Studies on mass distribution profile of detached fibre fringe in a comber

R Chattopadhyay* & R Ghosh
Department of Textile Technology, Indian Institute of Technology, New Delhi 110 016, India

Received 12 September 2002; accepted 9 December 2002

The mass distribution characteristics of detached combed fringes along their length after collecting them from detaching roller nip have been studied. The distribution profile reveals valuable information regarding the way the profile changes with combing parameters such as piecing index, feed / nip, and type of feed (forward or backward). The mass distribution profile of single as well as overlapped double and triple fringes has also been studied. The mass profile of individual fringes is found to be close to skewed bell shaped curve that changes with process parameters.

Keywords: Comber, Piecing index, Forward feed, Backward feed, Fibre fringe

1 Introduction
The importance of combing process is increasing more and more due to the ever increasing demand on quality. The extraction of short fibres, neps, foreign matters and improvement in fibre parallelization make the combed yarn superior to its carded counterpart. The improvement in process performance during spinning and post-spinning stages is also well known.

A combed sliver is essentially an assembly of sequentially arranged overlapped combed fibre fringes. The overlapped portions result in periodic mass variation present in combed sliver known as piecing wave. The measures adopted to suppress this periodicity through appropriate machine design and process parameters are: (i) the use of off-centre location of sliver forming trumpet at each comber head, (ii) the adjustment of distance between sliver trumpet and draw box so as to make the arrival of pieced portions of adjacent slivers out of phase in draw box, (iii) resorting of sufficient number of post-combing drawing and doubling operations, and (iv) the use of autoleveller either on comber draw box or post-comber draw frame.

However, all these are the corrective actions taken after generation. It would be more meaningful to look for the possibilities of suppressing the irregularity at the generation stage itself. In this connection, it is extremely important to know the mass profile of detached combed fringes. In an overlapped structure, even if the individual detached fringes happen to be uniform along their length, the periodicity will still be apparent. Shaw1, while analyzing the mass profile of single fringe as a function of index number, opined the need for the production of symmetrically shaped tufts or fringes and their perfect matching during overlapping for the production of uniform sliver. The work was restricted to studying the single fringe produced on an old comber. The technology of combing has undergone lot of changes over the years. It is imperative to know how technological parameters, such as piecing index (PI), feed / nip and extent of feed, affect the mass distribution profile of individual detached combed fringe. The present work was therefore undertaken to study the above technological parameters. This will not only help the machine manufacturers to refine their technology further but also help the technologists to have a better understanding about the implications of combing process parameters on the regularity of combed sliver.

2 Materials and Methods

2.1 Materials
Comber laps of 40° mixing were collected from a mill. The mean fibre length was 17.5mm.

2.2 Determination of Mass Profile of Combed Fringe
2.2.1 Mass Profile of Single Fringe
The mass profile of single fringes was determined using the procedure suggested by Goritskii2,3. The lap was engaged with the feed roller and the combing machine (Lakshmi - Rieter E 7/4) was switched on so as to bring it to a normal state of operations. The machine was subsequently switched on to slow speed mode so that it can be stopped as soon as the
detaching rollers were about to turn backward. This corresponded to index number 10. Both the top detaching rollers were lifted and a strip of black paper (30 cm × 20 cm), with lines drawn at 5mm interval, was placed on the bottom pair of rollers. One end of the paper was hung a bit over the back detaching roller. The top rollers were then replaced. The machine was restarted in slow speed mode. Initially, the paper moved backward due to the backward motion of the detaching rollers. This was immediately followed by the forward movement. During this movement, the combed fringe held by the nipper assembly was placed on the paper and they both moved forward together. The machine was stopped as soon as the detachment was over. The detached fringe was found stuck to the paper. The top detaching rollers were lifted and the strip of paper along with the combed fringe was carefully removed. Fig. 1 shows the picture of detached combed fringes.

The paper along with the fringe was cut by a photographic paper cutter at the 5mm interval to generate 5mm strips. The weight of the paper strips with and without fibres was sequentially recorded on a sensitive balance. The difference between these two weights was calculated to determine the weight of 5mm fibre fringe. The whole process was repeated for at least five times to determine the average weight of 5 mm pieces of the fringe. The weights of these sections when plotted sequentially on a graph paper generate the average mass distribution profile of single fringe. The same procedure was repeated to collect double and triple fringes on the paper and their mass distribution. The total length of the fringes and weights were also recorded.

2.2.2 Determination of Piecing Length
The piecing length, i.e. the overlapped portion of successive fringes was determined from the experimentally observed values of single and triple fringe lengths. Let us consider l the length of the single fringe and L the total length of the triple fringe (Fig.2). If the piecing length is p, then

\[ p = \frac{(3l - L)}{2} \]  ... (1)

Therefore, one can determine p from the experimentally observed values of l and L.

2.2.3 Nature of Motion of Detaching Rollers
The characteristics of mass distribution profile of the detached fringe will be governed by (i) the spatial distribution of leading fibre ends in the combed but undetached fringe held by the nippers, and (ii) the nature of movement of the nipper assembly and detaching rollers i.e. detachment draft. To determine the nature of motion of the detaching rollers, a strip of paper was inserted into the nip of the detaching rollers. The main machine pulley was turned by hand. This caused the detaching rollers to move along with the paper. The movement of the paper with respect to a fixed position on the machine frame was recorded. Simultaneously, the corresponding index numbers were also recorded. Since the movement of paper represents translational movement of the detaching rollers, by plotting paper movement vs index number, the nature of motion of the detaching rollers was obtained.

3 Results and Discussion
3.1 Mass Profile of Single Fringe
3.1.1 General Mass Profile
The mass distribution of several single fringes obtained at piecing index (PI) setting of 0 is shown
in Fig. 3. Though the variation in corresponding section weights can be observed for five different fringes obtained under identical conditions, the general nature of the curve remains unchanged. In all the cases, the peak has been observed around 50mm from the front edge. The profile takes the form of a bell shaped curve indicating non-uniform mass distribution along the length of fringe. It is thick at the middle and gradually thins down towards both the edges. The distribution is not symmetric. A comparison of the nature of mass distribution of the two halves of the curve would reveal that the weight of equidistant sections from the line on which the peak lies is always more for the leading edge than that for the trailing edge. The leading edge is slightly longer as well.

3.1.2 Influence of Piecing Index

To understand the role of piecing index on the mass profile, fringes were collected at six different piecing indices, viz. -2.0, -1.0, -0.5, 0, +0.5, +1.0. Distribution diagrams for five typical cases are shown in Fig.4. It can be seen that though the general shape of the profile remains more or less same, the nature changes with piecing indices, indicating redistribution of the fibre mass within the fringe. The mass gets concentrated more and more towards the left, i.e. on the leading edge, with corresponding shift in location of the peak as the PI value is changed from 0 to -2.0. The profile is most symmetric at 1.0 PI but at zero PI value, it is slightly negatively skewed. At -1.0 and -2.0 piecing indices, it is positively skewed. The fringe length and it's weight at different piecing indices are given in Table 1. The average fringe length is around 95 mm and the average weight is 290 g. The difference observed at different settings may be due to the normal variability present in the feed lap.

3.2 Mass Profile of Overlapped Fringes

The mass profile of triple fringes is shown in Fig.5. It is observed that the distribution profile obtained at zero PI value has a flattened portion at the top with least waviness. It indicates a reasonably even distribution of fibre mass in the fringes. The profile with -2.0 PI value shows a single prominent peak, indicating maximum departure from a desired

---

### Table 1—Influence of piecing index on fringe characteristics

<table>
<thead>
<tr>
<th>Piecing index</th>
<th>Length of fringe, mm</th>
<th>Average weight of fringe, mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.0</td>
<td>95</td>
<td>335.6</td>
</tr>
<tr>
<td>-1.0</td>
<td>95</td>
<td>254.2</td>
</tr>
<tr>
<td>-0.5</td>
<td>95</td>
<td>267.0</td>
</tr>
<tr>
<td>0</td>
<td>95</td>
<td>299.2</td>
</tr>
<tr>
<td>+0.5</td>
<td>90</td>
<td>299.6</td>
</tr>
<tr>
<td>+1.0</td>
<td>90</td>
<td>283.8</td>
</tr>
</tbody>
</table>

---

![Fig.3—Mass profile of several single detached combed fringes (piecing index, 0; feed type, forward; and amount of feed, 5.6 mm/nip)](image)

![Fig.4—Characteristics of mass profile of single fringes at different piecing indices](image)

![Fig.5—Profile of overlapped triple combed fringes (feed type, forward; and feed amount, 5.6 mm/nip)](image)
flat profile. The profiles obtained at +1.0 PI value take intermediate position. The piecing lengths for different piecing indices are shown in Table 2. The piecing length varies with piecing indices and its range is 60 - 70 mm. The piecing length appears to increase as one goes to extreme negative values of the index, while it decreases on going towards positive value.

3.3 Influence of Mode of Feed

The profiles at two different modes of feed, i.e. forward and backward, are depicted in Fig. 6. Though the nature of mass distribution remains broadly same, a significant departure near the leading edge, i.e. in the region 25-50 mm from the front edge, can be observed for single fringe. The distribution at the trailing edge remains same. When all other parameters remain constant, the forward feed reduces noil loss and increases productivity. It is reflected in the total weight of the fringes. The weight obtained in forward feed is 13% more than that obtained in backward feed. For triple fringe, the excess mass is found to be distributed near the top and the increase in fringe mass is from 722.6 g to 837g, i.e. 15.8%.

3.4 Influence of Feed / Nip

It can be seen from Fig. 7 that as the feed length is enhanced from 4.8 mm to 5.6 mm, the excess material get distributed mainly again on the leading edge of fringe without any change in location of peak. The profile of the trailing edge remains unchanged. A 9.2% increase in feed length causes 16.6% increase in weight of the total fringe.

For triple fringe, the increase in weight was from 624.4 g to 722.6 g, i.e. 15.7%. The distribution profile may be seen to change near the front edge and at the top. This is so because for single fringe the mass profile changes at the leading edge only.

3.5 A Comparative Study of Mass Profiles of Overlapped Fringes

For better visualisation of transformation of single fringes into a sliver, the mass distribution profiles of a single and corresponding double and triple fringes are shown in Fig.8. The profile has been restricted up to

![Fig. 6](image-url)  
Fig.6—Mass profile of single (a) and triple (b) combed fringes [feed amount, 5.6 mm/nip; and piecing index, -0.5]

![Fig. 7](image-url)  
Fig.7—Mass profile of single (a) and triple (b) combed fringes at feed lengths of 4.8 and 5.6 mm/nip [feed type, backward; and piecing index, -0.5]
three fringes since under the present circumstances (i.e. fringe length of around 90-100 mm and overlapping length of around 60-70 mm) any part of the combed sliver would represent fibre mass coming from the three successive fringes. In most of the cases, the top part of the profile assumes a flattened configuration for triple fringes. However, the waviness in the profile seen at the top part is visibly much less for zero PI and maximum for -2.0 PI. This indicates the role of PI on the uniformity in the mass distribution along the comber head sliver.

During the process of detachment, the combed fringe held by the nippers gets drafted as it is progressively fed into the nip of the detaching rollers. This is so because the surface speed of the detaching rollers is faster than the approaching velocity of the nipper assembly. The detaching process, therefore, results in the distribution of mass of the approaching combed fringe held by the nippers over a longer length. The mass profile of the combed fringe held by nippers before the detachment is tapering in nature as the trailing ends of all the fibres lying in front of the nipper get combed out during the process of combing by half lap. Had the draft (the ratio of surface speed of the detaching roller to the approaching velocity of the nipper) been constant, the tapering mass profile would have been faithfully translated into a profile of similar nature. However, since the detachment draft is not constant and it changes with the time due to the change in velocity of both detaching rollers and nipper assembly during their forward journey, the profile of the detached fringe is not likely to be symmetrical. As the PI value is changed, the mass profile also changes since the nature of detaching roller movement also changes (Fig. 9). The transformation from single to overlapped fringes shows appearance of multiple peaks. The leading and trailing edge profiles of triple fringes are very much similar to the corresponding single fringe profile. This is expected as the section weight belonging to these edges would come only from a single fringe. The zone over which actual overlapping takes place, the individual section weights will have contribution of different magnitudes either from two consecutive fringes in case of double fringe or from three consecutive fringes in case of triple fringe. The nature of the profile in this range is extremely important from the point of view of the intensity of periodicity in mass. This periodicity should be as minimum as possible. The profile at various PI settings shows a change in waviness. In an extreme case at -2.0 PI, a single prominent peak is observed. This can be ascribed to the lagging detaching action which results in longer overlapping zone. It basically means shifting of the commencement of overlapping process more towards the tip of the leading edge of the single fringe and highly positively skewed profile of the single fringe.

4 Conclusions
4.1 The mass profile of detached single fringes has bell shaped distribution. The profiles are found to be dependent on piecing index.
4.2 The mass profiles of overlapped fringes are dependent on the mass profile of corresponding single fringes as well as the amount of overlap.

4.3 The nature of the displacement of detaching rollers varies depending upon piecing index setting. As the piecing index is changed from +1.0 to -2.0, the detaching rollers move in a lagging phase.

4.4 Whenever the piecing index setting is changed, not only the amount of overlap changes but also the basic mass profile of the single detached fringes changes.

References
1 Shaw J, Rectilinear cotton combing : Sliver regularity at the combing head, J Text Inst, 53 (1962) 797 - 813.