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Short Communications

Effect of diagonal path on the physical properties of compact and conventional ring yarn

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Effect of diagonal path on the physical properties of compact and conventional ring yarns has been investigated. The compact and conventional ring yarns have been spun using three completely different paths in the ring frame, like normal path, right diagonal path and left diagonal path. The yarn spun by the left diagonal path has an additional advantage over the other two paths for both conventional ring yarn and compact yarn in terms of yarn hairiness, yarn evenness, tenacity, elongation and breaking force.

Keywords: Breaking force, Compact yarn, Cotton, Ring yarn, Tenacity, Yarn elongation, Yarn evenness, Yarn hairiness

In spite of transformation and speedy technological changes within the spinning processes, ring spinning still remains the leading spinning technology. Within the spinning method for staple yarns, spinning triangle is really necessary. It holds the distribution of fibre tension within the spinning triangle and hence improves the quality of spun yarns.

The yarn hairiness affects the yarn strength, spinning efficiency, weaving and knitting performance in addition to the properties of resultant materials made of such yarns, particularly their pilling tendency and dye uptake[1]. The yarns made by the diagonal feeding in ring spinning improve their properties, specifically the hairiness, for both compact and conventional spinning technology, because of the fibre tension distribution in spinning triangle. It is also evident that the hairiness of yarn with Z twist reduces with the right horizontal offset of spinning triangle, whereas the hairiness of the yarn of S twist is reduced with the left horizontal offset of spinning triangle[2].

The modification in the yarn path in the ring frame affects the quality of the yarn and spinning efficiency. It is observed that the hairiness of the yarn is reduced by the right diagonal path because of the increased pre-twisting of fibres on the right-hand side of the spinning triangle to the Z twist yarn[3]. Also, the right diagonal path shows an improvement in the tenacity along with the hairiness reduction of yarn[4].

However, in the left diagonal path of the Z twist yarns there is up to 40% decrease in yarn hairiness and slight enhancement in the strength[5,6]. Consequently, there are no significant ideas generated due to a plenty of disagreement among the above reviews.

Thus, in this work, the scope for modified yarn path further and its impact on the properties of compact and conventional ring spinning yarns have been studied.

Experimental

Materials

Single yarns of 60 Ne (9.54 tex) were produced by conventional and compact spinning. Table 1 shows the details of roving and machine parameters in conventional and compact ring spinning. Yarns were collected from straight, left diagonal and right diagonal paths.

Methods

Diagonal Path of Yarn

Figure 1 shows the schematic diagram of normal, right and left diagonal path of yarn in ring spinning. Right diagonal path of the yarn is achieved by the

Table 1 — Fibre and spinning machine process parameters

Parameters	Compact	Conventional
2.5 Span length, mm (MCU 5 fibre)	32	32
Micronaire	3.8	3.8
Machine make	Suessen	LR 6
Spindle speed, rpm	18600	18600
TPI	32.34	32.95
Hank	1.2	1.2
Total draft	48.6	48.72
Traveller No.	14/0	14/0
Yarn twist	‘Z’	‘Z’

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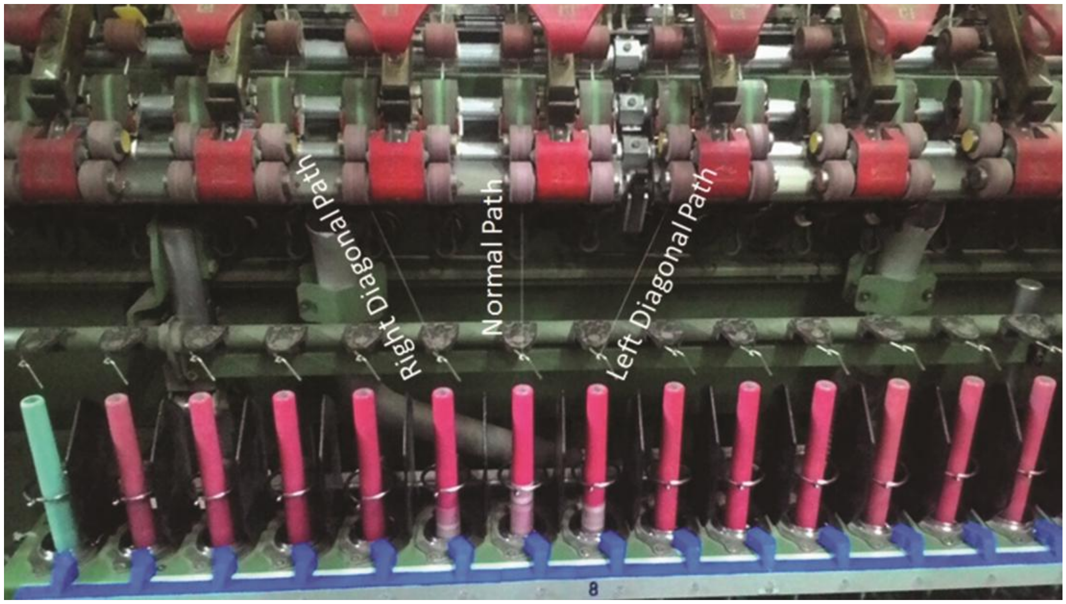

Fig. 1 — Schematic diagram of normal, right and left diagonal path

mismatching of the right side of the spindle and vice versa for the left diagonal path.

Yarn Testing

Yarn breaking strength and extension were estimated on a Zwick universal testing instrument. The gauge length was 500 mm with the extension rate of 150 mm/min. An unevenness tester was used to determine the yarn unevenness using a testing speed of 100 m/min. Yarn hairiness is measured by using Zweigle hairiness tester. All the tests were performed under the standard atmospheric temperature of 20º C ± 2º C and RH of 65 ± 2 %.

Results and Discussion

Yarn Hairiness Properties

Table 2 shows the Zweigle yarn hairiness value (S3) of the assorted diagonal path of compact and ring yarns. During this analysis, left diagonal path has resulted in 30-39% hairiness reduction. Apparently, it is additionally evident that S3 values are comparatively low for the conventional yarn and left diagonal path as compared to compact normal path yarn.

The enhancement in yarn appearance achieved by left diagonal path is attributed to longer path modification in spinning triangle and tension. The yarn hairiness of the Z twist yarn is caused by the fibres situated on the left side of the spinning triangle[7]. Also for 'Z' twist yarn, the fibres present in the left side of the spinning triangle are more uncontrolled in nature than the fibres present in right side of the spinning triangle. Hence, the yarn path has been modified in such a way that the fibres are controled on the left side of the spinning triangle and it reduces the hairiness of yarn.

Table 2 — Zweigle yarn hairiness value (S3)

Yarn path	Statistic	95 CI
Conventional left	289.6	±9.551
Conventional right	498.5	±7.170
Conventional normal	477.5	±6.532
Compact left	268.7	±7.365
Compact right	408.9	±4.798
Compact normal	399.2	±5.056

The spinning triangle behaviour of the various paths of the yarns is shown in Fig. 2. The left, centre and right side fibre of the spinning triangle for normal path yarn is mentioned as L, C and R respectively. OL, OC and OR represent the theoretical fibre length of the left, centre and right side of the spinning triangle. Figures 2 (b) and (c) represent the similar concept for left and right diagonal path of yarn.

In left diagonal path, the uncontrolled fibres (O_lL_l) could also be controlled by reducing the spinning triangle length on the left side. And fibres present in the right side (O_lR_l) may be controlled by twisting (Z) tension[8]. Therefore, the left diagonal path has less hairiness as compared to the right diagonal path.

Physical Properties of Yarn

The effect of diagonal feedings on yarn properties is shown in Table 3. It is evident that the left diagonal

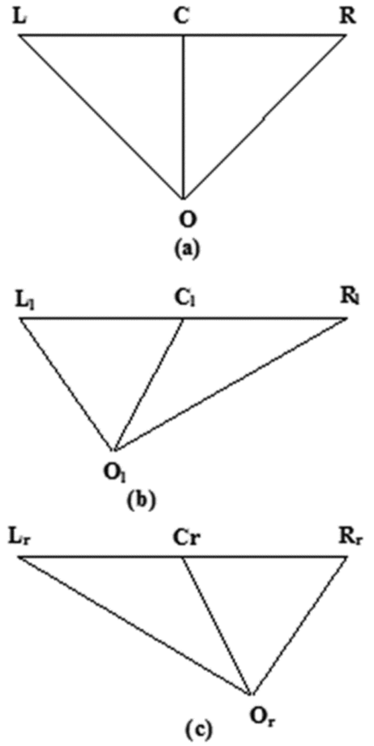

Fig. 2 — Spinning triangle of (a) normal path yarn, (b) left diagonal path yarn and (c) right diagonal path yarn

path has led to lower imperfections than the right diagonal path in both conventional and compact spinning systems. This might be due to the fact that the fibres present in the left diagonal spinning triangle are in better control than in the right diagonal and normal path of the yarn. Moreover, several researchers[9-12] have observed that the compact yarn has an advantage over the ring-spun yarn in terms of yarn physical properties.

Figure 3 shows the physical properties like tenacity, elongation and breaking force of the left diagonal, right diagonal and normal path of the yarn. It is clear that the left diagonal yarn path has better behaviour in physical properties in comparison to the other paths. The elongation of the yarn could also be increased due to the better control of fibres in the left diagonal path as it reduces the evenness also. The yarn spun from the left diagonal path has more evenness as compared to the other path (Table 3). This evenness of yarn reduces the probability of yarn breaking on the weak spot. Therefore, tenacity and breaking force show the highest value for the left diagonal path yarn.

Yarns spun by feeding roving in the left-hand diagonal path in compact and conventional ring

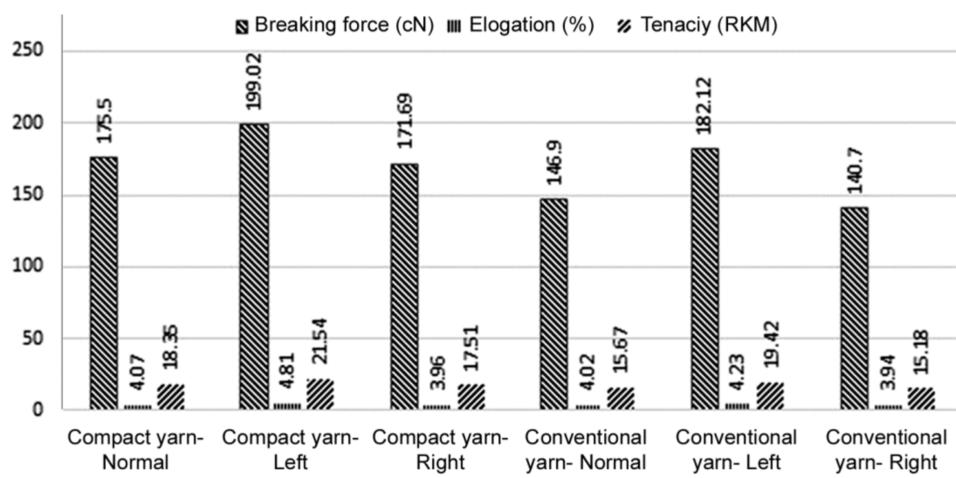

Fig. 3 — Diagonal path yarn properties

Table 3–Diagonal path yarn properties

Parameter	Compact yarn			Conventional yarn		
	Normal	Left	Right	Normal	Left	Right
U%	11.13	8.60	12.33	11.75	11.44	12.22
Thin (-50%)	8.00	2.20	9.20	20.00	9.60	20.80
Thick (+50%)	65.00	35.00	69.00	80.00	38.60	80.60
Neps (+ 200%)	145.00	108.60	152.60	215.00	116.20	220.60
Hairiness	3.11	2.33	3.50	4.95	2.87	5.09
Breaking force, cN	175.50	199.02	171.69	146.90	182.12	140.70
Elongation, %	4.07	4.81	3.96	4.02	4.23	3.94
RKM	18.35	21.54	17.51	15.67	19.42	15.18

spinning process show considerably lower hairiness followed by slighter enhancement in tenacity. This reduces yarn hairiness by 30-39% in comparison to conventional yarns. Also, the left diagonal path shows the best improvement in yarn evenness, tenacity, and elongation and in breaking force. Thus, it is concluded from the left diagonal path that the conventional ring yarn could also be substituted for conventional compact yarn because of the similar performances.

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