Properties of OE rotor and MJS yarns spun at high spinning speeds

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The properties of OE rotor and MJS yarns spun from acrylic-cotton (70:30) blended fibres have been compared. Both OE rotor and MJS yarns could be spun with a wide range of spinning speeds without getting adversely affected in their tenacity and breaking extension. Spinning speed and ribbon width have been found to affect the abrasion resistance and flexural rigidity of MJS yarns. The effect of rotor speed in this regard is minimal.

Keywords: Acrylic-cotton yarn, Flexural rigidity, MJS yarn, Rotor-spun yarn, Wrapper fibre

1 Introduction

Immense interest is being shown in air-jet spinning throughout the textile world. This system is capable of spinning finer yarns at production speeds of up to 300 m/min and has gained significant importance in comparison with ring- and rotor-spinning systems. However, air-jet spinning has not been accepted universally due to the harsh handle of fabrics made from yarns spun on this system. In recent years, various processing parameters have been examined so as to establish the jet-wrapping process, but the controversy over the potential future of this technology still continues. Since the yarn manufacturers pay attention to the maximum utilization of available spinning technologies, it is difficult to choose the most suitable yarn for the optimum quality and economic aspect of a given final substrate. As air-jet spinning is extensively used for spinning of finer yarns, one would expect that this system would not yield satisfactory yarn quality in coarse yarns like 29.5 tex. This could be reflected in yarn properties as well as the type of the fibre and demands our attention. Some researchers have compared the properties of ring- and air-jet spun yarns1-5, but no such extensive comparison of OE rotor and air-jet spun yarns has been made. This paper aims at comparing the characteristics of air-jet spun yarns with those of OE rotor-spun yarns.

2 Materials and Methods

2.1 Preparation of Yarn Samples

Two sets of yarns of 29.5 tex were spun from a blend of acrylic and cotton (70:30) fibres on OE rotor and air-jet spinning machines at different spinning speeds. The specifications of acrylic and cotton fibres used are given in Table 1. A predetermined quantity of combed cotton and acrylic fibres was mixed and processed on a Laxmi Rieters' blowroom line. The conversion to drawn sliver was carried out by using a MMC card and a Laxmi Rieters' drawframe DO/6. Three drawing passages were given to the card sliver so as to produce a finished sliver of 3.2 ktex. The sliver was spun into 29.5 tex yarn on the Murata air-jet spinner 802 MJS. The spinning conditions used are given in Table 2. Equivalent OE rotor yarns were also spun on Ingolstadt rotor spinner RU11/ RU80 (4602) using different twist factors, viz. 37.4, 41.1 and 45.3. The rotor speeds used were 40,000, 50,000 and 60,000 rpm. Spinning of OE rotor yarns was carried out on a 48 mm rotor using an opening roller covered with OS21 saw tooth wire and running at 7000 rpm, and a

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Acrylic fibre</th>
<th>Cotton fibre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length, mm</td>
<td>38.00</td>
<td>25.10</td>
</tr>
<tr>
<td>Denier, dtex</td>
<td>1.66</td>
<td>1.66</td>
</tr>
<tr>
<td>Tenacity, cN tex⁻¹</td>
<td>22.73</td>
<td>20.30</td>
</tr>
<tr>
<td>Breaking extension, %</td>
<td>30.50</td>
<td>5.00</td>
</tr>
</tbody>
</table>

*Span length, 2.5%
Table 2—Spinning conditions for MJS yarns

<table>
<thead>
<tr>
<th>Yarn ref. no.</th>
<th>Spinning speed m/min</th>
<th>Ribbon width mm</th>
<th>First jet pressure kg/cm²</th>
<th>Second jet pressure kg/cm²</th>
<th>Feed ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>S₁</td>
<td>170</td>
<td>3</td>
<td>3.0</td>
<td>4.5</td>
<td>0.97</td>
</tr>
<tr>
<td>S₂</td>
<td>170</td>
<td>4</td>
<td>3.0</td>
<td>4.5</td>
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<tr>
<td>S₃</td>
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</tr>
<tr>
<td>S₄</td>
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<td>3</td>
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</tr>
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<td>200</td>
<td>5</td>
<td>3.0</td>
<td>4.5</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Ratio of peripheral speed of delivery roller to peripheral speed of front roller.

Fig. 1—Variation of tenacity with spinning speed

notched draw-off nozzle (external diam., 15.5 mm; and internal diam., 3 mm).

2.2 Tests
All the yarns were tested for tenacity and breaking extension on the Instron tensile tester using a 500 mm test specimen and 200 mm/min extension rate. Mean tenacity and breaking extension were calculated from thirty observations for each yarn sample. Yarn irregularity was determined using the Uster evenness tester. The flat abrasion resistance of the yarns was determined by the Taber universal wear tester. The number of rubs needed to cause yarn rupture was noted down. For each sample, 10 tests were carried out. The flexural rigidity was measured on weighted ring yarn stiffness tester by ring loop method.

3 Results and Discussion

3.1 Tenacity
Fig. 1 shows the tenacity values of acrylic-cotton yarns in relation to the spinning system and some process parameters. The tensile properties of MJS yarns depend, to a very large extent, on the frequency and length of the wrapping fibres to promote high core fibre interactions. It is generally accepted that the tenacity of air-jet yarn is higher than that of a rotor-spun yarn. However, in the present work, the tenacity of acrylic-cotton MJS yarns is 22–30% lower than that of their OE rotor counterparts due to insufficient length of wrapping and insufficient length of cotton fibre. Artzt et al. also mentioned that the special fibre lengths,
such as 32 mm, used for rotor spinning are disadvantageous for air-jet spinning. Tenacity results indicate the possibility of spinning OE rotor yarns with a wide range of production speeds without significantly affecting the yarn tenacity. In case of MJS yarns, there is a slight increase in tenacity as the spinning speed is increased from 170 m/min to 200 m/min. As can be seen from Fig. 1, the tenacity of OE rotor-spun yarns drops very slightly though consistently with the increasing twist factor but hardly changes when rotor speed is raised from 40,000 rpm to 60,000 rpm. In case of MJS yarns, the tenacity is lower at lower production speed and increases with an increase in production speed due to the expected increase in wrapped-in length. The use of wider condenser further increases the tenacity of MJS yarns. With wider condenser the same number of fibres is spread over a greater width at the nip of the front roller. As a result, the inter-fibre cohesion is lower which leads to more edge and thus wrapper fibres. This is in accordance with the earlier finding by Shah who observed an increase in yarn tenacity, breaking extension and wrapper fibres with increase in condenser width.

3.2 Breaking Extension

Fig. 2 depicts the values of breaking extension of OE rotor and MJS yarns. The breaking extension of MJS yarns varies from 9.35 to 11.56% and that of OE rotor yarns from 18.3 to 20.4%. The trends for breaking extension are similar to those observed in case of tenacity. It may be certainly concluded that acrylic-cotton MJS yarns have lower resistance to extension due to inter-fibre slippage in the yarn core because they are inadequately bound by insufficient wrapper fibres. Puttachaiyong and Oxenham demonstrated that all cotton and cotton blends result in yarns with inferior properties. The high breaking extension of OE rotor-spun yarns, on the other hand, can be ascribed to the presence of many hooked, looped and disoriented fibres in the yarn structure. The breaking extension of the two types of yarn reflects distinctly different trends in respect of production speed. For OE rotor-spun yarns, the breaking extension drops slightly as the rotor speed is increased, whereas in case of MJS yarns, the breaking extension registers higher values with increasing production speed. Similar trends are seen in respect of increased ribbon width. Such a behaviour can again be attributed to the aforementioned factors.

3.3 Irregularity

The OE rotor yarns spun from acrylic-cotton (70:30) blend are more even than the equivalent MJS yarns (Fig. 3). For both these yarns, there is a slight deterioration in yarn evenness as the spinning speed increases. For MJS yarns, the unevenness increases slightly as the ribbon width is increased. This is due to the greater incidence of wrapper fibres, which adversely affect unevenness owing to their contribution to short-term mass irregularity of yarn.

3.4 Abrasion Resistance

The number of abrasion cycles to rupture point for OE rotor and MJS yarns with changes in parameters studied are shown in Fig. 4. The fact that jet-spun yarns have better abrasion resistance than the OE rotor-spun yarns does not hold true for this investigation. It is observed from Fig. 4...
that acrylic-cotton MJS yarns show lower resistance to abrasion than the OE rotor yarns. As explained earlier, the binding wrapper fibres in MJS yarns resulting from high torsional rigidity, low breaking extension and short length of cotton fibre are inadequate to protect the core of twistless parallel fibres. The rupture of surface wrappers during abrasion causes a rapid exposure of the unprotected core to the abrasive action, leading to its early rupture. In addition, the tight wrappers make the air-jet yarn sheath immobile unlike the rotor-spun yarn sheath which is mobile and thus enhances the abrasion resistance. Toughness index, which is an indicator of the ability of textile substrate to absorb work, also significantly affects the abrasion resistance. A lower toughness index of acrylic-cotton MJS yarns compared to that of OE rotor yarns signifies less ability and thus a lower abrasion resistance. All these factors contribute to the lower abrasion resistance of MJS yarns. With regard to production speed, the abrasion resistance shows similar trends for OE rotor and MJS yarns. For OE rotor yarns, the abrasion resistance hardly alters with change in twist factor but increases with increase in rotor speed, whereas in the case of MJS yarns, the abrasion resistance shows an increase with increase in production speed as well as ribbon width. This increase can be attributed to an increase in wrapped-in length and the number of wrapping fibres which effectively shield the core, leading to higher abrasion resistance.

3.5 Flexural Rigidity

The flexural rigidity values for OE rotor and
MJS yarns are shown in Fig. 5. The common observation that MJS yarns are more rigid than OE rotor-spun yarns holds good for this blend too. In MJS yarns, the clustering effect of core fibres due to their parallel arrangement and winding by tight wrapper fibres allows little freedom of movement of fibres during bending.

The flexural rigidity of OE rotor yarn does not show any trend with change in twist factor. It increases slightly as the rotor speed increases. The expected increase in yarn compactness due to increase in wrappers and centrifugal force on the fibre-band in the rotor groove could account for this increase. The influence of production speed on flexural rigidity of MJS yarns is along the expected lines. As can be seen from Fig. 5, the flexural rigidity values tend to increase as the production speed increases. The increase in edge fibres, as mentioned earlier, contributes to the intensified wrapped-in portion and wrapper fibres, which impede the movement of fibres in the yarn. Interestingly, the flexural rigidity of MJS yarns decreases when the ribbon width is decreased. This is because a narrower condenser leads to a reduction in wrapper fibres.

4 Conclusions
4.1 Acrylic-cotton MJS yarns are weaker by 20-30%, less extensible by 36-43%, less even by 20-40%, more rigid by 15-20% and have 30-42% lower abrasion resistance than the corresponding OE rotor yarns.
4.2 Both OE rotor and MJS yarns could be spun with a wide range of spinning speeds. However, the influence of spinning speed on tenacity, breaking extension, irregularity, abrasion resistance and flexural rigidity is relatively large for MJS yarns that for OE rotor yarns. In MJS yarns, these characteristics register an increase with increase in spinning speed, whereas in OE rotor yarns, there is no significant change.

References