Apron slippage in ring frame: Part III – Design and development of anti-slip apron for improved yarn quality

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The use of anti-slip apron in place of normal apron shows a total elimination of apron-to-apron slippage due to the positive means of motion transmission from bottom apron to top apron. As there is no apron-to-apron slippage in case of anti-slip apron, it can control the movement of floating fibres in a better way. Thus, the use of anti-slip aprons improves the yarn quality.

Keywords: Anti-slip apron, Apron-to-apron slippage, Yarn quality, Yarn tenacity

Among the various zones of ring frame, the drafting zone has the maximum influence on yarn quality, and within the drafting zone the apron zone is most critical zone. In the main drafting zone of ring frame, as the number of fibres is relatively small and the fibres move at a faster rate, the strict control over the movement of fibres is very essential. Therefore, in the main drafting zone the pair of aprons are supposed to perform the most important task, i.e. controlling the movement of individualized fibres. The detailed study has already been reported on the phenomenon of apron slippage and its impact on yarn quality. Looking at the detrimental effect of apron-to-apron slippage on yarn quality, the present study has been planned to design and develop new type of apron, i.e. anti-slip apron, which results zero slippage in between bottom apron and top apron. A comparative study of the quality of yarn produced in laboratory using this new type of anti-slip apron and normal apron has also been reported.

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The basic requirement of an apron is to have its surface very smoothly polished for uniform movement of fibres within the apron zone. This smooth outer surface of the aprons, at the same time, has its negative point also. Due to very low surface friction of aprons, there is every possibility of apron-to-apron slippage which results in deterioration in yarn quality. To overcome the problems associated with the apron-to-apron slippage, an attempt has been made to modify the surface structure of both bottom and top aprons without interfering the smooth movement of fibres within the aprons. The design was intended to have a positive drive of top apron from bottom apron instead of frictional drive. The schematic diagram of anti-slip apron is shown in Fig. 1.

Fig. 1 shows the front view of an anti-slip apron of width W. Both the edges (G and G’) of the apron were embossed with the help of a suitably designed die. First of all, the circular metallic die was heated and then pressed against approximately 2mm of one edge (G) of an apron. As the heated die revolves in contact with the edge G of the endless apron, which is fitted on a circular wooden revolving frame, the edge G of the apron gets embossed continuously and uniformly. The same process was repeated for other edge G’ also. In the present study, only the straight and parallel groove with pitch of 1.0 mm was used, but embossing of different designs may also be tried. The only idea is to have a positive transmission of motion from bottom to top apron without disturbing the smooth middle

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**Fig. 1** — Schematic diagram of anti-slip apron
zone (S) for flow of fibres within the apron zone. Ten pairs of anti-slip aprons each for cotton (short cradle) and polyester/viscose (long cradle) were prepared.

The apron-to-apron slippage was observed with and without roving in the drafting zone. In the present study, ten spindles each for cotton and polyester/viscose (P/V) blend were selected in such a way that their apron-to-apron slippage (Sa) values without roving are very close to each other so that the mean of these ten spindles can be taken as representative slippage value. The apron-to-apron slippage (Sa) is calculated as follows:

$$\text{Apron-to-apron slippage (Sa), } \% = \frac{\text{Bottom apron speed} - \text{Top apron speed}}{\text{Bottom apron speed}} \times 100$$

The details of apron speed and apron-to-apron slippage values both with and without roving for normal as well as anti-slip apron are given in Table 1.

Ten roving bobbins of 1.1 hank were prepared each from 100% cotton (J-34 SG) and 65/35 polyester/viscose of 51 mm staple length. From each roving bobbin 20s Ne yarns were prepared with two types of aprons (normal and anti-slip) from the same spindle, keeping all other spinning parameters the same. The cotton yarns were spun with 4.2 TM and P/V yarns with 3.2 TM and the spindle speed was kept at 10,500 rpm both for cotton and P/V yarns. The mass irregularity and yarn imperfections were tested on Uster Tester-3 at a speed of 400 m/min for 1 min. The number of thin places, thick places and nep per km were measured at -50%, +50% and +200% levels. Yarn tenacity and breaking extension were measured on SDL Universal tensile tester using 50 cm gauge length and 10 cm/min extension rate. Hairiness index (HI) and diameter irregularity (Ud%) were measured in Keisokki hairiness tester (Laserspot Model LST) at a speed of 25 m/min. The details of the test results are given in Table 2.

Table 1 shows that for normal type of apron, where entire outer layer is finely polished, the top apron always moves at slower speed than that of bottom apron, i.e. there is apron-to-apron slippage even when there is no material in between the aprons. The fact that the apron-to-apron slippage becomes higher when there is material in between has already been established. The same phenomenon is valid for both cotton and polyester/viscose yarns. In case of anti-slip aprons, it has been

### Table 1 — Apron slippage with normal and anti-slip aprons

<table>
<thead>
<tr>
<th>Type of yarn</th>
<th>Type of apron</th>
<th>Speed of apron with roving, mm/s</th>
<th>Apron-to-apron slippage with roving, %</th>
<th>Speed of apron without roving, mm/s</th>
<th>Apron-to-apron slippage without roving, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton (carded)</td>
<td>Normal</td>
<td>17.96</td>
<td>17.79</td>
<td>0.05</td>
<td>17.76</td>
</tr>
<tr>
<td></td>
<td>Anti-slip</td>
<td>17.82</td>
<td>17.82</td>
<td>0.10</td>
<td>17.54</td>
</tr>
<tr>
<td>Polyester/viscose (65:35)</td>
<td>Normal</td>
<td>23.43</td>
<td>23.12</td>
<td>1.32</td>
<td>23.07</td>
</tr>
<tr>
<td></td>
<td>Anti-slip</td>
<td>23.26</td>
<td>23.26</td>
<td>0.00</td>
<td>22.73</td>
</tr>
</tbody>
</table>

*Yarn count, 20s Ne

### Table 2 — Effect of type of apron on yarn properties

<table>
<thead>
<tr>
<th>Type of yarn</th>
<th>Type of apron</th>
<th>Mass irregularity (%)</th>
<th>Diameter irregularity (%)</th>
<th>Imperfections/km</th>
<th>Tenacity cN/tex</th>
<th>Tensile properties</th>
<th>Hairiness index (HI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>Normal</td>
<td>14.54</td>
<td>15.80</td>
<td>69</td>
<td>758</td>
<td>10.80</td>
<td>13.27</td>
</tr>
<tr>
<td></td>
<td>Anti-slip</td>
<td>14.10</td>
<td>14.80</td>
<td>66</td>
<td>389</td>
<td>12.32</td>
<td>9.47</td>
</tr>
<tr>
<td>Polyester/viscose (65:35)</td>
<td>Normal</td>
<td>10.58</td>
<td>13.60</td>
<td>0</td>
<td>100</td>
<td>15.87</td>
<td>10.64</td>
</tr>
<tr>
<td></td>
<td>Anti-slip</td>
<td>10.02</td>
<td>10.50</td>
<td>0</td>
<td>60</td>
<td>17.53</td>
<td>8.96</td>
</tr>
</tbody>
</table>

*Yarn count, 20s Ne
observed that for both cotton and polyester/viscose there is no apron-to-apron slippage, i.e. top apron always moves at the same speed to that of bottom apron, even when there is material in between aprons. The obvious reason for this zero slip is the modified structure of the aprons. As both the edges of the bottom and top aprons are embossed (approx. 2mm in both edges) like toothed belt, there will be a positive transmission of motion from bottom apron to top apron, thereby resulting zero slip. It is also clear from Table 1 that the speed of bottom apron is always slightly lower in case of anti-slip apron than that in case of normal apron. This may be due to the fact that positive transmission of motion from bottom apron to top apron causes some extra restrictive force on bottom apron which results in more slippage between bottom roller and bottom apron.

It may be observed from Table 2 that both the mass and diameter irregularities improve when the normal apron is replaced with the anti-slip apron for both cotton and polyester/viscose yarns. In case of normal apron, due to the apron-to-apron slippage the movement of fibre gets disturbed and this results in increase in irregularity. But in case of anti-slip aprons, as there is no relative motion in between the aprons, there will be streamline movement of fibres within the apron zone which results in reduction in both the mass and diameter irregularities. Table 2 also shows that the use of anti-slip apron improves the yarn imperfections drastically for both cotton and P/V yarns as compared to normal apron. As already discussed, when the apron-to-apron slippage increases there will be turbulent movement of fibres within the drafting zone, causing rolling of fibres which results in generation of neps and thick places. No consistent trend is observed in case of thin places and hairiness.

The tenacity of both the cotton and P/V yarns improves when anti-slip apron is used (Table 2). As has already been discussed, the use of anti-slip apron results in smooth flow of fibres in the apron zone. On the other hand, normal apron results in apron-to-apron slippage and thus the movement of fibres gets disturbed and the fibres become entangled. The non-straightness of fibres causes reduction in spinning-in coefficient, resulting drop in yarn tenacity. No clear trend is observed in case of breaking elongation. Table 2 also shows that the use of anti-slip apron results in improvement in CV% of tenacity and breaking elongation both for cotton and P/V yarns.

References