Development of Polyester/Acrylic/PTT Imitating Mink Cashmere Knitted Fabric

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Abstract. In order to produce a kind of imitating mink cashmere knitted fabric with light, soft, suede fullness and fine texture, being well received by consumers, polyester/acrylic/PTT were selected to design spinning and knitting process, finally each process of 21tex blended yarn on the polyester/acrylic/PTT (40/30/30) took the necessary measures by repeated experiments. To improve the yarn performance, the three factors of spinning process from drafting ratio, spacer thickness, cradle pressure were designed by orthogonal design, and the two indexes (yarn strength and yarn hairness) optimization ensured spinning yarn meet the knitting yarn. Knitting imitation mink cashmere fabric has good fabric appearance and wearing properties and reduce the cost of production, which meet the need of consumers.

Introduction

Imitating mink cashmere knitted fabric has some superior properties, such as soft, light, smooth, warm, unique style, full suede, good warmth retention property, so it is well received by consumers. However, wild animal fur has tapered, and the market price is rising with the improvement of people's consciousness of protecting wild animals, therefore, it is very important to develop imitating fur products [1].Imitating cashmere knitted fabric has been developed in recent years. Compared with natural fur, imitating cashmere knitted fabric has many advantages, such as Light, soft, bulky hand, bright in color, non- stale and cheaper price.

Polyester fiber has high modulus, good elasticity. Polyester fabric has good crinkle-proof, dimension stability and shape retention [2]. Acrylic fiber has soft touch and high elasticity, so it is nicknamed "synthetic wool" [3]. PTT fiber has good resistance to fouling, comfortable elasticity, soft handle and excellent drapability[4].

In this paper, three kinds of fibers are selected to design spinning and knitting process, then, 21tex blended yarn process on the polyester/acrylic/PTT (40/30/30) takes the necessary measures by repeated experiments. Selecting draft after, gauge thickness and cradle pressure for designing orthogonal tests. And, the test optimize spinning process by the yarn strength and hairiness, in this case, the yarn could meet the requirements of weaving. Knitting yarn as the one base of Imitating mink cashmere knitted fabric, the other side of the base is the villi. The imitating mink cashmere knitting fabric reduces the production cost, and meets the needs of the consumers under the condition of good fabric appearance and costume performance.

Material Selection and Production Process

Fineness of polyester fiber is 1.7 dtex, its length is 38 mm, its moisture regain is 0.4%. Fineness of acrylic fiber is 3.3 dtex, its length is 38 mm, its moisture regain is 2%. Fineness of PTT fiber is 1.6 dtex, its length is 38 mm, its moisture regain is 0.5%. Polyester, acrylic and PTT are mixed according to the wet weight blend ration of 38/31/31.Three kinds of fibers have quick wet absorption and bigger static electricity in the production, so inventory antistatic agent of 0.5% is needed for ensuring production. Water should be determined according to the moisture regain of raw
material and the temperature and humidity of the workshop. The relative humidity of workshop should be kept in the 75-80% to reduce the damage of the fibers[5].

Specific technological process is as follows:

2 × A0022 disc type plucker→FA121 metal impurity removal equipment→FA104 six roller opener(attached A045B cotton type setting)→FA022 warehouse mixing machine→FA106 porcupine opener(attached A045B cotton type setting)→FA107 porcupine opener (attached A045B cotton type setting )→A062 the cotton electrical distribution(the cotton two-way match)→2 × A092AST vibrating hopper feeder(attached A045B cotton type setting)→2 × FA141 singles hand rollmachine→FA201B carding machine→FA306 drawing frame( × 3)→FA458A rovingframe→FA507B spinning frame→ NO.21C Automatic winder→HP-18SMM man fur knitting machine of number E14→finishing technology

The Main Technology Measures in Each Process

Scutching Process

In the actual production process, the three kinds of raw materials are synthetic fibers, they have a quick wet absorption and bigger static electricity, especially, polyester fiber and PTT fiber in the production. Three kinds of fibers need wet application and place for 24 hours before they are used. It can be solved by adding talcum powder on the lap roller when there is still more difficult in rolls. Specific Blowing process parameters are as follows: lap dry quantitative is 395 g/m, the speed of the porcupine beater is 800r/min, lap roller speed 12.3 r/min, the speed of comprehensive beater is 1001.7 r/min, the distance of the blade out of shelf is 5.0 mm, falling distance of beater intermittence is 5 mm/time. The experiment measured the quality of cotton lap irregularity is 1.0%.

Carding Process

The electrostatic phenomenon is weak when adding the agent. The roll is poor compared with the roll of ordinary polyester in the factory, the reason may be less PTT fiber, so, on the process conditions, it is difficult to do a large number of uniform roll mixing effect which the same as the factory generally do. Main technical parameters of carding process are as follows: Card sliver dry quantitative is 21.51g/5m. Rotation rate of cylinder is 359.02r/min. Doffing speed is 359.02r/min. Roller rotation speed is 28.3 r/min. Flat linear speed is 140.41mm/min. Separation between cylinder and flats is 0.25 0.23 0.2 0.2 0.23mm. Separation roller and cylinder is 0.18mm. The experiment measures that the weight unevenness of card sliver is 4.1% and uster yarn irregularity of the card sliver is 4.4%.

Drawing Process

During the drawing process, in order to reduce the fiber winding roller phenomena, drawing process takes some measures, such as improving the fiber straight parallel degree, improving sliver unevenness, the draft zone with heavy pressure, and low speed. Chemical fiber should be pre-drawing, and the drafting ratio at back zone to help remove the leading hook, and the main process parameters are shown in table 1. Experimental measured in sliver quality irregularity is 8% and the CV is 3.2%.
Roving Process

Due to poor cohesiveness of fibers, roving process should use heavy pressure in draft zone. The front draft zone undertakes main draft. The back draft zone belongs to simple roller draft form, therefore, its ability to control the fiber is poor, and the small draft should be used. To effectively reduce long neps defects of the knitting yarn and the burden of draft, the low twist factor should be used. The specific process parameters are as follows: Roving quantitative is 4.07g/10m. Front roller speed is 224.27 r/min. Spindle speed is 625.7 r/min. The back zone draft is 1.31 times. Twist factor is 64.27. The roller center distance (front×middle×back) is separately 35×49×55mm. Roller pressure is 120×300×200×50 N/double spindle.

The experiment shows that the quality of roving irregularity is 1.2%, and uster sliver is 7.9%.

Spinning Process and Winding Process

In spinning process, in order to make the draft progress well, the drafting roller nip must have enough grip force, so as to adapt to the change of the drafting force.

Avoiding roller pressure insufficiently, otherwise yarn will slip under the back of roller nip and will increase the yarn uneven and weight deviation. Specific spinning process parameters are:

Drafting ratio of back zone is 1.20 times. Twist factor is 330. Spindle rotate speed is 14287.9 r/min. The front roller speed is 175 r/min.

Automatic winding machine mainly to clear yarn defects, setting clear scope of yarn: Thick<50% (50cm). Long slubs>50%(50cm). The chunky>200%(3cm). The speed is 850m/min.

The Determination of Quality Indicators about Process Optimization. The back draft range is between 1.04 and 1.20, which belongs to the simple roller draft. The reasonable back zone draft can reduce the burden of the front draft and is good to control fiber movement. Plate thickness of gauge can determine the distance between two apron pin. Reasonable gauge is beneficial to improve yarn quality. In order to make the draft, the roller must have enough grip force. So selecting zone draft multiple, gauge thickness, cradle pressure as the performance of yarn process optimization, choosing strength and hairiness as quality indexes of process optimization in the spinning process.

The Analysis on Influence Factors of Quality Index. When the back draft is close to the critical draft ratio, the yarn hairiness is less, the yarn CV value is lower, and the thick and thin neps are less. Too large spacing block is bad for yarn evenness, however, too small is easy to result in a "dead jaw". Increasing roller weighting can stabilize draft, control float fibers, reduce thin neps of knitting yarn and enhance the yarn strength. Considering the final performance of the three factors affect for the yarn, selecting the back draft, spacing block and cradle pressure optimize the design of spinning process.

A scheme of orthogonal test about polyester/ acrylic/PTT (40/30/30), which includes three factors and three levels, was designed (in Tab.2). A scheme of orthogonal test and the test results are shown in Tab.3.
Design of Three Factors and Three Levels Orthogonal Experimental

Table 2. Orthogonal experiment of three factors and three levels.

<table>
<thead>
<tr>
<th>levels factors</th>
<th>A (the back draft)</th>
<th>B (gauge block)</th>
<th>C (cradle pressure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.2</td>
<td>4.0</td>
<td>2.0</td>
</tr>
<tr>
<td>2</td>
<td>1.1</td>
<td>3.5</td>
<td>2.5</td>
</tr>
<tr>
<td>3</td>
<td>1.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Table 3. Test programs and results about orthogonal spinning experiment.

<table>
<thead>
<tr>
<th>samples</th>
<th>the back draft</th>
<th>thickness of gauge block</th>
<th>cradle pressure</th>
<th>strength /CN</th>
<th>3mm hairiness /amounts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.2</td>
<td>4.0</td>
<td>2.0</td>
<td>417.1</td>
<td>3.200</td>
</tr>
<tr>
<td>2</td>
<td>1.2</td>
<td>3.5</td>
<td>2.5</td>
<td>411.2</td>
<td>2.200</td>
</tr>
<tr>
<td>3</td>
<td>1.2</td>
<td>3.0</td>
<td>3.0</td>
<td>395.3</td>
<td>1.600</td>
</tr>
<tr>
<td>4</td>
<td>1.1</td>
<td>4.0</td>
<td>2.0</td>
<td>441</td>
<td>4.250</td>
</tr>
<tr>
<td>5</td>
<td>1.1</td>
<td>3.5</td>
<td>3.0</td>
<td>349</td>
<td>2.000</td>
</tr>
<tr>
<td>6</td>
<td>1.1</td>
<td>3.0</td>
<td>2.5</td>
<td>363.3</td>
<td>1.000</td>
</tr>
<tr>
<td>7</td>
<td>1.0</td>
<td>4.0</td>
<td>2.0</td>
<td>440.8</td>
<td>2.400</td>
</tr>
<tr>
<td>8</td>
<td>1.0</td>
<td>3.5</td>
<td>3.0</td>
<td>306</td>
<td>3.334</td>
</tr>
<tr>
<td>9</td>
<td>1.0</td>
<td>3.0</td>
<td>2.5</td>
<td>274.7</td>
<td>4.120</td>
</tr>
</tbody>
</table>

Results and Discussions. The results about orthogonal test of strength and hairiness are shown in Tab.4.

Table 4. Analysis of orthogonal test.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Strength</th>
<th>hairiness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>K1j</td>
<td>1225.4</td>
<td>1298.9</td>
</tr>
<tr>
<td>K2j</td>
<td>1153.3</td>
<td>1076.2</td>
</tr>
<tr>
<td>K3j</td>
<td>998.7</td>
<td>997.3</td>
</tr>
</tbody>
</table>

\[
\overline{K}_{ij} = \frac{1}{S} K_{ij}
\]

Remarks: B is the thickness of gauge block and C is the cradle pressure in Table 3; \( K_{ij} \) is the level number of the i; \( S \) is the number when i appears.
of the j column, $\bar{K}_j$ indicating that factors j column when to level i, the mean value of obtained experiment results; $R_j = \max\{K_{ij}\} - \min\{K_{ij}\}$, $R_j$=the range or range of factors on j column.

It can be seen from Tab.3, the draft ratio, thickness of gauge block, cradle pressure are three main factors on yarn hairiness and strength, and the impact abilities are: B>C>A. In the process of selecting the best solution, the back draft ratio A1, thickness of gauge block B1, cradle pressure C1 are the best process. It is to say when the back draft ratio is 1.2, gauge block thickness is 4mm, cradle pressure is 2, and the yarn has the best breaking strength. While when the back draft ratio is A1, thickness gauge block is B3, cradle pressure C3, the back draft ratio is 1.2, and the thickness of gauge block is 3, cradle pressure is 3.0, yarn hairiness is the least. According to the impact of the three factors are B>C>A, best programs to optimize strength-based were chose. The back draft ratio is 1.2, gauge block thickness is 4mm, cradle pressure is 2, which can spin yarn with optimal performance.

Weaving

The high simulation mink cashmere knitted fabric adopt slivers feeding to form plush. When ground yarn is fed into the fabric, specialized feeding and carding mechanism is used to feed fibrous slivers. Knitting needle grasps a certain amount of fiber bundle and hook for feeding of yarn, which are woven together into a circle. The two head end of the fiber strip is exposed to the opposite side of the fabric. Specific process parameters are as follows: barrel diameter of 762mm, the total number of stitches 1056 needles. Ground yarn: Polyester/Acrylic/PTT (40/30/30) 21tex blended. Slivers weight: 13g. Total feeding density: 60%. Feeding Density: 100%. Fabric width: 1.45m. Fabric density: horizontal 14 stitches/inch. Vertical: 22 mesh/inch. Gram weight 800g/m2.

Finishing

The main finishing process of imitation mink cashmere is pre-cut shape → finalize the design→hot light→shearing→packaging stereotypes. Appropriate to reduce the height of the hair on pre-cut. Then the hair will be cut on low temperature to obtain a high shearing fine view, as well as smooth and uniform. At the same time, the design finalize can eliminate stereotypes produce wrinkles in the pre-treatment process. The finished product can be maintained good dimensional stability and smooth appearance [6]. Mink cashmere setting machine temperature is controlled at 135°C~155°C, width 155m±2cm, gram weight 1000g/m or so, pile height 16~19mm. Finishing hot light decreases the plush fiber density and increases flexibility [7]. Considering the heat resistance of raw materials, reasonable hot light temperature on the hot light is very important. Hot light temperature of imitation mink velvet fabric does not exceed 160°C, from 150°C high temperature to 90 °C, and low temperature has a total of 11 times. Imitated mink wool fabric shearing is higher than yarn height of 20%-30%. Pre-cut shearing blade pitch is 15mm, while finished scissors shearing blade pitch is 18mm. In order to achieve better quality and high simulation effect on mink product, further processing has been added. Finishing auxiliaries washing makes mink cashmere fiber products supplier, more beautiful, and delicate touch.

Conclusion

The procedures of the spinning of polyester/acrylic/PTT (40/30/30) 21tex composite yarn were necessary measures. The yarn which can meet the requirements of the knitting was weaved as imitation mink cashmere fabrics grassroots. The imitation mink suede is soft, fluffy, elegant and with a strong sense of fur. Currently, the general plush fabrics cannot meet people's needs. Our future efforts should take advantage of modern science and technology to develop a high versatility imitation plush fabric.
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