Contribution of Fibre Length and Fibre Denier to Characteristics of Ring- and Rotor-spun Viscose Rayon Yarns

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Contrary to the view held so far that the strength of rotor-spun yarns is relatively insensitive to fibre length, the maximum tenacity is observed for fibres of 38 mm length. Rotor yarns spun either from finer or longer fibres exhibit lower breaking extension. The unevenness decreases with increase in fibre length in ring-spun yarns but shows an upward trend in rotor-spun yarns.

Keywords: Fibre denier, Fibre length, Ring-spun yarn, Rotor-spun yarn, Twist loss, Viscose rayon yarn, Wrapper fibres

1 Introduction
In spite of their superior properties such as high uniformity, imperfections, breaking extension, hairiness, strength variability, etc. rotor-spun yarns are sometimes considered inferior to ring-spun yarns because of their lower strength due to bipartite structure. The difference in the structures of these yarns has been studied by many workers. The interaction between the fibre characteristics and the mechanism of yarn formation on the rotor frame is expected to be different from that on the ring frame. For example, longer fibres which are ideally suited for ring yarn may be a bad choice for rotor yarn. Many researchers have optimized the fibre parameters for spinning man-made fibres and their blends on rotor spinning machines. The conclusions drawn from these studies have often been contradictory. In the present study, an attempt has been made to investigate the effect of fibre length and denier on the various characteristics of rotor-spun viscose yarns so as to optimize these parameters.

2 Materials and Methods

2.1 Preparation of Yarn Samples
Two sets of yarns (16s cotton count) were spun on ring and rotor spinning machines from viscose rayon fibres of three different lengths and two deniers. The specifications of the viscose rayon fibres used are given in Table 1. The conversion to drawn sliver was carried out by using a Shirley miniature carding machine and a draw frame. Two draw frame passages were given to the carded web. The slivers were spun into yarns on a Suessen OE spin tester. The rotor speed and the opening roller speed were kept constant at 40,000 rpm and 6000 rpm respectively; the rotor diameter was 56 mm. For ring spinning, the drawn sliver was converted into a suitable roving.

2.2 Tests
The yarns were tested for single strand strength and breaking extension on an Instron tensile testing machine. Yarn unevenness and imperfections were determined on an Uster evenness tester. Yarn diameter was measured on a 'projectina microscope'. Twist, in all yarns, was measured on a Eureka twist tester using the detwist-retwist method.

3 Results and Discussion

3.1 Measured and Nominal Twists
In ring yarns, the difference between the actual and nominal twists is quite negligible, but in rotor yarns, this difference appears to be considerable (Table 2). The actual twist is lower than the nominal twist. The twist loss has been assigned to the fibre slippage at the point of yarn formation within the rotor. The twist

<table>
<thead>
<tr>
<th>Fibre denier</th>
<th>Fibre length (mm)</th>
<th>Tenacity (mN/tex)</th>
<th>Breaking extension (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>38</td>
<td>25.50</td>
<td>18.33</td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>25.30</td>
<td>18.24</td>
</tr>
<tr>
<td>1.5</td>
<td>38</td>
<td>25.60</td>
<td>18.30</td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>25.70</td>
<td>18.39</td>
</tr>
</tbody>
</table>

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loss increases with increase in fibre denier owing to the higher resistance of rotor yarns to bending and twisting. The incidence of wrapper fibres in yarns spun from coarser and stiffer fibres increases, which, in turn, increases the twist loss. Apart from fibre linear density, the twist loss is considerably influenced by the length of the fibre used. As is evident from the test results, the rotor yarns spun from longer fibres exhibit higher twist loss due to the greater incidence of wrapper fibres. This is in agreement with the finding of Salhotra and coworkers. As regards the influence of fibre length on yarn twist, Bancroft has also reported that longer fibres require a higher twist than shorter fibres while spinning on a rotor frame.

3.2 Tenacity
Table 3 shows that for same twist factor the tenacity of rotor yarn is lower than that of ring yarn. The lower strength of rotor-spun yarns has been related to its unique structure by several workers. The decrease in the strength of rotor yarn depended upon the characteristics of the fibre used. Some earlier studies had shown that the strength of rotor-spun yarn is relatively insensitive to fibre length. However, this study shows that this is not so. The maximum yarn strength is observed for fibres of 38 mm length and it decreases as the fibre length increases up to 51 mm. This may be ascribed to the higher twist loss involved in spinning of longer fibres. The tenacity of ring yarn, on the other hand, increases as the fibre length is increased from 38 mm to 51 mm. Increase in fibre fineness results in a higher tenacity for both ring and rotor yarns.

3.3 Breaking Extension
The breaking extensions of ring and rotor yarns spun from different fibre lengths and deniers are given in Table 3. In general, the rotor yarns are more extensible than the ring yarns. The breaking extension of rotor yarns tends to drop slightly as the fibre denier is decreased, but for ring yarns the trend is just the reverse. The breaking extension of rotor yarns is considerably decreased as the fibre length is increased. Such an effect is only marginal for ring yarns.

3.4 Yarn Unevenness and Imperfections
Table 4 shows that the rotor yarns are more even and have less imperfections than the corresponding ring yarns. For both these yarns, there is a slight increase in U% as the fibre denier increases, as expected. In regard to fibre length, the yarn irregularity shows opposite trends for ring and rotor yarns. In the case of ring yarns, U% is lower, as usual, for longer fibres. However, for rotor yarns the U% shows an increase as the fibre length increases. This trend can be
Table 4—Effect of Fibre Length and Denier on Unevenness and Imperfections of Ring- and Rotor-spun Yarns

<table>
<thead>
<tr>
<th>Fibre denier</th>
<th>Fibre length (mm)</th>
<th>Yarn diam. (mm)</th>
<th>Rotor-spun yarn</th>
<th>Ring-spun yarn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>U%</td>
<td>Imperfections/1000 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Thin places</td>
<td>Thick places</td>
</tr>
<tr>
<td>1.2</td>
<td>38</td>
<td>0.26</td>
<td>9.7</td>
<td>3</td>
</tr>
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<td></td>
<td>44</td>
<td>0.29</td>
<td>10.1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>51</td>
<td>0.31</td>
<td>11.0</td>
<td>7</td>
</tr>
<tr>
<td>1.5</td>
<td>38</td>
<td>0.33</td>
<td>10.0</td>
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<tr>
<td></td>
<td>44</td>
<td>0.37</td>
<td>11.2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>51</td>
<td>0.39</td>
<td>11.6</td>
<td>9</td>
</tr>
</tbody>
</table>

*Nominal tex twist factor, 38.28

attributed to the greater incidence for wrapper fibres, which will adversely affect U% as well as neps owing to their contribution to the mass irregularity of yarn. The thick places also show opposite trends for ring and rotor yarns, increasing with fibre length in the case of latter and decreasing in the case of former. Thin places do not show any particular trend for ring yarn but show a distinct increase in the case of rotor yarn spun from longer fibres. The increase in neps in ring yarn with increase in fibre length is well known and is usually ascribed to the higher level of neps generation at the card.

The increase in thin and thick places in rotor yarn with increase in fibre length is due to the greater disorientation of the fibres as these lie in the rotor groove. This factor is also partly responsible for the increase in U% and neps in rotor yarns.

4 Conclusions
4.1 The rotor yarns spun from finer denier and relatively shorter fibres are stronger.
4.2 With an increase either in fibre length or fibre linear density, the twist loss in rotor yarns tends to increase.
4.3 Rotor yarns have higher breaking extension than ring yarns. The breaking extension of rotor yarns decreases with increase in fibre length and decrease in fibre linear density.

4.4 The effect of fibre length on yarn unevenness and thick places in ring and rotor yarns is just the reverse. In ring yarns these characteristics show improvement with increase in fibre length, but in rotor yarns, a distinct deterioration. The neps in both ring and rotor yarns show an upward trend with increasing fibre length.

References