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Study on Sirospunning System to Reduce the Hairiness of Yarn

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Abstract

The twisting process of Sirospunning and Ringspunning was compared and analyzed as to the phenomenon that Sirospunning decreases yarn hairiness. It can be obtained from the analysis of geometrical model that more hairiness is twisted into the yarns and the amount of apparent hairiness is reduced through its special twisting. It can be calculated that when the count is equal Sirospunning can reduce the hairiness more than 22% compared with Ringspunning. The key factor the effect of tassel spacing of Sirospunning was studied using geometrical model, and the reason why the increase of tassel spacing could decrease the amount of hairiness was obtained. At last, the result of theoretical analysis was validated through series of experiment.

Keywords: Sirospunning, Hairiness, Tassel spacing, Geometrical Model

Sirospunning was studied by CSIRO and IWS together in 70s of 20th century. Sirospunning improves conventional Ringspunning technology, decreases the amount of apparent hairiness effectively, makes the surface of yarns smoothy, and improves the resistance of yarns to abrasion and the quality of yarns. Till now, a lot of research has been focused on Sirospunning abroad, however, the question that how to decrease the hairiness has not been resolved; In the research of the factors of Sirospun yarns, researchers got the agreement that the tassel spacing was the vital factor influencing the structure and the properties of yarns [1], and that the larger the tassel spacing the better of the rigidity, hairiness, the resistance to abrasion and amplexus [2]. The theoretical evidence of the way tassel spacing influencing the yarn hairiness is yet to be known. Consequently, the purpose of this paper was to analyze the above questions by establishing geometrical model, and to validate the results through experiment to get the conclusion.

1. The comparison of triangle region between Ringspunning and Sirospunning

The twists of Ringspunning and Sirospunning are produced by the motion of the steel traveler. The produced twist is transferred upwards to the converging point.

When Ringspunning twisting, the tassel of the jaw circumgyrates around the axis, the width of the tassel shrinks gradually, and the two sides are folded into the yarns center gradually to form the twisting triangle region, as shown in Figure. 1(left). In the twisting triangle region, the width and section of the tassel are changed, and the yarns are formed from compressed to columniform [3].

When Sirospunning twisting, firstly, two branches of tassel are combined after exported with the same pace from the front roller; before combined, there is a segment of single-yarn twisting region and the tassel form the single-yarn structure in this region, as shown in Figure. 1(right). Fibre basically array in a fastigiate screwy line. Then two branches converge to be twisted, belonging to lang lay. The combined twist increases rapidly on the basis of single twist, making the single yarn and fibre screwy line more obvious, increasing the slope degree of fibre, and making the section of branches become round structure [4].

In Figure. 1 the twist is obtained when tassel is added at section A; section B shows the distribution shapes of fibre before yarns produced; section C shows the shapes of the produced yarns.

In Sirospunning, due to the shortened single branch yarn twisting region, the obtained twist decreases, the assembly of fibre becomes relatively supple; the opportunity of the fibre ends coming out reduces, leading to the decrease of the hairiness. In addition, during the following combination of yarns, parts of the hairiness of the single yarn are twisted into the yarns, the hairiness decrease. Consequently, the hairiness of Sirospun yarn is less than that of Ringspun yarn.

2. The hairiness comparison of Ringspunning and Sirospunning

In order to study the hairiness difference between Ringspunning and Sirospunning, an ideal Sirospunning model (Figure.

3) was established on the basis of the practical observation on Sirospunning (Figure.2). It can be found from the analysis of referenced literatures [4-6] that the section shape of Sirospun yarn is round the same to the ordinary Ringspun yarn. In addition, the two single yarns separate the Sirospun yarn equally, and do not affect each other, there exists an obvious boundary. Therefore, in the model shown in Figure.3, it is assumed that the shapes of the two branches of single yarn are standard circle at section B before Sirospun yarn formed. They are represented by O1 O2, with the same size, semidiameter r; After Sirospun yarn formed, the section shapes of Sirospun yarn and Ringspun yarn are standard circle, semidiameter R, the same shape of the produced yarn at section C; the boundary is a straight line BC, as shown in Figure.3.

Ideally speaking, due to the same count of produced yarns at section B, the areas of Sirospun yarn and Ringspun yarn are equal.

$\pi R^2=2\pi r^2$

$$R=\sqrt{2}r \qquad (1)$$

After twisted, two branches of single yarn are combined towards to the center. A part of the single-yarn hairiness are twisted into the yarns, as represented as the hairiness on part of arc of O1 O2 in Figure.3 twisted into the inside line BC of yarns. The rest hairiness of the arc would exist on the yarn surface, to form the hairiness of Sirospun yarns. It is assumed that the distribution of yarn hairiness on the yarn surface is even, the length of the section arc could represent the relative amount of yarn hairiness.

$$L_{BC}=2R \qquad (2)$$

According to the circle perimeter equation, the perimeter of O1 obtained:

$$L_{01}=2\pi r \qquad (3)$$

The outside length of single yarn untwisted:

$$L_{single}=L_{01}-L_{BC} \qquad (4)$$

From (1), (2), (3), (4): $L_{single}=3.452r$ (5)

In the model, the sizes of two branches spun yarns are same, and known as total symmetry. Then, the representative outside length of Sirospun yarn LS

$$L_S=2L_{single}=6.904r \qquad (6)$$

The perimeter of Ringspun yarn cross section LH

$$L_H=2\pi R=8.880r \qquad (7)$$

Consequently, the ratio of the apparent Sirospun yarn hairiness Ns to that of Ringspun yarn NH, τ:

$$\tau=\frac{N_S}{N_H}=\frac{L_S}{L_H}=0.78 \qquad (8)$$

In this situation, from the above model calculation, it can be found that the Sirospun yarn hairiness could be decreased up to 22% compared with that of Ringspun yarn. Actually, the boundary BC of the two single yarns does not must be straight line. The research demonstrated that the single yarn section inside the twisted Sirospun yarn basically belonged to circle or ellipse, and the boundary could exist as curve, which was also proved by microscope image of the cross section (Figure.3). Therefore, the calculated result that taking BC as the straight line is the minimum. That is to say, Sirospunning can decrease hairiness more than 22% compared with conventional Ringspunning.

3. The effect of spacing on Sirospun yarn hairiness

In order to study the influence of tassel spacing on Sirospun yarn hairiness, the further geometrical model was established based on the previous theoretical analysis, shown as below.

In the previous analysis, it was assumed that the fibre section on the converging point was round. But actually due to the certain spacing between Sirospun yarn tassels, so there exists an angle on the converging point, in addition, the fibre on the converging point could squeeze to each other; these reasons result in that the fibre shape at section B is not standard circle, shown in Figure. 4.

In Figure. 4, the two columns represent the formed two branches thin yarns. At section A, d represents the tassel spacing; a represents the angle between tassel and the central axis; ellipses O'1 O'2 represent the projection shape of the two thin yarns O1 O2 at section B, as the real shape yarn when it goes through section B, major diameter r, minor diameter r', shown as Figure.5.

Obtained from the according relationship in Figure.4:

$$r'=r\cos\alpha \qquad (9)$$

The perimeter equation of ellipse:

$L01'=2\pi r'+4(r-r')$ (10)

Obtained from (1) (2) (4) (9) (10):

$Lsingle'=1.172r+2.28r\cos\alpha$ (11)

Obtained from (6) (7) (8) (11), the apparent hairiness ratio of Sirospun yarns to Ringspun yarns:

$\tau'=0.264+0.514\cos\alpha$ (12)

From the experimental observation, it could be obtained that the value of α is at the range of 0~45. So τ' is the decay function of α. α increases and τ' decreases with the rise of d. That is to say, the decreased percentage of Sirospun yarn hairiness increases with the rise of tassel spacing. When $\alpha=0$, the model is equal to the ideal condition, and $\tau'=0.78$, agree with the previous conclusion.

4. Validating experiment

On the electric small sample Sirospunning machine, using double bugles addition, Sirospun yarns with different tassel spacing were produced through modifying the central distance between the two bugles. The hairiness indexes of Sirospunning and Ringspunning with same count were compared using equipment.

Roving raw: cashmere 50%\1.5D viscose 50%

Twist: 30 twisting/m; ingot weight: 7.5g/10m

Spun yarn size: 76tex; Spun yarn twist: 420 twisting/m

Testing equipment: YG172 Spun yarn hairiness tester

Experiment time: 5 times, length of segment: 10cm

The experimental data are shown in Table 1. Compared Sirospunning with Ringspunning, it could be found that Sirospunning hairiness indexes of all kinds of length are smaller than those of Ringspunning obviously. The decreased percentage of Sirospunning hairiness with the length 3mm is at the range of 22%-48% compared with that of Ringspunning hairiness. From the table, it could be found that all the hairiness indexes of different lengths are in the decreasing trend and the decreased percentage of hairiness increases with the rise of Sirospun yarn tassel width, which validates the results from the model.

5. Conclusions

Due to the special twisting of Sirospunning, more hairiness is twisted into the yarns, then the apparent tassels decreasing; it was assumed that the tassel spacing of the perimeter in the longitudinal section and cross section was even. And the section of Sirospun yarn could be represented by geometrical model. The arc length of the hairiness distributed section could represent the hairiness condition of the whole yarn, using this method, Sirospunning with the same count could decrease the hairiness up to 22% compared with that of Ringspunning; The tassel spacing is one of the factors influencing Sirospun yarns. Theoretical analysis and experimental results show that the angulation of triangle region increases with the rise of the tassel spacing, and more hairiness would be twisted into the yarns, leading to the increase of the decreased percentage of Sirospunning.

References

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Table 1. The yarn hairiness of Sirospunning and Ringspunning

Hairiness length	2mm	3mm	4mm	5mm	6mm
Hairiness index of Ringspun yarn (branch/m)	44.96	15.12	5.98	2.62	1.24
d=0mm Hairiness index of Sirospun yarn (branch/m)	37.02	11.14	4.24	1.92	0.8
Decreased hairiness compared with Ringspuning (%)	18	26	29	27	35
d=3mm Hairiness index of Sirospun yarn (branch/m)	37.34	11.82	5.12	2.34	1.2
Decreased hairiness compared with Ringspuning (%)	17	22	14	11	3
d=6mm Hairiness index of Sirospun yarn (branch/m)	33.42	10.40	5.04	2.02	1.12
Decreased hairiness compared with Ringspuning (%)	26	31	16	23	10
d=11mm Hairiness index of Sirospun yarn (branch/m)	33.90	9.14	3.66	1.42	0.76
Decreased hairiness compared with Ringspuning (%)	25	40	39	46	39
d=13mm Hairiness index of Sirospun yarn (branch/m)	32.24	8.82	3.32	1.48	0.68
Decreased hairiness compared with Ringspuning (%)	28	42	44	44	45
d=15mm Hairiness index of Sirospun yarn (branch/m)	30.88	7.98	3.16	1.00	0.44
Decreased hairiness compared with Ringspuning (%)	31	47	47	62	65
d=17mm Hairiness index of Sirospun yarn (branch/m)	29.50	7.80	2.76	1.06	0.40
Decreased hairiness compared with Ringspuning (%)	34	48	54	60	68

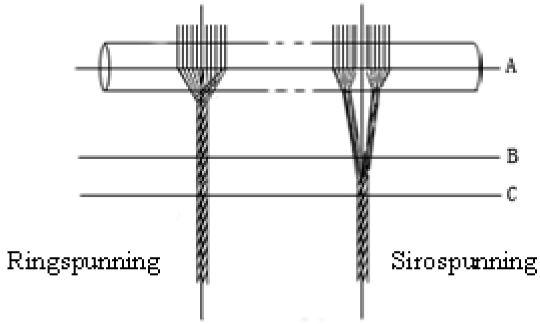

Figure 1. The twisting structures of Ringspunning and Sirospunning

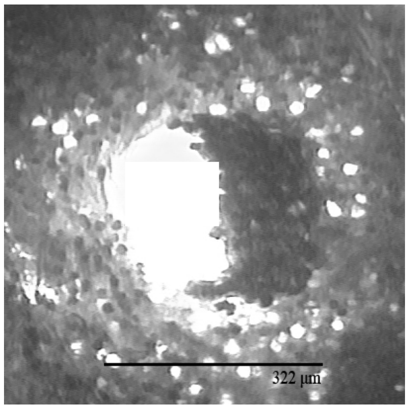

Figure 2. The cross section diagraph of Sirospun yarn

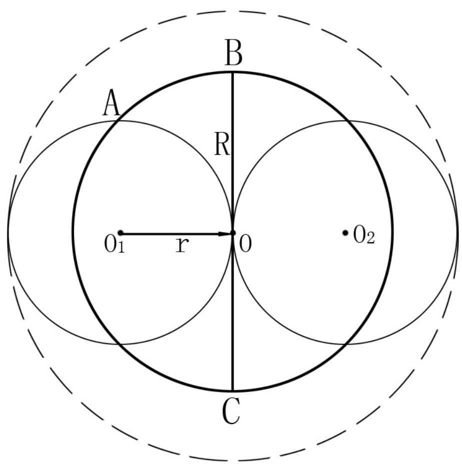

Figure 3. The Sirospun yarn structure diagraph in ideal state

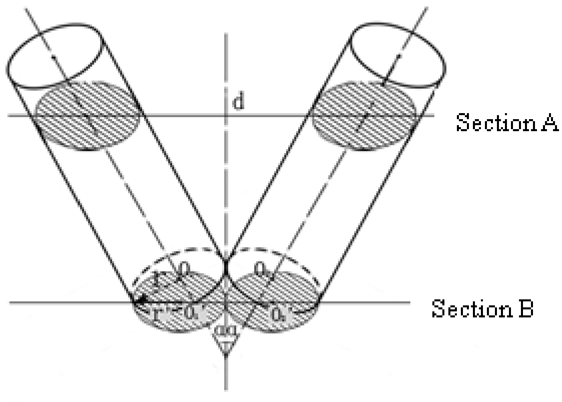

Figure 4. The analysis diagraph of Sirospun yarn triangle region

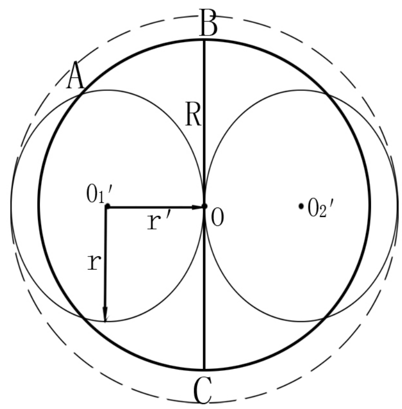

Figure 5. The structure diagraph of Sirospun yarn