Yarn hairiness controlled by various left diagonal yarn path offsets by modified bottom roller flute blocks in ring spinning

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The influence of modified yarn path on spinning triangle and, in turn, on yarn hairiness has been studied using 100% cotton yarns of the counts 25s, 40s, 60s, 70s & 100s, and polyester/cotton blended (70/30) yarns of the counts 30s, 45s & 64s with various left diagonal path offsets in ring spinning. The study has been carried out using DJ5 ring frame model by modifying the bottom roller flute blocks, pressure bar and pneumafil hole accordingly. The yarns have been tested for hairiness, strength, unevenness and breakage and the test results are compared with the various yarns produced by different left diagonal path offsets and normal straight path. It is observed that there is up to 40% reduction in hairiness at 60 mm offset left diagonal path with slight increase in the strength for all the counts produced except 100s.

Keywords: Cotton, Left diagonal path, Polyester, Spinning triangle, Yarn hairiness

1 Introduction

The spinning triangle and spinning angle affect the yarn breakage and influence the yarn structure. The long and narrow width spinning triangle implies a long weak point and hence causes more end breakages. However, a resultant advantage of this small width triangle is that the edge fibres are better bound in the yarn, which gives a smoother (less hairy) yarn and hence less fly generation.

Stalder\textsuperscript{1} has confirmed that when the spinning triangle gets smaller with increasing spinning tension, the hairiness is reduced. According to Klein\textsuperscript{2}, when the spinning triangle is short, the fibres from the edges must be strongly deflected to get bounded into the yarn structure.

Yarn hairiness has a significant effect on yarn strength, spinning efficiency, weaving and knitting performance as well as on the properties of resultant fabrics made from such yarns, particularly their pilling tendency and uneven dye uptake\textsuperscript{3}. These protruding fibres make no contribution to yarn strength and elongation. They are also often unwelcome in downstream processes and amount to deficient utilization of raw material. It is obvious that even ring-spun yarns are not ideal in terms of structure and quality. The quest for higher quality ring-spun yarns therefore continues, particularly in the area of hairiness reduction\textsuperscript{4}.

In the recent developments like compact spinning by Rieter and Zinser, the spinning triangle is reduced to ensure less yarn hairiness. Wang\textsuperscript{5} in his study confirmed that the right diagonal path produces yarn of lower hairiness in worsted spinning. Left diagonal path reduces hairiness in coarser counts than straight path and right diagonal path\textsuperscript{6}.

The present work is aimed at developing less hairy yarn in ring spinning with 100% cotton and polyester/cotton blend. The left diagonal path (LDP) offset has been modified by using a newly designed bottom roller and the effect of LDP offset on various yarn properties, like hairiness, imperfections and strength, studied.

2 Materials and Methods

2.1 Materials

100% cotton yarns of the counts Ne 25s, 40s, 60s, 70s & 100s and polyester/cotton blended (70/30) yarns of the counts Ne 30s, 45s & 64s were produced with various left diagonal path offsets (0-70mm) in DJ5 model ring spinning. The 25s and 40s count yarns

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were spun from Shankar 6 cotton, 60s and 70s counts from Giza 86 type cotton and 100s count were spun from Russian cotton. In case of polyester/cotton blends, 70% Recron and 30% Shankar 6 type cotton were used. The fibre specifications are given in Tables 1 and 2.

2.2 Methods

It has already been confirmed\(^6\) that the LDP of around 70mm (by threading the yarn in adjacent spindle) gives better yarn with lower hairiness for coarser counts. Hence, in this work, the yarns were spun with various offsets from 10mm to 70mm with left diagonal path, as shown in Fig. 1. With the left diagonal arrangement, the yarn emerging from a drafting unit is taken up by an adjacent side to the left of the drafting unit, instead of the bobbin directly below it. Hence, in order to have various LDP offsets from 10 mm to 70 mm, the bottom roller flute design, pressure bar and pneumafil ducts have been modified.

In ring spinning, the yarn is spun with Z-twist and hence the left diagonal arrangement gives better control of the fibres on the left-hand side of triangle. This is due to the shortening of spinning triangle at the left side which reduces the distance travelled by the uncontrolled fibres to reach the convergence point as compared to conventional straight path. Therefore, with this left diagonal arrangement, the yarn hairiness is reduced.

The details of roller design, pressure bar, pneumafil pipe and spacer & aprons are given below:

2.3 Processing Method

The study has been carried out in the right hand side of DJ/5 ring frame. All cotton and polyester/cotton blend yarns were spun with various left diagonal offsets (Fig. 5) from 10 mm to 70 mm at a spindle speed of 14,000 rpm and with the process parameters as shown in Tables 3 and 4.

2.4 Testing Methods

The hairiness was tested using Zweigle G565 hairiness tester under standard conditions at
100 m/min speed and 5g pretension. The number of hairs for all the classes was observed. This hairiness measurement (S3) gives the number of >3mm long protruding fibres in 100m yarn and the absolute number of protruding fibres.

The tensile properties of yarns were tested on the Premier Tensomax 7000 V2.3 at a speed of 5000 mm/min and at a pretension of 0.5cN/tex, which works with constant rate of extension (CRE) principle.

The imperfection testing was done by Uster tester 3 module under standard conditions at a speed of 100 m/min. This measures the faults using capacitance principle.

![Fig. 2—Schematic diagrams of normal and designed bottom rollers (units in mm) [a–normal back bottom roller, b–normal middle bottom roller, c–normal front bottom roller, d–designed back bottom roller, e–designed middle bottom roller, and f–designed front bottom roller]](image)

![Fig. 3—Schematic diagram of pressure bar (a–normal and b–designed)](image)

![Fig. 4—Schematic diagram of pneumafil pipe (a–normal and b–designed)](image)
3 Results and Discussion
3.1 Effect of Various Offsets of Left Diagonal Path on Yarn Hairiness

The S3 values are shown in Table 5 for the various counts spun. It is observed that in case of long hairs (>3 mm length) there is 40-75% hairiness reduction in S3 values at 60 mm LDP offset yarn compared to the straight path yarn. A significant test has been conducted for straight and 60 mm LDP offset with respect to hairiness and it is found that the reduction in hairiness is significant at 95% and 99% confidence levels. This may be due to the reduction in distance between the front roller nip and the convergence point, resulting in reducing the travelling distance of less controlled fibres.

The significant reduction in hairiness at 60 mm LDP offset may be due to the fact that one side of triangle (which follows ‘Z’ path) gets more tension than the other side (Fig. 6c). So, the fibres which come through right side of spinning triangle gets more tension and it is controlled by higher tension and pre-twisting. Hence, the fibres get bound inside the yarn and hence minimum hairiness is observed at 60 mm offset length.

The fibres which come through other side (left side) of triangle have to travel short distance than normal. That is, it has short uncontrolled path before reaching to converging point. Hence, here also there is an opportunity to control hairiness (Fig. 6c).

There is a small reduction in hairiness value upto 20mm offset in all the 3 polyester/cotton blended yarns, which then increases upto 40mm LDP offset length and a maximum reduction is observed at 60mm offset length (Table 5). This is because at straight path and at lower offsets, two sides of the spinning triangle get more or less equal amount of force. Hence, there is less chance of control of fibres on any side.

<table>
<thead>
<tr>
<th>LDP offset length, mm</th>
<th>25sC</th>
<th>40sC</th>
<th>60sC</th>
<th>70sC</th>
<th>100sC</th>
<th>30sP/C</th>
<th>45sP/C</th>
<th>64sP/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5981</td>
<td>6697</td>
<td>1407</td>
<td>901</td>
<td>3415</td>
<td>5531</td>
<td>440</td>
<td>3932</td>
</tr>
<tr>
<td>10</td>
<td>5434</td>
<td>5101</td>
<td>1809</td>
<td>887</td>
<td>3005</td>
<td>4180</td>
<td>217</td>
<td>3289</td>
</tr>
<tr>
<td>20</td>
<td>5510</td>
<td>5398</td>
<td>1788</td>
<td>959</td>
<td>3965</td>
<td>4556</td>
<td>225</td>
<td>3068</td>
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<tr>
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<td>7796</td>
<td>6810</td>
<td>1518</td>
<td>998</td>
<td>3432</td>
<td>5486</td>
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<td>5570</td>
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<td>934</td>
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<td>6674</td>
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<td>1090</td>
<td>4617</td>
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<td>3439</td>
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<td>4409</td>
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<td>1699</td>
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<td>3933</td>
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<td>861</td>
<td>3866</td>
<td>6096</td>
<td>195</td>
<td>3831</td>
</tr>
</tbody>
</table>

C—Cotton, and P/C—Polyester/cotton.
In the 100% cotton yarns, reduction in hairiness is observed up to 20mm offset and similarly maximum reduction is observed at 60mm offset length. The hairiness reduction is less in finer counts like 70s and 100s than in coarser counts. This is due to the fact that the higher tension in the right side edge of the triangle results in fibre breakage with long fibres and loss of broken fibres through aspirator.

3.2 Effect of LDP Yarn Path on Imperfections

Yarn imperfections increase when counts become finer and a maximum of 15.73 U% is observed for 100s count as against 9.56 U% for 25s count at 60mm LDP. This may be due to increased tension in spinning triangle, fibre breakage and fibre loss inside the aspirators. The maximum reduction in thick places, thin places and neps was observed at 60mm LDP offset length as in case of hairiness. In polyester/cotton blended yarns up to 45s, there is a significant reduction in thick places, thin places and neps, when compared to straight path yarn. There is no significant change in CV%.

3.3 Effect of LDP Yarn Path on Tensile Properties

The tensile properties of samples produced from various LDP offset lengths are at par with the straight path yarn and hence the LDP offset length does not affect tensile properties of all the samples. In case of 25s cotton and 30s polyester/cotton yarns, the observed tenacity is 18.04 Rkm and 25.19 Rkm respectively in straight path yarn as against 18.32 Rkm and 25.92 Rkm in 60mm LDP.

4 Conclusions

The effect of various LDP offset lengths on yarn hairiness and other quality has been studied. The cotton and polyester/cotton blend yarns produced with 60 mm LDP offset length show higher hairiness reduction compared to their straight path yarns except for 100s count. There is no significant change in imperfections as well as tensile properties of LDP yarns compared to the straight path yarn. To have various LDP offset lengths the design of all the three bottom roller flutes blocks, pressure bar holes, pneumafil pipe, spacer and aprons have been altered accordingly. The study confirms that there is no need to have any new designed roller to get this 60 mm offset. It is possible by moving the traverse guide 10mm left side (the yarn path is within flutes block) and threading the yarn to left adjacent spindle. Low hairiness yarn can be obtained from this system without any external modifications. The newly designed roller can be used for any count. So, either low offset path or straight path can be selected for finer count. This will be a new spinning concept like compact spinning in future.

Industrial Importance: Ring spinning remains the dominant spinning technology even today, in spite of modernisation and rapid technological development in the field of spinning because of its advantages. Today, the main goal of industry is to achieve improved yarn quality that will ensure better competitiveness and higher yarn prices. This LDP yarn path gives quality yarn with reduced hairiness in the existing ring spinning process itself without any additional attachments for the coarser counts.

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References

3 Barella A, Yarn hairiness, Text Prog (Textile Institute, UK), 1983.