(REFEREED RESEARCH)

# RESEARCH ON QUALITIES OF COLORED FANCY SPUN YARN

## RENKLİ FANTEZİ İPLİK KALİTELERİ ÜZERİNE BİR ARAŞTIRMA

**Tao ZHANG[1], Ying ZHANG[2], Xuzhong SU[3], Xinjin LIU[3]**

*[1]School of Vocational and technical, Wuhan Textile University, Wuhan 430200, P. R. China*
*[2]School of Clothing, Wuhan Textile University, Wuhan 430200, P. R. China*
*[3]School of Textile and Clothing, Jiangnan University, Wuxi 214122, P. R. China*

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**ABSTRACT**

Colored spun yarn is the yarn spun by fibers with two or more different colors, which has special color mixing effect and meets the needs of the market. In the spinning of the colored spun yarn, the fibers should be dyed and mixed firstly, which is the most important step during the yarn spinning. In the paper, colored fancy spun yarn spinning was studied. Taking the cotton fiber as example, the dyeing of fibers was presented, and the properties of the colored fiber and the natural fiber were tested and analyzed comparatively firstly. Then, 18.2tex (32S) three different colored fancy spun yarns, the colored AB Sirospun yarn, multicolored yarn and section-color yarn were spun on the EJM128K ring spinning frame, respectively. The detailed spinning processes were given. Then, the properties of yarn, yarn hairiness, strength and evenness were tested and analyzed comparatively. The results show that comparing with the natural fibers, the thickness of the colored fiber was increased slightly while the breaking strength was decreased slightly. Meanwhile, comparing with the multicolored yarn and section-color yarn, the colored AB Sirospun yarn has the largest breaking strength, the best yarn evenness and the least yarn hairiness.

**Keywords:** Colored AB Sirospun yarn, Multicolored yarn, Section color yarn

**Corresponding Author:** Tao ZHANG e-mail: 83635431@qq.com

### 1. INTRODUCTION

Recently, composite spinning method has attracted more and more attentions, in which the composited yarn can be spun by feeding several different roving simultaneously [1]. Colored spun yarn is one kind of composited yarn spun by fibers with two or more different colors, which has special color mixing effect [2]. In the yarn spinning, the fibers should be dyed and mixed firstly, which is the most key step during the yarn spun [3]. Therefore, the colored spun yarn is more environmental friendly since the dyeing of the spun yarn is not needed. Fancy yarn is another one important kinds of composited yarn. There are many kinds of fancy yarns in the market, such as AB Sirospun yarn [4], section color yarn [5], and so on. AB Sirospun yarn is one kind of Sirospun yarn, in which two different roving A and B were feed [6]. Section-color spinning method is achieved by feeding two different roving simultaneously, in which one white roving is feeding into the middle roller continuously, and one colored roving is feeding into the back roller discontinuously, and the discontinuous color changing on yarn axial direction can be produced correspondingly [5].

Colored fancy spun yarn is a kind of composited yarn spun by both the colored spun yarn spinning and the fancy yarn spinning methods. Some fancy effects and discontinuous colors can be produced in the yarn correspondingly. However, there are a lot of difficulties in the practical yarn spinning. For example, comparing with the common ring spun yarn, the evenness of Section-color yarn is worsening seriously due to its spinning mechanism [5]. During the colored yarn practical spinning, there are difficulties during the color matching of the fiber, and so on.

Motivated by all these research works above, this paper attempts to study the colored fancy spun yarn spinning. The dyeing of the cotton fibers was presented firstly, and the properties of the colored fiber and the natural color fibers were tested and analyzed comparatively. Then, 18.2tex

three different colored fancy spun yarns, the colored AB Sirospun yarn, multicolored yarn and section-color yarn were spun on the EJM128K ring spinning frame, and corresponding detailed spinning processes were given. Furthermore, the properties including yarn hairiness, strength and evenness were tested and analyzed comparatively. The properties of the three colored fancy yarn spinning methods were compared and emphasized comprehensively, which is different from the previous studies.

## 2. EXPERIMENTAL

### 2.1 Dyeing of the cotton fiber

Cotton fiber is the most widely used natural fiber at present. In general, the colored spun yarns were often used to high-grade knitted fabric. Therefore, there is high requirement for the qualities of the materials for the colored spun yarn spinning. For the cotton colored spun yarn, the linear density cotton fibers should be controlled in 1.78-1.85dtex and the quartile length 31mm, and the maturity of the fiber 1.6-1.8. Meanwhile, for the high-count colored yarn spinning, some long-staple cotton fibers should be mixed in the roving. In the paper, the cotton fibers with linear density 1.8dtex, quartile length 31mm and maturity 1.7 was chosen as the test sample.

The cotton fiber is one natural cellulose fiber, which has better moisture absorption, and the reactive dyes should be used in the fiber dyeing. As one natural fiber, there are ten percent impurities approximately. Therefore, the impurity removal process should be done before the fiber dyeing. In the paper, the sodium carbonate mixed with sodium hydroxide was used to impurity removal of the cotton fiber. Meanwhile, the sodium silicate was added in order to improve the whiteness of the fiber, and the sodium bisulfate was added in order to remove the lignin. Then, the dyeing process of the cotton fiber was presented as follows. First, 150g cotton was taken as the simple. Then, 3L waters and penetrating agent DM-1230 were added to the cotton and dried. Then, 3g dyeing B-4KFN was added and mixed with the cotton fiber sufficiently, and some $Na_2SO_4$ were also added. Then, the solution was heated until the temperature reached 60℃, and some $Na_2SO_4$ were added during the heating. When the temperature reached 60℃, another some $Na_2SO_4$ were added, and the solution was heated 15min in the constant temperature 60℃. Then, $Na_2CO_3$ were added for dye fixation 30min. Finally, the loose color of the cotton fiber was removed by water washing, and the fiber was dried. The detail dying process was shown in the following Table 1.

### 2.2 Spinning methods

Three different colored fancy spun yarns, colored AB Sirospun yarn, multicolored yarn and section-color yarn were spun on the EJM128K ring spinning frame.

**(1) AB Sirospun yarn**

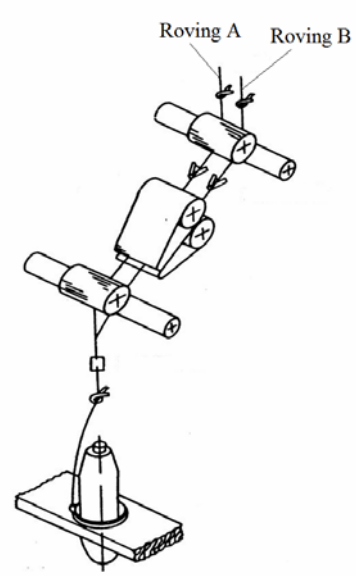


**Fig.1.** Spinning process of the AB Sirospun yarn

AB Sirospun yarn spinning progress is shown in Fig.1, which is conducted on a conventional ring frame by feeding two different roving A and B into the back roller via the bell mouth simultaneously. The spinning process can be presented as follows: first, two roving A and B are feeding into the back roller simultaneously, and two fiber strands come from the draft zone and enter the nip of the front roller. Second, a primary twist is imposed to those two fiber strands, where two smaller primary triangles are produced. Finally, two fiber strands are twisted into an AB Sirospun yarn by a final twist, and corresponding one final spinning triangle is produced [6]. That is, there are three spinning triangles in the Sirospun yarn spinning, which is benefit for the twist transmission and make the Sirospun yarn has less hairiness. Moreover, when the substrands are twisted into final AB Sirospun yarn under the final twisting, lots of harnesses are rolled into the spun yarn body, and make the hairiness of Sirospun yarn decreased further [7]. In the paper, the feeding two roving A and B are chosen as two roving with the same materials but different colors.

**(2) Multicolored yarn**

Spinning process of the multicolored yarn is similar as the AB Sirospun yarn, in which also two roving C and D are feeding into the back roller simultaneously. However, the feeding two roving C and D are different from the roving A and B in the AB Sirospun yarn, in which both the roving C and D have the multicolor. In the roving process of the production of the roving C or D, two kinds of sliver with different colors were feeding simultaneously, and make the roving has two different colors correspondingly.

**Table 1.** Dying process of the cotton fiber

| Materials | Dye | Additives | Instruments | Pressure | Reagents |
|---|---|---|---|---|---|
| Carded Cotton lap | B-4KFN | $Na_2SO_4$, $Na_2CO_3$, DM-1230 | Induction cooker, Electronic balance, Beaker, Glass rod, 101A-1B Drying oven | Atmospheric | The ration of Cotton to dyeing solution is one to twenty, $Na_2SO_4$: 40g/L, $Na_2CO_3$: 10g/L |

**(3) Section-color yarn**

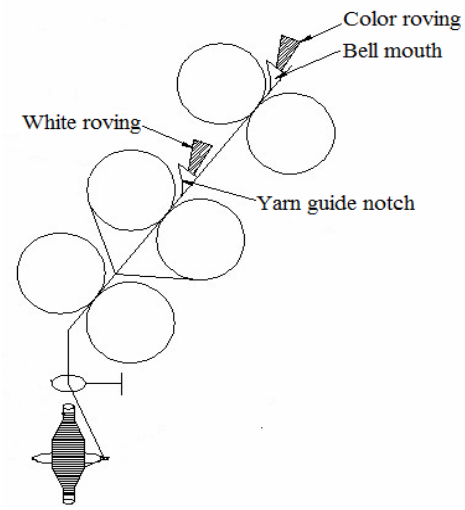


**Fig. 2.** Spinning process of the Section-color yarn

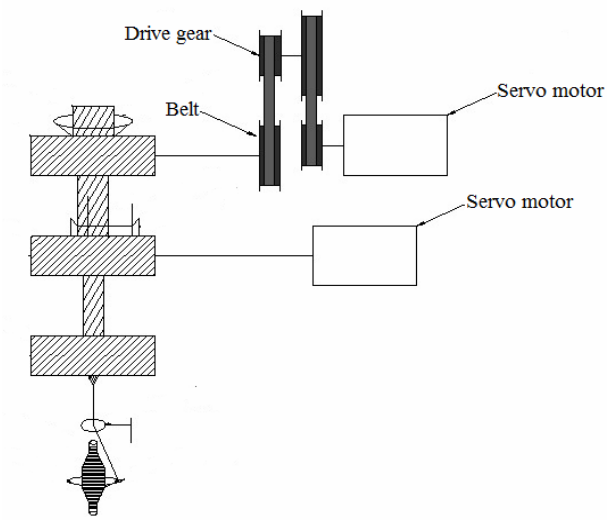


**Fig.3.** Control system of Section-color yarn spinning

The spinning process of Section-color yarn was shown in Fig.2, and corresponding control system was shown in Fig.3. In the Section-color yarn spinning system, back roller is controlled by one servomotor via a pair of drive gear and the belt, and middle roller is controlled by one servomotor directly, and front roller is controlled by main motor of the ring spinning frame, and the speed of front roller is monitored by the speed sensor and then sends to PLC. Meanwhile, both two Servo motors are connected to PLC directly, and the speed of two rollers can be coordinated controlled. In the Section-color yarn spinning, one white roving is feeding into the middle roller via a kind of yarn guide notch continuously, and one color roving is feeding into the back roller via bell mouth device discontinuously. For producing the discontinuous color changing on yarn axial direction, there are two states of the movement of the two feeding roving. The first state is that one white roving and one color roving are feeding simultaneously, and the back roller and middle roller runs simultaneously in this time, and the color section of the yarn is produced. The second state is that the back roller stops running, i.e. the color roving stops feeding, and the middle roller runs accelerated in this time, and the white roving is feeding more in order to compensate the color fibers missing, and the white section of the yarn is produced correspondingly [5]. In the paper, the color roving is the roving produced by the dyeing cotton fibers, and the white roving is the roving produced by the natural cotton fibers.

Based on the discussions above, we know that in the colored AB Sirospun yarn, multicolored yarn and section-color yarn spinning, two roving are feeding. However, feeding methods of the two roving are different. That is, in the colored AB Sirospun yarn and multicolored yarn spinning, two roving are feeding into the back roller simultaneously, while in the section-color yarn spinning, the white roving is feeding into the middle roller continuously, and the color roving is feeding into the back roller discontinuously. Meanwhile, in the colored AB Sirospun yarn spinning, two feeding roving A and B are color roving with one single color, while in the multicolored yarn spinning, two feeding roving A and B are multicolored roving. Therefore, the differences of the spinning process would make the qualities of three kinds of colored fancy yarns different, which were explained in the following.

**2.3 Spinning parameters**

In this section, spinning parameters of the colored spun yarns were presented. For the colored AB Sirospun yarn, multicolored yarn and section-color yarn, the fore-spinning processes were same. Therefore, the key spinning parameters in the roving process and spinning process were presented in the paper. Meanwhile, we know that the tensile of the cotton fiber is decreased after dyeing. Therefore, some polyester was added in order to improve the fiber strength. In the paper, three kinds of 60/40 polyester and cotton blended colored fancy yarns were spun. Furthermore, the polyester and cotton were blended in the raw material.

**(1) Roving process**

The sliver of 13.1g/5m was used as raw material. For the colored AB Sirospun yarn, multicolored yarn spinning, the designed linear density of the roving is 3.3g/10m (330tex). For the Section-color yarn, the designed linear density of the color roving is 3g/10m (300tex), and the designed linear density of the white roving is 4.4g/10m (440tex). By using the roving frame JWF1415, corresponding roving was spun, and the detail parameters of the roving process were presented in Table 2.

**(2) Spinning process**

By using the obtained roving, 18.2tex colored AB Sirospun yarn, multicolored yarn and section-color yarn were spun on the EJM128K ring spinning frame. For the AB Sirospun yarn, multicolored yarn spinning, double bell mouth was installed above the back roller, and two roving were feeding into the back roller via the double bell mouth simultaneously. For the section-color yarn spinning, the ring spinning is modified by the slub yarn control device JC-SF. Then, the detail parameters of the spinning process of the AB Sirospun yarn and multicolored yarn were presented in Table 3 and the detail parameters of the spinning process of the section-color yarn was presented in Table 4.

**Table 2.** Parameters of the roving process

| Yarn kind | | Linear density (g/10m) | Total draft | | Back zone draft | Twist (/10cm) | Twist factor |
|---|---|---|---|---|---|---|---|
| | | | Mechanical | Practical | | | |
| AB yarn | | 3.3 | 8.03 | 7.869 | 1.21 | 5.4927 | 102.37 |
| Multicolored yarn | | 3.3 | 8.03 | 7.869 | 1.21 | 5.4927 | 102.37 |
| Section-color yarn | | 4.4, 3 | 6.02, 8.92 | 5.9, 8.74 | 1.21 | 3.6991, 3.9404 | 79.61, 70.02 |
| Roller center distance (mm) | | Roller pressure (N) | | Winding density (/10cm) | Nip gauge (mm) | Rotating speed (r/min) | |
| 1-2 | 2-3 | 1×2×3 | | | | Flyer | Front roller |
| 55 | 50 | 300×200×250 | | 3.8768 | 4 | 850 | 175.92 |
| 55 | 50 | 300×200×250 | | 3.8768 | 4 | 850 | 175.92 |
| 55 | 50 | 300×200×250 | | 3.1589, 3.8768 | 4 | 850 | 261.21, 245.22 |

**Table 3.** Key spinning parameters of the AB Sirospun yarn and multicolored yarn

| Ring spinning frame | | Conditioned weight(g/100m) | Conventional moisture regain (%) | Total draft | | Back zone draft | Twist (/10cm) | Twist factor | Distance between bell mouth |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Mechanical | Practical | | | | |
| EJM128K | | 1.75 | 5.26 | 38.663 | 37.89 | 1.17 | 88.42 | 379.8 | 4.5 |
| Roller center distance (mm) | | Roller pressure (daN) | Roller diameter (mm) | Rotating speed of front roller (r/min) | | Ring | | Traveller | Aprons nip gauge (mm) |
| Front | Back | 1×2×3 | 1×2×3 | | | Type | Diameter (mm) | | |
| 45 | 60 | 18×14×14 | 27×25×27 | 180 | | PG1 | 42 | BU8/0 | 2.8 |

**Table 4.** Key spinning parameters of the section-color yarn

| Ring spinning frame | | Conditioned weight (g/100m) | Conventional moisture regain (%) | Front zone draft | | Back zone draft | Twist (/10cm) | Twist factor |
|---|---|---|---|---|---|---|---|---|
| | | | | Mechanical | Practical | | | |
| EJM128K | | 1.75 | 5.26 | 25.65 | 25.14 | 1.68 | 78.04 | 332.9 |
| Roller center distance (mm) | | Roller pressure (daN) | Roller diameter (mm) | Rotating speed of front roller (r/min) | | Ring | | Traveller |
| Front | Back | 1×2×3 | 1×2×3 | | | Type | Diameter (mm) | |
| 50 | 43 | 18×14×14 | 27×27×27 | 120 | | PG1 | 42 | BU8/0 |

### 2.4 Testing methods

The tensile of the colored and natural cotton fiber was tested by using the single fiber tensile strength tester YG001.

The abrasion color fastness of the colored fancy yarns was tested by using the abrasion fastness device YG571B, and ten times for each simple was tested. In each test, the reciprocate movement is 104±3mm, and the pressure is 9±0.2N, moisture content in the wet friction is 95-100%, and other test conditions were chosen according to the standard GB/T 3920-2008.

The soaping color fastness of the spun colored fancy yarns was tested by using the soaping fastness device SW-12(L). The staining was evaluated by using the grey sample card, and the discoloration was evaluated by using the grey sample card padding cloth 100mm×40mm, and the padding cloth were chosen as the cotton cloth and dacron cloth respectively. In the test, the bath temperature is 60$^{\circ}$C, and the test time is 30min, the reagent is 1000ml III standard water+4g synthetic detergent+2g anhydrous sodium carbonate, and other test conditions were chosen according to the standard GB/T 3921-2008.

The properties of yarn, hairiness, strength and evenness were tested and analyzed comparatively. The measuring results can be obtained as follows. First, taking five bobbin yarns as measuring samples and all the samples are placed at least 48 hours under standard conditions (65±2% RH and 20±2$^{\circ}$C). Second, for each bobbin yarn, the hairiness is tested ten times using YG173A hairiness tester under 30 m/min speed, and the test time is 1 minute, and take the average value of ten tested results as the hairiness of this one bobbin yarn. The tensile of yarns is also tested ten times on YG068C fully automatic single yarn strength tester at a speed of 500 mm/min with a pretension 1.8cN/tex, and takes the average value of ten tested results as the breaking force of this one bobbin yarn. The evenness is done one time by USTER TESTER 5 evenness tester at a speed of 200m/min, and the test time is 0.5 minute, and takes the value as the evenness of this one bobbin yarn. Finally, the average values of five bobbin yarns are taken as the corresponding qualities of spun yarn.

## 3. Results and Discussions

### 3.1 Colored fiber qualities

(a) The natural fiber (b) The colored fiber

**Fig.4.** Surface morphology of the cotton fiber

**Fig.5.** Longitudinal section morphology of the cotton fiber

The properties of the colored cotton fibers were analyzed and compared with the natural cotton fibers. The surface morphology of two kinds of cotton fibers were shown in Fig. 4. Then, by using the video microscope with magnification 500, the longitudinal section morphology of the cotton fibers were shown in Fig.5. From the figure, it is easy to see that comparing with the natural cotton fiber, the fineness of the colored fiber is increased. Concretely speaking, by using electron microscope, the diameter of the colored cotton fiber can be tested as 17.28mm and the diameter of the natural cotton fiber is 16mm. The results of tensile of the cotton fibers were shown in Table 5. It is shown that comparing with the natural cotton fiber, the breaking strength and breaking elongation of the colored cotton fiber are both decreased. Meanwhile, from the Fig.4 and Fig.5, we can see that comparing with the natural cotton fiber, the appearance morphology of the colored cotton fiber is same, while the hand feeling is worse and is hard to be separated with each other.

**Table 5.** Tensile of the cotton fiber

| | Breaking strength /cN | Breaking elongation /% |
|---|---|---|
| Colored cotton fiber | 4.56 | 6.67 |
| Natural cotton fiber | 4.94 | 7.26 |

### 3.2 Yarn qualities

In this section, the qualities of the colored AB Sirospun yarn, multicolored yarn and section-color yarn were analyzed. The abrasion color fastness, soaping color fastnesses and other conventional qualities of yarn, strength, evenness and hairiness were tested and analyzed comparatively.

(a) Simple (b) Dry friction (c) Wet friction

**Fig. 6.** Tested results of the abrasion color fastness of the colored AB Sirospun yarn

(a) Simple (b) Dry friction (c) Wet friction

**Fig. 7.** Tested results of the abrasion color fastness of the multicolored Sirospun yarn

(a) Simple (b) Dry friction (c) Wet friction

**Fig. 8.** Tested results of the abrasion color fastness of the section-color yarn

**Table 6.** Tested results of the abrasion color fastness

| | High-class | First grade | AB Sirospun yarn | Multicolored yarn | Section-color yarn |
|---|---|---|---|---|---|
| Dry friction | 4 | 3-4 | 4-5 | 4-5 | 4-5 |
| Wet friction | 3 | 2-3 | 3-4 | 3-4 | 4 |

The tested results of the abrasion color fastness of the yarns were shown in Fig.6, 7 and 8 respectively. According to the standard FZ/T 12014-2006, the detail results were presented in Table 6. From the Table, it is shown that the abrasion color fastnesses of all three kinds of colored fancy spun yarns are achieved high-class. Meanwhile, the abrasion color fastness in the dry friction is similar for three kinds of yarns. For the abrasion color fastness in the wet friction, comparing with AB Sirospun yarn and multicolored yarn, the Section-color yarn is a little better.

The tested results of the soaping color fastness of the spun colored fancy yarns were shown in Fig.9-11 respectively. According to the standard FZ/T 12014-2006, the detail results were presented in Table 7. From the Table, it is shown that the discolorations of the AB Sirospun yarn and multicolored yarns are achieved high-class, while the discolorations of the Section-color yarn is a little worse and achieved the first grade. Meanwhile, the staining of all three kinds of colored fancy yarns is achieved high-class.

(a) Simple (b) Cotton cloth (c) Dacron cloth

**Fig.9.** Tested results of the soaping color fastnesses of the colored AB Sirospun yarn

(a) Simple (b) Cotton cloth (c) Dacron cloth

**Fig.10.** Tested results of the soaping color fastnesses of the multicolored yarn

(a) Simple (b) Cotton cloth (c) Dacron cloth

**Fig.11.** Tested results of the soaping color fastnesses of the Section-color yarn

**Table 7.** Tested results of the soaping color fastnesses

| | High class | First grade | AB Sirospun yarn | Multicolored yarn | Section-color yarn |
|---|---|---|---|---|---|
| Discoloration | 4 | 3-4 | 4 | 4 | 3-4 |
| Staining | 3-4 | 3 | Cotton cloth 4, Dacron cloth 4-5 | Cotton cloth 3-4, Dacron cloth 4-5 | Cotton cloth 4-5, Dacron cloth 4-5 |

**Table 8.** Tested results of the yarn tensile

| Yarn kind | Breaking strength (cN) | Breaking elongation (%) | Breaking tenacity (cN/tex) |
|---|---|---|---|
| AB yarn | 290.58 | 6.98 | 15.97 |
| Multicolored yarn | 237.34 | 6.44 | 13.04 |
| Section-color yarn | 270.62 | 6.69 | 14.87 |

**Table 9** Tested results of the yarn evenness

| Yarn kind | CV /% | Thin (-40%) /km$^{-1}$ | Thin (-50%) /km$^{-1}$ | Thick (+50%) /km$^{-1}$ | Thick (+50%) /km$^{-1}$ | Nep (+140%) /km$^{-1}$ | Nep (+200%) /km$^{-1}$ | Nep (+280%) /km$^{-1}$ |
|---|---|---|---|---|---|---|---|---|
| AB yarn | 14.02 | 120.0 | 6.0 | 852.0 | 126.0 | 592.0 | 136.0 | 35.0 |
| Multicolored yarn | 14.93 | 252.0 | 8.0 | 1016.0 | 190.0 | 639.0 | 150.0 | 37.0 |
| Section-color yarn | 18.19 | 1458 | 258.0 | 1395 | 307.0 | 780.0 | 124.0 | 32.0 |

**Table 10** Tested results of the yarn hairiness

| Yarn kind | ≥1mm Hairiness /(10m)$^{-1}$ | ≥2mm Hairiness /(10m)$^{-1}$ | ≥3mm Hairiness /(10m)$^{-1}$ | H |
|---|---|---|---|---|
| AB yarn | 702.40 | 235.70 | 50.30 | 2.69 |
| Multicolored yarn | 1358.50 | 292.30 | 65.10 | 4.15 |
| Section-color yarn | 1282.70 | 267.00 | 68.90 | 3.61 |

In the following, conventional qualities of the colored fancy spun yarns, strength, evenness and hairiness were tested and analyzed comparatively. The tested results of the yarn tensile properties, including yarn breaking strength and breaking elongation were shown in Table 8. As shown in Table 8, it is obviously that AB Sirospun yarn has the best breaking strength and breaking elongation, Section-color yarn takes the second place, and Multicolored yarn has the worst. The tested results of the yarn evenness including yarn CV, number of thin places, thick places and neps were shown in Table 9. As shown in Table 9, it is obviously that AB Sirospun yarn has the best yarn evenness, multicolored yarn takes the second place, and Section-color yarn has the worst. Meanwhile, comparing with the AB Sirospun and multicolored yarn, the evenness of Section-color yarn is worse seriously. The tested results of the yarn hairiness including hairiness number and hairiness H value were shown in Table 10. As shown in Table 10, it is obviously that AB Sirospun yarn has the least yarn hairiness, multicolored yarn takes the second place, and Section-color yarn has the most.

The possible reason is that in the AB Sirospun yarn spinning, the weak-link can be complement when the two substrands were twisted into a final Sirospun yarn, and lots of harnesses are rolled into the spun yarn body. However, in the multicolored yarn spinning, since the feeding two roving C or D are produced by feeding two kinds of sliver with different colors simultaneously in the roving process, the qualities of the roving would be poor and make the spun yarn qualities worse correspondingly. In the Section-color yarn spinning, the discontinuous color distribution on the Section-color yarn is produced by the discontinuously feeding of color roving into the back roller, and then discontinuously separated from the feeding white roving in the middle roller. In the practical spinning, the fibers in the middle roller would be slipped forward, which make the separation point of feeding color roving slip forward correspondingly, and the thin place would be produced, and make the worsen evenness of Section-color yarn correspondingly, and also not benefit for yarn strength.

## 4. CONCLUSİONS

In the paper, the colored fancy spun yarn spinning has been studied. The dyeing of the cotton fibers has been presented, and the properties of the colored fiber and the natural fibers were tested and analyzed comparatively. The results show that comparing with the natural color fibers, the thickness of the colored fiber was increased slightly while the breaking strength was decreased slightly. Therefore, some polyester has been added in order to improve the fiber strength. Then, 18.2tex 60/40 polyester and cotton blended colored AB Sirospun yarn, multicolored yarn and section-color yarn have been spun on the EJM128K ring spinning frame, and corresponding key spinning parameters in the roving process and spinning process have been given in detail. The abrasion color fastness, soaping color fastnesses and other conventional qualities, yarn strength, evenness and hairiness have been tested and analyzed comparatively. It is shown that for the abrasion color fastness in the wet friction, comparing with AB Sirospun yarn and multicolored yarn, the Section-color yarn is a little better. For the discolorations, AB Sirospun yarn and multicolored yarns are achieved high-class, while the discolorations of the Section-color yarn is a little worse and achieved the first grade. Meanwhile, comparing with the multicolored yarn and section-color yarn, the colored AB Sirospun yarn has the largest breaking strength, the best yarn evenness and the least yarn hairiness.

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