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Effects of godet wheel position on compact siro-spun core yarn characteristics

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Cotton-spandex compact siro-spun core yarns (29.2tex/44.4dtex and 14.6tex/44.4dtex) have been prepared on two kinds of compact spinning, viz complete condensing spinning system (CCSS) and lattice apron compact spinning system (LACSS) respectively. Three godet wheel positions on two kinds of compact system have been selected and corresponding yarn covering effect is studied respectively. Especially, the surface morphology and cross-sections of the core yarns are observed. Then, the covering effects are compared and affecting factors are analyzed. Moreover, other yarn properties including yarn hairiness, strength and evenness are also tested and compared. The results indicate that the covering effect of staple fibres is the most even when the godet wheel position is set on left side for both CCSS and LACSS.

Keywords: Complete condensing spinning systems, Core-spun yarns, Cotton yarns, Godet wheel positions, Lattice apron compact spinning systems

1 Introduction

Compact spinning is a great improvement in traditional ring spinning, which is achieved by equipping with a fibre condensing device on ring spinning frame to condense the fibre bundle. It can decrease or even eliminate spinning triangles, and improves yarn strength and decreases yarn hairiness[1,2]. Complete condensing spinning system (CCSS) is a new kind of pneumatic compact spinning, the structure of it is shown in Fig. 1. In CCSS, the front roller is instead by a perforated hollow roller (**5**) with diameter of 50 mm. There are strip grooves on surface of the hollow roller. The front top roller (**2**) and output top roller (**1**) are installed above the perforated hollow roller (**5**). An air suction card (**4**) is set inside the perforated hollow roller. Moreover, an airflow guiding device (**3**) is set on surface of perforated hollow roller. In the spinning, two top rollers and the air suction card work together to form the condensed zone. It can narrow the fibre strand and improve yarn quality[3].

Core-spun yarn is a kind of composite yarn in which the core filament is covered by the outer staple fibres. The combination of advantages of both outer staple natural fibres and core synthetic fibres, which can improve the comfort and softness of clothing[4]. However, in the practical spinning, it often occurs that the outer staple fibres cannot cover the core yarn evenly and completely. The bad covering effect would decrease the strength and elasticity of yarn. Furthermore, it may lead to the unevenness in dyeing, and the bare filaments tend to break during weaving. It has been shown that the covering effect of the core yarn can be improved by using both the compact spinning and Siro spinning[5]. Moreover, mechanical properties such as yarn tenacity and evenness affect the weaving and knitting as well as the fabric performance[6,7].

In core spinning, the increase in filament feeding angle decreases the deviation of core filament in core-spun yarn[8]. In siro-spinning system, proper strand space and pre-draft of spandex filament make filament more close to yarn center[9,10]. Moreover, yarn twist factor influences the strength and covering effect[11,12]. In traditional ring spinning, godet wheel position has little influence on covering effect of core-spun yarn, but it influences the covering effect significantly in

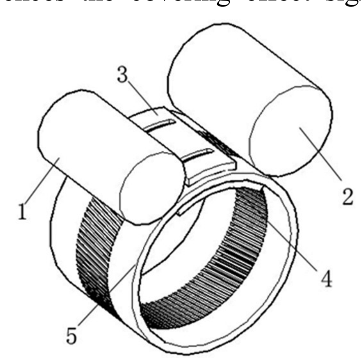

Fig. 1 — Structure of CCSS [1-Output top roller, 2-Front top roller, 3-Airflow guiding device, 4- Air suction card, and 5- Perforated hollow roller]

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siro-spinning system[13,14]. It determines the feeding position of filament. Moreover, it should be set according to twist direction. The filament feeding position is set in left if the twist direction is Z, while the filament feeding position should be in right if the twist direction is S[15]. The godet wheel position should be set properly to make sure good covering effect of core-spun yarn.

In this study, 29.2tex/44.4dtex and 14.6tex/44.4dtex cotton-spandex core-spun yarns have been spun on the QFA1528 ring spinning machine equipped with two kinds of compact spinning including CCSS and LACSS (lattice apron compact spinning system) respectively. Three godet wheel positions on two kinds of compact systems have been selected and corresponding yarn qualities are tested respectively. Especially, the cross sections of the spun yarns were presented by YG172 Hardy's thin cross-section sampling device, and the covering effects of spandex are observed and analyzed. Finally, the best godet wheel position is obtained.

2 Materials and Methods

2.1 Materials

The combed cotton roving with linear density 4.0g/10m and the spandex with linear density 44.4dtex were used. The cross-section was made by YG172 Hardy's thin cross-section sampling device. Both surface morphology and cross-section of yarn were observed with MOTTC B1 video microscope. Automatic yarn strength tester (YG086C) was used to measure tenacity and elongation. Yarn hairiness tester (Uster Zweigle HL400) and yarn evenness tester (Uster Tester 5) were used to test yarn hairiness and evenness respectively. All specimen yarns were conditioned for 24h in the environment of 22°C temp. and 62% RH.

2.2 Yarn Spinning

Three godet wheel positions were set in both LACSS and CCSS systems. 29.2tex/44.4dtex and 14.6tex/44.4dtex cotton-spandex core-spun yarns were spun respectively. The core filament feed positions are shown in Fig. 2. In first position (left), the core filament is fed from the middle of left roving sliver. In second position (middle), the core filament is fed from the middle of two roving sliver. In third position (right) , the core filament is fed from the middle of right roving sliver.

For both 29.2tex/44.4dtex and 14.6tex/44.4dtex cotton-spandex core-spun yarns, the strand spacing is 5mm, and the pre-draft multiple of spandex is 3.251. For 29.2tex/44.4dtex cotton-spandex core-spun yarn, the draft ratio is 28.80, the draft ratio of back zone is 1.28 and the yarn twist factor is 320. For 14.6tex/44.4dtex cotton spandex core-spun yarn, the draft ratio is 58.20, the draft ratio of back zone is 1.28, and the yarn twist factor is 360.

2.3 Evaluation of Yarn Properties

Firstly, the quantity of bare spandex (10m yarn) was observed by MOTTC B1 video microscope. Then, cross-sections of six kinds of yarn were made by YG172 Hardy's thin cross-section sampling device. Next, cross-sections were also observed by the video microscope to analyze weather the filament is in the core of yarn. Then, compared the quantity of bare spandex in 10m yarn and cross-sections of yarn spun on three godet wheel positions. Finally, the yarn with least bare spandex in 10m yarn and the yarn with filament in the center exactly were observed, and the responding godet wheel position is taken as the optimal position for covering effect. Moreover, qualities of yarns spun on optimal godet wheel position were investigated. Yarn properties including tenacity, elongation, hairiness and evenness were tested by automatic yarn strength tester (YG086C), yarn hairiness tester (Uster Zweigle HL400) and yarn evenness tester (Uster Tester 5) respectively.

3 Results and discussion

3.1 Covering Effect of Spun Yarn

Lattice Apron Compact Siro-spun Yarn

For both 29.2tex/44.4dtex and 14.6tex/44.4dtex cotton-spandex core-spun yarns with LACSS, there is no bare spandex on yarn surface when godet wheel is set at three different positions.

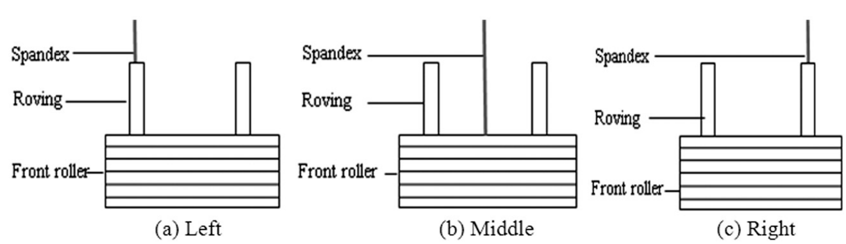


Fig. 2 — Different feed positions of core filament

Figure 3 (a) shows the cross-section of 29.2tex/44.4dtex cotton-spandex core-spun yarn with LACSS when godet wheel is set at three different positions. Figure 3 (b) shows the cross-section of 14.6tex/44.4dtex cotton-spandex core-spun yarn with LACSS when godet wheel is set at three different positions. It is easy to observe that the filament is closest to yarn center when godet wheel is set on left. That is, the yarn spun on left godet wheel position has better covering effect than yarn spun on middle and right godet wheel positions. In spinning of cotton-spandex core-spun yarn with LACSS, the fibre in condensed zone tends to rollover along the direction of airflow slot. So, the sliver can get false twist in direction of Z. For cotton-spandex core-spun yarn having Z twist direction, the false twist is beneficial to the covering of outer staple fibre on the filament. Thus, the yarn has best covering effect when godet wheel is set on left.

Complete Condensed Siro-spinning Core-spun Yarn

For both 29.2tex/44.4dtex and 14.6tex/44.4dtex cotton-spandex core-spun yarns with CCSS, there is no bare spandex on yarn surface when godet wheel is set at three different positions.

Figure 4 (a) shows the cross-section of 29.2tex/44.4dtex cotton-spandex core-spun yarn with CCSS when godet wheel is set at three different positions. Figure 4 (b) shows the cross-section of 14.6tex/44.4dtex cotton-spandex core-spun yarn with CCSS when godet wheel is set at three different positions. It is observed that the filament is closest to yarn center when godet wheel is set on left. That is, the yarn spun on left godet wheel position has better covering effect than the yarns spun on middle and right godet wheel positions. In spinning of cotton-spandex core-spun yarn with CCSS, the fibre in condensed zone tends to migrate towards left along the direction of airflow slot on surface of air suction card. For cotton-spandex core-spun yarn having Z twist direction, the core filament moves more steadily when feed from left position. So, the yarn has best covering effect when godet wheel is set on left.

The staple fibre strand is condensed in compact zone of both LACSS and CCSS, which cover the core filament closely. Therefore, there is no bare spandex on compact siro-spinning core-spun yarn surface.

Overall, compared with LACSS core-spun yarn, the CCSS core-spun yarn has better covering effect. In

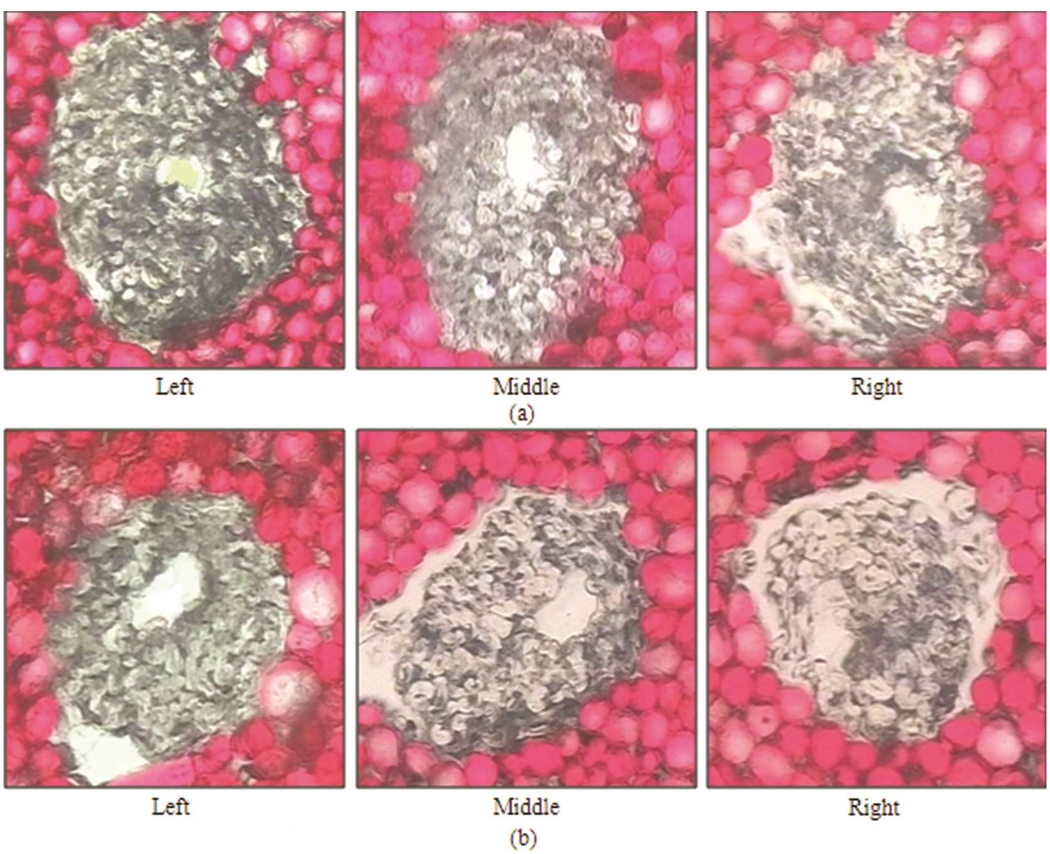


Fig. 3 — Cross-sections of (a) 29.2tex /44.4dtex and (b) 14.6tex/44.4dtex lattice apron compact siro-spinning core-spun yarns

condensed zone of former, the fibre strand tends to rollover. But in condensed zone of the latter, it keeps straight and move parallel, which is advantageous for the covering of staple fibre on core filament. Thus, the outer staple fibre can cover the core filament evenly and the core filament can be closer to the yarn center. In process of core-spun yarn with compact and siro-spinning system, the position of godet wheel should not be set too far left, as it can worsen the covering effect. Because there is a certain width of godet wheel groove, which leads to the cross-wise migration of core filament during movement.

3.2 Yarn Qualities Comparison of Two Compact Yarns

Table 1 shows yarn tenacity, elongation, hairiness and evenness of 29.2tex /44.4dtex and 14.6tex/44.4dtex cotton-spandex core-spun yarns prepared on two compact systems.

From Table 1, it can be seen that yarn tenacity and elongation of two compact yarns are approximately the same. But the tenacity and elongation evenness of CCSS core-spun yarn is better than that of LACSS core-spun yarn. As in CCSS core-spun yarns, the outer staple fibre covers the filament more evenly in long-term, it improves the strength evenness. Table 1 shows that compared to LACSS core-spun yarn, evenness of complete condensed siro-spinning core-spun yarn improves slightly. Moreover, Uster hairiness S3 value of the two compact yarns is approximately the same while S1+2 values of CCSS core-spun yarn increases a lot as compared to that of LACSS core-spun yarn. That is, harmful hairiness of

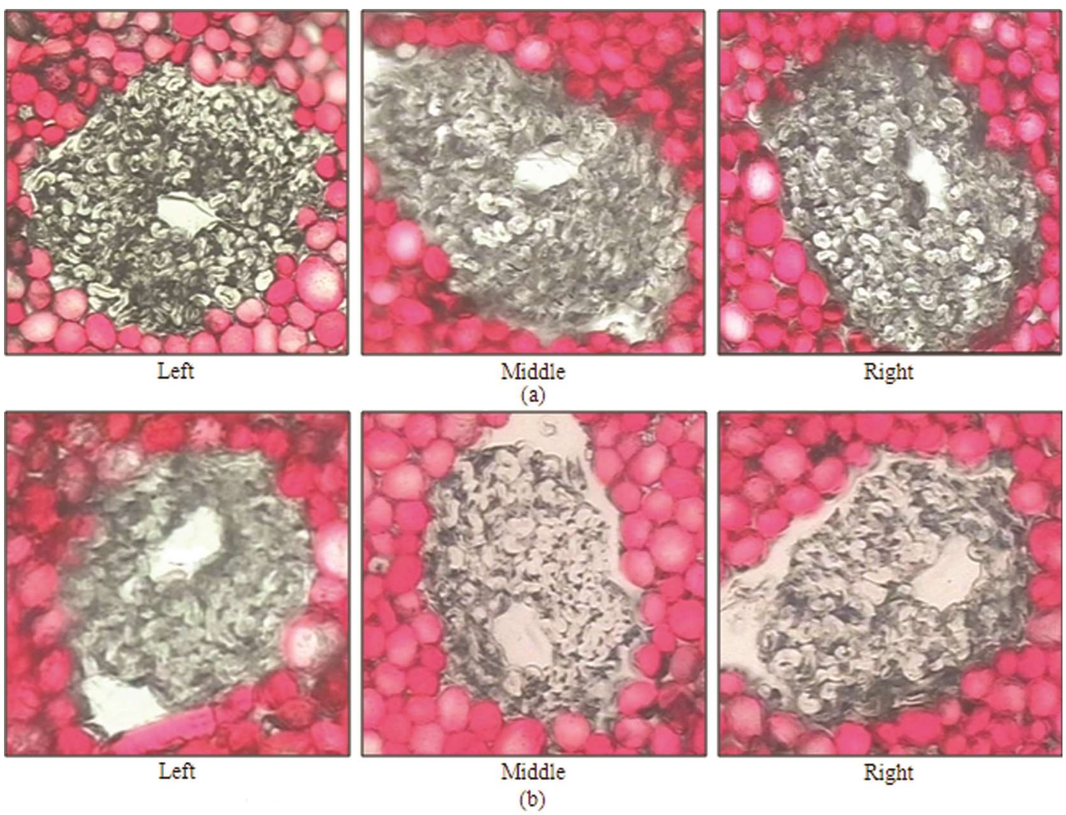
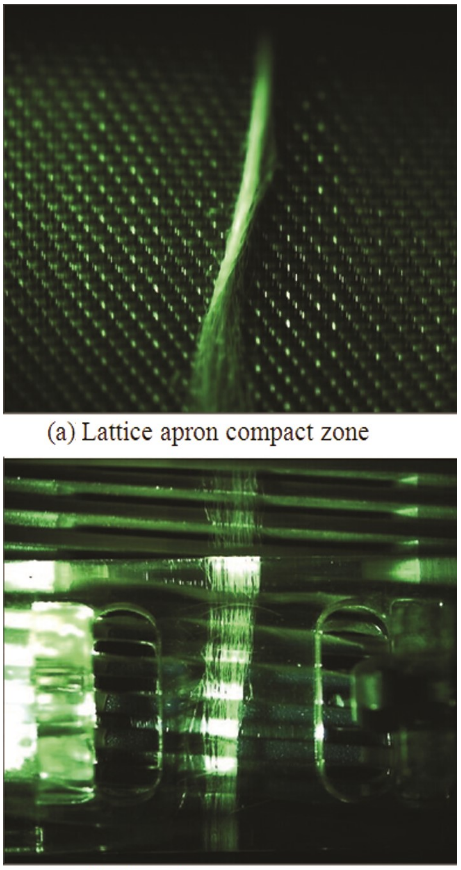


Fig. 4 — Cross-section of (a) 29.2tex /44.4dtex and (b) 14.6tex/44.4dtex complete condensed siro-spinning core-spun yarns

Table 1 — Mechanical properties of core-spun yarn (29.2tex /44.4dtex)

Yarn count	Condensed system	Hairiness S1+2 value	Hairiness S3 value	Strength cN	Strength unevenness CV %	Elongation %	Elongation unevenness CV %	USTER unevenness CV%
29.2tex /44.4dtex	LACSS	11797	328	319.08	9.51	4.65	9.14	9.18
	CCSS	18832	336	329.42	8.32	4.50	8.11	9.14
14.6tex /44.4dtex	LACSS	6170	290	193.69	10.47	4.24	14.87	12.21
	CCSS	12573	307	202.24	3.15	3.98	10.29	11.97



(a) Lattice apron compact zone

(b) Complete compact zone

Fig. 5 — Fibre sliver in compact zone

CCSS core-spun yarn is approximately the same as LACSS core-spun yarn, but short hairiness of CCSS core-spun yarn is more than that of LACSS core-spun yarn. Figure 5 shows the fibre strand morphology in compact zone obtained by high-speed camera. It can be seen that fibre strand tends to rollover in lattice apron condensed zone, but it keeps straight and moves parallel in complete condensed zone. Thus, fibre ends in LACSS are more easy to be twist in yarn body, and the short hairiness is less. In contrary, a great quantity of short hairiness in CCSS yarn makes fabric more soft and full. And the short hairiness can have great advantages of thermal dissipation during spinning, which can extend rings and travelers service life.

4 Conclusion

The godet wheel position influences the covering effect of core-spun yarn. There is no bare spandex on surface of core-spun yarn spun with compact and siro-spinning system. For 29.2tex/44.4dtex and 14.6tex/44.4dtex cotton spandex core-spun yarns, the filament is closer to yarn center when it is feed from the middle of left roving. And it deviates from the yarn center when it is feed from the middle of right roving and middle of two roving. Thus, the godet wheel should be set on left position, and core filament is feed inside the left roving.

Compared with LACSS, core-spun yarn with CCSS has better qualities. In CCSS, the fibre strand migration in direction of airflow slot in condensed zone improves the covering effect, which makes it a more proper way to spin core-spun yarn.

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