Advances in Engineering Research, volume 181
International Conference on Electronical, Mechanical and Materials Engineering (ICE2ME 2019)

Research on the Color Difference of Single Group Colored Yarn by Different Processing Methods

Jingru Yang and Tianyong Zheng*
Zhongyuan University of Technology, Henan, China
*Corresponding author

***Abstract*—Different processing methods of colored yarns were applied in the past few years for meeting the different demands of color mixing. However, insufficient understanding of the color difference caused by processing method leads to lack of basis for reasonable selection of processing method. In this study, twelve kinds of colored yarn samples from single group colored fibers were spun by ring spinning and rotor spinning respectively, also with different mixing methods and color ratios. Then the color differences were measured by spectrophotometer, and effect of processing method on the color difference was analyzed. The results show that processing method has a great influence on the color difference of single group colored yarn.**

Keywords—colored yarn; color difference; ring spinning; rotor spinning

I. Introduction

The object of color measurement of colored yarn is usually the finished knitting fabric. However, the procedure of colored yarn could be different, and the color mixing methods could not be the same. There was no systematic research on the color difference caused by processing method. The factories could not find the production problems in time due to insufficient attention to the color difference, which could cause production efficiency and economic losses frequently. In this paper, the influencing factors of the color difference of single group colored yarns caused by different processing methods were studied.

Low volume, multi-species and multi-batches are major features on the process of colored yarn. A few tens of kilograms and hundreds of kilograms orders would not be surprised. For this kind of orders, not only the possibility of using carding is low, but equipment suitable for mass production, such as bale openers and multi-bin mixers, is not suitable. However, the development trend of spinning machinery requires faster speeds and greater output, which is counterproductive to the characteristics of colored yarn. In this case, many small factories do not use advanced high-speed spinning equipment instead of traditional low-speed equipment to process colored yarns. So the processing of colored yarns makes the impression that the production threshold is so low that small factories could take the orders. Actually, the production threshold of colored yarn is very high. The process of colored yarns needs efficient production management and high quality control.

II. Materials and Methods

A. Brief Summary

There are a great number of spinning methods to process colored yarns. From the aspects of processing equipment, open and clean cotton coiling equipment, carding and joining equipment, wool spinning front equipment, ordinary ring spinning equipment, remodeled draw frame and roving frame, siro-spinning equipment, compact spinning equipment, rotor spinning equipment, air-jet vortex spinning equipment, fancy yarn equipment, and special colored spinning equipment are examples of applications in the process of colored yarns. According to actual requirements, every factory selects different equipment and combines a variety of processes to process colored yarns. Most factories still use the traditional processing method such as ring spinning.

The reason is essentially for meeting the demand of color mixing. Different mixing method leads to different processing method. At present, in the production of colored yarns, mixing bulk fibers is the main way of fibers mixture. According to the color matching requirements, several different colors of fibers were weighed separately, and these fibers were mixed together and then they were conventionally spun. The yarn process, after clearing, carding, and drawing, is obtained by dyeing the sliver, and then spinning into colored yarn. Manual blending, cotton blending, blender blending, wool blending, and bale blending belongs to bulk fiber blending.

Another way is using the draw frame to achieve the paralleled color mixing. Different types of fiber could be made into slivers by different cleaning processes, and then be combined together to achieve different sliver quantification through different proportional mixing. The mixing ratio is consistent in the longitudinal direction of the slivers. However, there are drawbacks in the paralleled stripping. The two parallel blends often fail to meet the blending requirements. If multiple strips are to be drawn, it would lead to excessive drafting and increase the number of draw frames. In addition, the process of mixing slivers may cause broken slivers, missing slivers, bridging, resulting out of control of the proportion of components. Even auto-leveling draw frame could not solve the problem.

B. Mixing Methods

There are many kinds of processing methods for colored yarn, and mixing method is the key factor. Here are some common mixing methods.

1) Manual mixing: Which is known as artificial mixing, has low production efficiency, high labor intensity, poor working environment, and unstable quality: It is difficult to ensure the color uniformity and applied to small proportion color production and proofing. A small amount of different types of fibers are weighed in proportion, the total amount is up to 50kg. The fibers need to be manually torn and repeatedly mixed, and then be fed into the spinning process. Although the manual mixing is inefficient, it has the advantages of undamaging the fiber, unlimited composition, and adapting to small batches and many varieties. It could meet some special requirements for colored yarns. Therefore, it is still in use.

2) Cotton box mixing: The principle of the machine is cross-ply and multi-layer mixing. The practice has proved that colored yarns with little difference in fiber properties and color still meet the mixing requirements, while it is difficult to meet the requirements for colored yarns where multiple components, different colors, and different properties of fibers are fully mixed to achieve a uniform effect.

3) Multi-tank blender mixing: Multi-warehouse blenders are mixed through the time difference mixing principle, which is better than ordinary cotton box, but it still could not meet the precise and uniform requirements. The first problem is that it does not adapt to small batches and many varieties. Secondly, the thickness of the active control output material does not meet the exact mass ratio requirements. Thirdly, the blended fiber components are limited and could not exceed the number of positions.

4) Special blender mixing: This machine is not complicated. The blender generates random mixing, tiled direct taking, reverse mixing and other mixing methods. The decomposition of fibers is flexible tearing, which is similar to artificial ways, but more delicate and uniform than it.

5) Wool fiber machine mixing: The wool blender machine is used to complete the mixture of colored fibers, and then the fibers are put into the normal spinning process.

6) Bales mixing: The colored fibers from the bale plucker are packaged and fed into the ordinary spinning process.

7) Drawing frame mixing: The combination of drawing processes has certain mixing effect. However, it only be used as an auxiliary method. According to the proportion of color slivers, the "one mixing two drawing" method or "two mixing one drawing" method could be chose.

8) Sliver and lap mixing: This method is also referred to as the double-comb process, or the blending process, it combines slivers with cleaning laps. Generally, there are two methods. One method is feeding the combing slivers into rolling machine and sending to combing curtain. The rotation of horn rollers drives slivers and colored fibers to the rolling machine where they are combined to form a mixed fiber roll. The other method is to feed combed sliver from carding machine and cotton lap into the rolling machine where they are made into cotton laps. This method is suitable for the case that the color ratios differ greatly.

C. Attentions

Different processing method shows that the existing spinning equipment could not fully meet the demands of colored yarns, and the mixing techniques of colored yarns need more exploration.

At the same time, the homogeneity of mixing needs to be viewed dialectically. Mixing evenly is attached great important, otherwise the transversal striation would appear on the fabric. However, the non-homogeneous effect is deliberately made. On the other hand, getting the ultimate uniform mixing is not difficult and could be repeated in the spinning process, but blending is meaningless at the cost of damaged fibers.

III. EXPERIMENTAL DETAILS

The experiment adopted the control variable method and classified in accordance with multiple variables. The three variables such as mixing ratios of three colors, two mixing methods, two spinning methods, were randomly configured, and then classified. Comparative analysis made the conclusions more obvious. In the conditions of same color ratio and spinning method, different mixing methods should have a certain influence on the color of the spun yarns. Under the circumstance of the same color ratio and mixing method, different spinning methods also should have an effect on the color of the spun yarns. If mixing method and spinning method are consistent, different color ratios should affect the brightness and saturation of colored yarns.

Considering the different ratio of colors, the color of fibers needs to be selected carefully. One of the requirements is that these colors are bright. The other one is that the two colors should not be similar to each other. Therefore, the finally selected fiber colors were red, yellow and white. Each group of samples had different color ratio, mixing method, and spinning method, as shown in Table I.

TABLE I. EXPERIMENTAL DESIGN

Group	Color Ratio (Red, Yellow, White)	Mixing Method	Spinning Method
1	4:1:3	Slivers mixing	Ring
2	6:1:1	Slivers mixing	Ring
3	4:3:1	Bulk mixing	Ring
4	4:3:1	Slivers mixing	Ring
5	4:3:1	Bulk mixing	Rotor
6	6:1:1	Slivers mixing	Rotor
7	4:1:3	Slivers mixing	Rotor
8	4:3:1	Slivers mixing	Rotor
9	4:1:3	Bulk mixing	Rotor
10	6:1:1	Bulk mixing	Rotor
11	4:1:3	Bulk mixing	Ring
12	6:1:1	Bulk mixing	Ring

According to the experimental design, four types of yarns need to be spun with three color ratios, slivers obtained by rotor spinning with bulk mixing, slivers obtained by ring spinning with bulk mixing, slivers obtained by rotor spinning with slivers mixing and slivers obtained by ring spinning with slivers mixing.

Twelve group colored yarns were obtained under the condition of 3 different color ratios by ring spinning or rotor spinning with slivers mixing or bulk mixing respectively. The spun yarns were evenly and tightly wound on the winding board, and then spinning method and mixing method of each group were recorded. These labels made it more clear and intuitive to draw conclusions from the measurement data. Yarn fineness is 25tex and twist is 60 T/cm, as shown in Figure I.

FIGURE I. COLORED YARNS OF RING SPINNING AND ROTOR SPINNING WITH DIFFERENT MIXING METHODS

IV. RESULTS

Twelve group colored yarns were measured with spectrophotometer. In order to make the experimental results more accurate, each color of measurement board was taken four different points to measure. And 48 sets of data were got, and then four groups of the same color proportion were compared and classified respectively. Comparison results of color difference were printed.

The spun yarns from ring spinning with bulk mixing method were used as a template, and then other colored yarns were compared with the template. According to the measurement results of Datacolor SF600X spectrophotometer, the total color difference were compared and analyzed, as shown in Table II.

TABLE II. COLOR DIFFERENCE (D65 / 10)

Compared Groups	Color Difference Value
3-4	4.194
3-5	3.449
3-8	1.634
2-12	1.335
6-12	1.335
10-12	1.194
1-11	2.814
7-11	2.091
9-11	0.610

V. DISCUSSION

1) *According to the analysis of two types of bulk mixing and slivers mixing with same color ratios, it clearly shows that color difference between two types of spun yarns from rotor spinning is not large:* Color difference of spun yarns from ring spinning is relatively large, indicating that spinning method has a certain influence on color difference. Yarns processed by rotor spinning do not have strong brightness comparing with yarns from ring spinning. From the tone aspects, difference among yarns from rotor spinning is bigger than that from ring spinning.

2) *Analysis of two types of ring spinning and rotor spinning with the same color ratios as shown in the Table II shows that two types of ring spinning have the largest difference under different types of light sources in color difference:* While the difference between the spun yarns from two types of rotor spinning is very small, which indicates that mixing method has a great influence on the yarns from the ring spinning, but has less influence on the yarns from rotor spinning. Similarly, in the comparison of brightness and saturation and tone, yarns from ring spinning with different mixing methods have great difference. It suggested that mixing methods have greater influence on the color of yarns from ring spinning than yarns from rotor spinning.

3) *Analysis of maximum and minimum color difference under the same color ratio shows that the selected reference sample is yarns from ring spinning with bulk mixing in each color of comparison process:* It could be clearly seen that the most contrasting color difference is yarns from ring spinning with slivers mixing. Colored yarns from ring spinning and rotor spinning both have greatly influence by mixing methods in color difference .The minimum color difference appears in the yarns from different spinning methods with same mixing methods. It shows that the spinning method also has a relatively small influence on the color difference.

4) *Under the same color ratios, yarns which are spun from ring spinning and rotor spinning with bulk mixing method were comparative analyzed:* It could be seen from the Table II that the value of yarns from different spinning methods are relatively large in color difference and saturation, but the tone and lightness difference is relatively small. It shows that yarns from different spinning method have a certain gap in the color, brightness, tone and saturation under the conditions of the same type of mixing method and spinning method.

5) *Contrast analysis was made between yarns from ring spinning with bulk mixing and rotor spinning with slivers mixing in the same color ratio:* The value of color difference, brightness saturation and tone is similar. The color difference of yarns from different spinning method is small in the same mixing method. The color difference of yarns with different mixing method is relatively big in same spinning method. Based on these two conclusions, it suggested that there is a gap between the two types of yarns in color difference, but the difference in brightness is not significant.

VI. CONCLUSIONS

Colored yarns started with mixing different colored fibers, and formed uneven color patterns through a series of spinning processes. In this study, the color differences of single group yarns by ring spinning and rotor spinning with different mixing methods and color ratios were analyzed. It could be found that mixing method has significant influence on colored yarn by ring spinning, but has less influence on the yarn by rotor spinning. Spinning method has less influence on colored yarns than mixing method. Meanwhile, rotor spinning has less influence on colored yarn than ring spinning.

ACKNOWLEDGMENT

This research was financially supported by Education Department of Henan Province of Key Scientific Research

Projects (15A540010).

REFERENCES

[1] Kandi S G, Tehran M A, Rahmati M. Colour dependency of textile samples on the surface texture[J]. Coloration Technology, 2008, 124(6).

[2] Pan R, Liu J, Gao W, et al. Automatic detection of the layout of color yarns with logical analysis[J]. Fibers and Polymers, 2012, 13(5).

[3] Pan R, Gao W, Liu J, et al. Genetic algorithm-based detection of the layout of color yarns[J]. Journal of The Textile Institute, 2011, 102(2).

[4] Seyam A-F M, Mathur K. A general geometrical model for predicting color mixing of woven fabrics from colored warp and filling yarns[J]. Fibers and Polymers, 2012, 13(6).

[5] İçoğlu H, Kireçci A. Investigation of the fastness properties and color values of cotton fabrics knitted from ring spun and Sirospun® yarns[J]. Journal of The Textile Institute, 2011, 102(2).