceeding the official moisture regain rate of the fibre mixture. For cotton, this rate is known to be 8.5 percent.

By adjusting the operational conditions in a manner to satisfy the formula:

$$(v^b \times 100)/60\ (\alpha_3 \quad \sqrt{Nm + T})\ 2^c/3 \qquad \leqslant 1$$

in which V^b is the speed of the false twist spindles in rpm, $\alpha_3 \sqrt{Nm}$ is the temporary twist in turns per metre, T is the initial twist of the ply yarn in turns per metre and C is the length of passage of the twisted yarn in centimetres in or on the heating element, satisfactory results are obtained. In practice, the foregoing formula implies treating periods exceeding one second and usually 1–3 seconds.

The fourth step of the process comprises returning the ply yarn to its initial twist. It has been found that the ply yarn retains its curling, even after a prolonged storage, when this step is carried out with a shrinkage upon reception on the bobbin of about 16–35 percent.

In the fifth step of the process the ply yarn is sized in a relaxed state and it is wound onto a preferably cylindrical support. The sizing can be effected on a false twisting machine with:

conventional sizing products comprising a large proportion of methyl alcohol,

waxes solidifying on the thread upon drying.

These products can be employed in the hot or cold state and preferably in the cold state (for example, between 15° and 25°C).

The amounts applied can be between 0.5 and 10 percent, depending on the product and the needs.

In the case of production on texturizing machines and in particular when employing the process known under the name "False twist" either with spindles or other false twist systems according to the "unfixed" technique or according to the "fixed false twist" technique, the foregoing steps 3,4 and 5 are carried out continuously.

The following examples illustrate the invention:

EXAMPLE 1

Single threads of Nm 60 are formed by intimately mixing 67 percent by weight of TERGAL fibres of type 110 (polyester cutting 40 mm) and 33 percent by weight of combed America cotton.

The Nm 60 was spun with a twist of 810 turns/metre (Z) and this twist was set in an oven under a vacuum for 20 minutes at a temperature of 90°C (maintained). The Nm 60/2 ply yarn was twisted at 660 t/m(S) and set for 20 minutes at 90°C.

The texturizing was carried out on a false twisting machine in the following conditions:

Indicated twist	2,197 turns (Z)
Speed of the false twist spindles	72,900 rpm
Texturizing twist	1,537 turns (Z)
Elongation	2%
Shrinkage upon reception	18%
Temperature upon texturizing	210°C
Sizing with 5% of product having a methyl alcohol base	
Length of the heating element	1 metre
Moisture content	6%

The ply yarn obtained has: an even appearance, bulk, is elastic and has a strength of 870 g, that is, a kilometric resistance (KMR) = 26.1.

EXAMPLE 2

Single threads are formed by intimately mixing 50 percent by weight of polyamide fibres 6/6 (cutting 60 mm) and 50 percent by weight of combed American cotton of metric number 30.

The Nm 30 was spun with a twist of 570 turns/metre (Z) and this twist was set in an oven under a vacuum for 20 minutes at 90°C. The ply yarn Nm 30/2 was twisted at 465 turns/metre (S) and set for 20 minutes at 90°C and then sized.

The texturizing was carried out on a continuous false twisting machine in the following conditions:

Speed of the false twist spindles	54,800 rpm
Indicated twist	1,550 turns/metre (Z)
Texturizing twist	1,085 turns/metre (Z)
Elongation	2%
Shrinkage upon reception	18%
Moisture content	5.5%
Texturizing temperature	200°C
Length of the heating element	1 metre

The ply yarn obtained has a very even appearance, bulk and has good elasticity and a strength of 1,100 g.

Articles were knitted by using the ply yarns produced in Examples 1 and 2. The ply yarns have a good knittability and the knitted articles have the following properties:

a. Appearance and handle of the articles similar to those of natural fibres.

b. The columns of the stitches are vertical and do not spiral.

c. The tendency to pill is that of articles knitted with non-elastic threads.

d. The dimensional stability of the knitted articles is at least equal to that of articles knitted with non-texturized threads with the following results:

After relaxation, washing and relaxation by vibrations, the % dimensional variations are:

in the direction of the column: between −1.1 and −2.2,

in the direction of the rows: between −0.4 and +0.4.

These values result from the following test conditions:

1. The relaxation is effected in an aqueous bath to which is added a wetting agent for 30 minutes at 95°C; with wringing and treatment in a relaxing machine for 5 minutes in a steam medium and then drying in the flat condition.

2. The washing is carried out once in a washing machine at 40°C for 30 minutes with a solution containing 3 g/l of commercial detergent; then the article is rinsed, wrung and dried.

3. For the relaxation by vibrations, the specimen is sprayed with a solution of wetting agent and treated in a relaxing machine for 5 minutes in a steam medium then dried in the flat state.

e. The elastic regain in the knitted articles exceeds that of articles based on non-texturized threads with the following results:

elastic regain in the wet state: 75–90 percent in the direction of the columns and rows;

elastic regain in the dry state: 80–90 percent in the direction of the columns and rows.

The elastic regain tests were carried out on rectangular specimens having a length of 300 mm. The initial distance between the jaws is 200 mm. The specimens are subjected to an elongation of 30 percent for 30 minutes, the regain time being 30 minutes.

Having now described my invention what I claim and desire to secure by Letters Patent is:

1. A process for producing a voluminous balanced and elastic ply yarn comprising a plurality of single threads of a mixture of non-keratinous natural fibres and discontinuous man-made fibres, comprising:

twisting each of said single threads in a first direction, with a twist factor α_1 of 95–110 then thermosetting each of said twisted single threads,

twisting said single twisted threads together into a ply yarn having an initial twist in a second direction opposed to the first direction, with an initial twist factor α_2 of 110–125,

thermosetting said initial twist of said ply yarn,

untwisting the ply yarn by twisting the ply yarn in said first direction opposed to said initial twist then overtwisting the ply yarn in said first direction with a twist factor $\alpha 3$ of 275–290 while heat treating the ply yarn in said overtwisted state to a temperature which is sufficient to permanently modify the molecules of the man-made fibres but insufficient to impair the natural fibres,

returning the ply yarn to said initial twist then relaxing the ply yarn and winding said ply yarn onto a support,

the process further comprising imparting to the ply yarn before said heat treatment a moisture content by weight which exceeds the official moisture regain rate of the mixture of fibres.

2. A process as claimed in claim **1**, wherein said twist factor α_1 is 100–105.

3. A process as claimed in claim **1**, wherein said twist factor α_2 is 115–120.

4. A process as claimed in claim **1**, wherein said twist factor α_3 is 280–285.

5. A process as claimed in claim **1**, wherein the fibres have a length of about 25 mm – 200 mm.

6. A process as claimed in claim **1**, wherein the single threads are thermoset at a pressure below substantially 70 cm of mercury at a temperature of about 80°–100°C for a period of about 15–30 minutes.

7. A process as claimed in claim **1**, wherein said temperature is substantially 90°C.

8. A process as claimed in claim **1**, wherein said period is substantially 20 minutes.

9. A process as claimed in claim **1**, wherein the ply yarn is thermoset at a pressure lower than substantially 70 cm of mercury at a temperature of about 80°–100°C for a period of about 15–30 minutes.

10. A process as claimed in claim **1**, wherein the initial twisted ply yarn is untwisted by twisting in the first direction with an elongation of about 0.1–2 percent.

11. A process as claimed in claim **1**, wherein said overtwist is effected with false twist spindles and heating element in conditions which satisfy the formula:

$$V^b \times 100/60\ (\alpha_3\ \sqrt{Nm + T})\ 2^c/3 \leqslant 1$$

in which V^b is the speed of the false twist spindles in rpm, $\alpha_3\ \sqrt{Nm}$ is the temporary twist in turns per metre, α_3 is the twist factor, Nm the metric number of the ply yarn, T is the initial twist of the ply yarn in turns/metre and C is the length in centimetres of passage of the ply yarn along the heating element.

12. A process as claimed in claim **1**, wherein the ply yarn is brought back to said initial twist with a shrinkage of 16–35 percent.

13. A process for producing a voluminous balanced and elastic ply yarn comprising a plurality of single threads of a mixture of non-keratinous natural fibres and discontinuous man-made fibres, comprising:

twisting each of said single threads in a first direction, with a twist factor α_1 of 95–110 then thermosetting each of said twisted single threads,

twisting said single twisted threads together into a ply yarn having an initial twist in a second direction opposed to the first direction, with an initial twist factor α_2 of 110–125,

thermosetting said initial twist of said ply yarn,

untwisting the ply yarn by twisting the ply yarn in said first direction opposed to said initial twist then overtwisting the ply yarn in said first direction with a twist factor α_3 of 275–290 while heat treating the ply yarn in said overtwisted state to a temperature of substantially 200°C,

returning the ply yarn to said initial twist, then relaxing the ply yarn and winding said ply yarn onto a support,

the process further comprising imparting to the ply yarn before said heat treatment a moisture content by weight which exceeds the official moisture regain rate of the mixture of fibres.

14. A voluminous balanced and elastic ply yarn comprising a plurality of single threads of a mixture of non-keratinous natural fibres and discontinuous man-made fibres, said yarn being the result of a process comprising:

twisting each of said single threads in a first direction, with a twist factor α_1 of 95–110 then thermosetting each of said twisted single threads,

twisting said single twisted threads together into a ply yarn having an initial twist in a second direction opposed to the first direction, with an initial twist factor α_2 of 110–125,

thermosetting said initial twist of said ply yarn,

untwisting the ply yarn by twisting the ply yarn in said first direction opposed to said initial twist then ov-

ertwisting the ply yarn in said first direction with a twist factor α_3 of 275–290 while heat treating the ply yarn in said overtwisted state to a temperature which is sufficient to permanently modify the molecules of the man-made fibres but insufficient to impair the natural fibres,

returning the ply yarn to said initial twist, then relaxing the ply yarn and winding said ply yarn onto a support,

the process further comprising imparting to the ply yarn before said heat treatment a moisture content by weight which exceeds the official moisture regain rate of the mixture of fibres.

15. A textile article comprising at least one ply yarn which comprises a plurality of single threads of a mixture of non-keratinous natural fibres and discontinuous man-made fibres, said yarn being the result of a process comprising:

twisting each of said single threads in a first direction, with a twist factor α_1 of 95–110 then thermosetting each of said twisted single threads,

twisting said single twisted threads together into a ply yarn having an initial twist in a second direction opposed to the first direction, with an initial twist factor α_2 of 110–125,

thermosetting said initial twist of said ply yarn,

untwisting the ply yarn by twisting the ply yarn in said first direction opposed to said initial twist then overtwisting the ply yarn in said first direction with a twist factor α_3 of 275–290 while heat treating the ply yarn in said overtwisted state to a temperature which is sufficient to permanently modify the molecules of the man-made fibres but insufficient to impair the natural fibres,

returning the ply yarn to said initial twist, then relaxing the ply yarn and winding said ply yarn onto a support,

the process further comprising imparting to the ply yarn before said heat-treatment a moisture content by weight which exceeds the official moisture regain rate of the mixture of fibres.

16. A process for producing a voluminous balanced and elastic ply yarn comprising a plurality of single thread of a mixture of non-keratinous natural fibres and discontinuous man-made fibres, comprising:

twisting each of said single threads in a first direction, with a twist factor α_1 of 95–110 then thermosetting each of said twisted single threads,

twisting said single twisted threads together into a ply yarn having an initial twist in a second direction opposed to the first direction with an initial twist factor α_2 of 110–125,

thermosetting said initial twist of said ply yarn,

untwisting the ply yarn by twisting the ply yarn in said first direction opposed to said initial twist then overtwisting the ply yarn in said first direction with a twist factor α_3 of 275–290 while heat treating the ply yarn in said overtwisted state to a temperature which is sufficient to permanently modify the molecules of the man-made fibres but insufficient to impair the natural fibres,

returning the ply yarn to said initial twist, then relaxing the ply yarn and winding said ply yarn onto a support.

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