Hairiness of Jute Yarn: Part I—Effects of On-line Spinning Tensions

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The level of on-line spinning tension was varied by changing independently flyer speed, position of felt-bobs fitted under the bobbin carrier, path geometry of yarn along a flyer leg before entering the flyer eye, and spindle eccentricity to study its effect on the hairiness of jute yarn. With increase in spinning tension, the hairiness decreased in general. Increase in flyer speed and spindle eccentricity increased the hairiness, whereas the outermost position of felt-bobs and two wrappings round a flyer leg before entering the flyer eye decreased the hairiness.

Keywords: Flyer speed, Jute yarn, Spindle eccentricity, Spinning tension, Yarn hairiness, Yarn path geometry

With the ever-growing competition from synthetics and paper, diversification of jute fibres to high-value decoratives is gaining ground. As a result, the demand for yarns with lesser and lesser amount of hairs is growing. Hairiness not only affects the appearance, handle, appeal and wet-processing treatments, but also causes high dust pick-up and shredding loss, particularly for jute products, as normal jute yarns are excessively hairy. Nowadays complaints are being received from overseas buyers that foodstuffs like sugar, salt, and flour are contaminated through transfer of loose fibres from the package itself.

The nature and causes of hairiness of yarns spun out of different textile fibres have been studied extensively. However, information on jute fibres is scanty. Hence the present study on how on-line spinning tensions affect the hairiness of jute yarns.

Materials and Methods
The level of on-line spinning tension was varied by changing independently (i) flyer speed, (ii) position of felt-bobs fitted at the bottom of a bobbin carrier, (iii) path geometry of a yarn along the leg of a flyer, and (iv) spindle eccentricity.

A typical path of yarn in the Mackie slip-draft jute spinning frame is shown in Fig. 1.

Four sets of yarns were spun. In each set, one of the parameters was varied while the others were kept according to the standard practice. The parameters used were: flyer speed, 4200 rpm; felt-bobs, placed at the middle position; yarn wrapped twice round the flyer leg before it entered the flyer eye; and spindle eccentricity, below ±5 mil.

Four samples of W2-grade jute fibre, 5 kg each, were drawn by proper sampling. The samples were emulsified with a standard oil-in-water emulsion (20:80) by applying 30% emulsion on the weight of fibres and passed through the softener. Emulsified and softened fibres were binned for 72 h and processed through standard jute machineries to spin yarns of 276 tex by following the small-scale spinning technique. The sequence of machineries was JF2 breaker card; JF4 finisher card; three passages of Mackie Screwgill drawing; and 4.25 in. Mackie slip-draft spinning frame. The first set of yarns was spun by varying the flyer speed in the order 3200, 3450, 3900, 4200 and 4700 rpm, while the second set was spun by changing the position of felt-bobs in three available positions, viz. inner, middle and outer. In the third set, the path geometry of
the yarn along the flyer leg was varied in five different fashions as mentioned below. Before entering a flyer eye the yarn came down directly from the wharf and made no wrapping round the flyer leg in the first case; wrapped once, twice and thrice round a flyer leg in the second, third and fourth cases respectively; and wrapped once round one leg after crossing over the other in the fifth case. Yarns of the fourth set were spun by varying the spindle eccentricity at $\pm 5$, $\pm 10$, $\pm 15$, $\pm 20$ and $\pm 25$ mil.

A jute yarn hairiness meter was used to count the number of hairs per unit length at a perpendicular distance of 2.3 mm from the surface of yarn. The mean and CV % of a minimum of 100 readings per sample were calculated, each reading representing the number of hairs in 2.5 m of yarn. Mean values were converted into mean numbers of hairs per 100 m of yarn.

Yarns were singed by the method developed in this laboratory. The yarn was passed at a constant speed of 270 m/min and 3 mm above the flat surface of a coil of Nichrome wire (22 SWG) of 1500 W capacity. A 6-A current was passed to get the glow. Under the above conditions, hairs were burnt almost completely without affecting yarn body vis-a-vis strength of the yarn. The percentage loss in the weight of post-singed yarns in relation to pre-singed yarns was considered as the index of hairiness.

Results and Discussion

Variations in the number of hairs with different flyer speeds are shown in Fig. 2. The figure shows that the hairiness increases with the gradual stepping up of the flyer speed and the increase is steep when the speed exceeds 4200 rpm.

As the flyer speed is increased, the yarn balloons off the flyer leg. The centrifugal force on the balloon, higher air resistance in the air vortex in and around the flyer legs, and higher shearing action at the flyer eye with higher speed, all these are the possible factors responsible for helping the fibres to eject out of yarn body and for showing higher hairiness. This trend confirms the findings of Pillay, Barella et al., Walton, and Boswell.

Variations in hairiness with different positions of felt-bobs fitted under the bobbin carrier are shown in Fig. 3.

At the outer position, the felt-bobs travel the longest path per revolution over the friction plate encircling the dead spindle and experience maximum frictional resistance as well as tension on the yarn. At the middle and inner positions the frictional resistance and tension on the yarn are gradually lower. This variation in yarn tension is reflected on hairiness inversely, producing a minimum number of hairs at the outer and maximum at the inner position of the felt-bobs.

These findings are in accord with generally accepted observations that with increase in yarn tension, hairiness decreases. De-Barr observed that a higher tension on yarn causes a greater binding of fibres and helps twists to go closer to the nip of the front rollers and this, in turn, reduces hairiness, as was observed by Walton also.

Fig. 4 shows that when the yarn passes directly from wharf bottom through a flyer leg without wrapping round, hairiness is maximum. Though the mode of yarn passage produces high tension on yarn, the acute angle subtended at the leg eye might cause a high shearing action at that point. This might help the fibre ends to get partially detached from yarn body,
resulting in higher hairiness. Reduction in the number of hairs due to high tension might have been overweighed by an increase in hairiness due to shearing action at the leg eye. A similar observation was made by Pillay\textsuperscript{10} with cotton yarn in ringframe. Moreover, as double-flanged bobbins are used in jute spinning, the yarn, while coming down from the wharf bottom, rubs the upper flange of the rotating bobbin throughout the whole length of its traverse and this may cause hairiness to increase further.

When a yarn wraps round a flyer leg before entering the flyer eye, the tension on the yarn reduces.\textsuperscript{11} In the case of one wrapping round one leg, the shearing action on the flyer leg eye and rubbing of yarn on the upper flange of a bobbin become less severe, which are reflected in the lower value of hairiness. Hairiness goes down substantially when a yarn wraps twice round the leg before entering the eye. Here the tension on yarn, angle at the eye and rubbing on the flange go down to such an extent that a lowest number of hairs are produced under these conditions. When the yarn is wrapped thrice round the leg, the rubbing action becomes negligible and the tension is reduced to such an extent that the yarn starts forming three balloons round the flyer leg. Owing to ballooning, the fibres experience centrifugal force and air resistance and get deflected from yarn body to produce a greater number of hairs. But when the yarn passes round one leg after crossing over the other before entering the eye. These might be the possible causes of increase in hairiness with increase in spindle eccentricity.

The values of hairiness by the number of hairs per unit length are found to corroborate those by the percentage loss in the weight of post-singed yarns in relation to pre-singed yarns (Figs 2, 3 and 5).

Table 1—Effect of Path Geometry of Yarn over Flyer Leg on Hairiness

<table>
<thead>
<tr>
<th>Path geometry of yarn over a flyer leg</th>
<th>Hair loss by singeing %</th>
<th>Free length of yarn exposed to air vortex cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directly from wharf to the eye without wrapping round the flyer leg before entering the eye</td>
<td>2.96</td>
<td>15</td>
</tr>
<tr>
<td>Wrapping once round the flyer leg before entering the eye</td>
<td>3.93</td>
<td>12</td>
</tr>
<tr>
<td>Wrapping twice round the flyer leg before entering the eye</td>
<td>3.05</td>
<td>8</td>
</tr>
<tr>
<td>Wrapping thrice round the flyer leg before entering the eye</td>
<td>4.26</td>
<td>6</td>
</tr>
<tr>
<td>Passing round one leg after crossing over the other before entering the eye</td>
<td>4.64</td>
<td>19</td>
</tr>
</tbody>
</table>

Fig. 4 — Variation in hairiness with mode of yarn passage over flyer leg

Fig. 5 — Variation in hairiness with spindle eccentricity
Conclusions

(1) Hairiness of yarn increases with increase in flyer speed.
(2) The outermost position of felt-bobs fitted under the bobbin carrier produces minimum hairs.
(3) Two wrappings round the flyer leg keep the number of hairs at a lower value.
(4) Hairiness increases with increase in spindle eccentricity.

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References