Effect of blend ratio on yarn evenness and imperfections characteristics of wool / polyester ring-spun yarn

Achintya K Samanta
Wool Research Association, Thane 400 607, India

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Effect of wool / polyester blend ratio on the evenness characteristics of yarn has been studied. Yarns with two different counts have been spun from each of four different blend ratios of polyester/wool in conventional worsted processing system and thereafter evenness and imperfection properties are studied. It is observed that yarn becomes more even with the increase in polyester content in the blend.

Keywords: Blend ratio, Evenness, Imperfections, Index of irregularity, Polyester, Ring-spun yarn, Wool

The term ‘blending’ is used by the yarn manufacturers to describe specifically the sequence of processes required for mixing of at least two components, which differ by at least one parameter which characterises the component fibres. Fibre blending consists of orientations of different fibres in the yarn structure in such a way that the content of each component remains same at every point of the yarn, throughout its length.

In staple fibre yarn processing, blending is carried out for a number of reasons, including uniformity, technical and engineering, functional and aesthetic and economic aspects. Blended yarns from natural and man-made fibres have the particular advantage of successfully combining the good properties of both fibre components, such as comfort of wear with easy care properties, cost reduction without significant sacrifice of yarn performance by partially replacing expensive fibres with less expensive ones, and cross-dyeing effects due to different dye affinity of two different fibre types.

These advantages also permit an increased variety of products to be made, and yield a stronger marketing advantage. Wool fibre is known for its warmth, resiliency and elasticity. The natural bulkiness is a unique property of wool fibre. But comparatively low breaking tenacity and high felting shrinkage during laundering of wool fibre makes the 100% woolen fabric less durable. Wool fibres also have an uneven cross-section throughout its length, which make it difficult to produce a regular yarn. To obtain the desirable characteristics in the final products, blending wool/polyester fibres is common practice in the woolen textile industry. In comparison with 100% woolen, wool/polyester blends have better evenness, higher breaking and abrasion strength, and display better easy-care properties. On the other hand, in comparison with 100% polyester, wool/polyester blending has many advantages such as less pilling, less static electrification, easier spinning, better moisture absorption property and better warmth.

While a yarn may vary in many properties, evenness is one of the most important quality aspects of a yarn. Yarn evenness, defined as the variation of mass per unit length, can affect several properties of textile materials, especially the final appearance of the woven/knitted fabric. The most obvious consequence of yarn evenness is the variation of strength along the yarn. An irregular/uneven yarn will tend to break more easily during further processing where stress is applied.

A high amount of yarn breaks in the processing line relates to higher machine stops, more standing time, higher piecing in the yarns and lower machine efficiency. Imperfections, on the other hand, can be defined as the total number of neps, thick and thin places in a given length of yarn. For ring-spun yarn, imperfections adversely affect yarn and fabric quality. A yarn with more imperfections will exhibit poor appearance grade, lower strength and poor performance in weaving, likely to produce fabric with low quality. The problem is particularly serious when a fault (i.e. a thick or thin place) appears at precisely regular intervals along the length of the yarn. In such cases, fabric construction geometry ensures that the faults will be located in a pattern that is very clearly apparent to the eye, and defects such as streaks, stripes, barre, or other visual groupings develop in the cloth. Such defects are usually compounded when the fabric is dyed or finished, as a result of the twist variation accompanying them. Other fabric properties, such as abrasion or pill-resistance, soil retention, drape, absorbency, reflectance, or lustre, may also be

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E-mail: achin.samanta@gmail.com
directly influenced by yarn evenness. Thus, the effects of irregularity are widespread throughout all areas of the production and use of textiles, and the topic is an important one in any areas of the industry.

In this study, polyester and wool have been blended at four different blend ratios (75/25, 65/35, 55/45 and 40/60, P/W) to produce ring-spun yarns using conventional worsted processing system. The evenness and imperfection properties of each yarn including C.V.m%, index of irregularity, thick places/km, thin places/km, and neps/km are studied.

**Experimental**

Merino wool fibre of 64s quality and 2.5 denier normal polyester fibres were blended together in four different blend ratios (75/25, 65/35, 55/45 and 40/60, P/W) to prepare the blended worsted yarn for this study. Detail of the fibre properties are given in Table 1.

The greasy wool was first scoured and carded to produce clean carded sliver. This carded sliver was then processed on a conventional worsted spinning system. The blending of wool and polyester was carried out at sliver stage after top dyeing process. Wool and polyester were blended in four different blend ratios. Conventional ring spinning system was used to produce two different yarn counts (48Nm and 60Nm) from each blend quality. The spinning parameters and process parameters are kept as per the regular industry practice at each stages of processing.

The evenness and imperfection characteristics of each yarn were tested on USTER Evenness Tester-4 with testing speed of 400m/min and testing time of 2.5 min. Along with yarn evenness properties thick (+50%), thin (-50%), neps (+200%), and yarn hairiness index were also measured. All tests were conducted under the standard laboratory conditions (27 ± 2°C and 65 ± 2% RH). Ten tests were conducted for each yarn sample and average of 10 readings was used for the analysis.

**Results and Discussion**

The experimental results of yarn evenness and imperfections are given in Table 2 for 48 Nm and 60 Nm yarns. Internationally, C.Vm% is more acceptable than U%, hence in this study, C.Vm% is considered as a measurement of yarn unevenness properties. It is observed that for both 48Nm and 60Nm yarns, C.V.m% is increased with the increase in wool fibre content in the blend percentage, i.e. yarn becomes more uneven with the increase in wool content.

Wool fibre shows higher length as well as diameter variation throughout its length, whereas polyester, being a synthetic fibre, has the same cross-section throughout its length and lower length variations. As fibre unevenness and length variation is one of the major reasons for yarn unevenness, increase in wool fibre content in the yarn structure increases the unevenness of the yarn. Also, the polyester used in this experiment is finer than wool and increase in polyester content increases the number of fibres in the yarn cross-section, which ultimately reduces the C.V.m% of the yarn. It is also observed from Table 2 that C.V.m% of 60 Nm yarn is always higher than that of 48 Nm yarn for all the blend combinations and the difference increases with the increase in wool content.

Yarn evenness largely depends on the number of fibres in the yarn cross-section. In this study, same fibres of polyester and wool are used for all the count and blend combinations. As 60Nm yarn is finer than

<table>
<thead>
<tr>
<th>Blend (P/W)</th>
<th>Nominal count, Nm</th>
<th>Actual count Nm</th>
<th>C.Vm%</th>
<th>Neps/km (+200%)</th>
<th>Thick/km (+50%)</th>
<th>Thin/km (-50%)</th>
<th>Hairiness index</th>
<th>Index of irregularity</th>
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<tbody>
<tr>
<td>48Nm yarn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>75/25</td>
<td>48</td>
<td>48.25</td>
<td>12.89</td>
<td>23.37</td>
<td>7.03</td>
<td>3.50</td>
<td>6.30</td>
<td>1.36</td>
</tr>
<tr>
<td>65/35</td>
<td>48</td>
<td>48.10</td>
<td>13.61</td>
<td>16.33</td>
<td>6.25</td>
<td>3.96</td>
<td>6.04</td>
<td>1.37</td>
</tr>
<tr>
<td>55/45</td>
<td>48</td>
<td>48.39</td>
<td>13.77</td>
<td>10.11</td>
<td>4.48</td>
<td>4.26</td>
<td>5.70</td>
<td>1.29</td>
</tr>
<tr>
<td>40/60</td>
<td>48</td>
<td>48.46</td>
<td>13.86</td>
<td>7.40</td>
<td>4.43</td>
<td>7.00</td>
<td>5.36</td>
<td>1.26</td>
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<tr>
<td>60Nm yarn</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>75/25</td>
<td>60</td>
<td>59.96</td>
<td>13.56</td>
<td>30.35</td>
<td>7.88</td>
<td>5.77</td>
<td>5.16</td>
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<tr>
<td>65/35</td>
<td>60</td>
<td>60.01</td>
<td>14.13</td>
<td>24.08</td>
<td>8.81</td>
<td>9.97</td>
<td>5.07</td>
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<tr>
<td>55/45</td>
<td>60</td>
<td>59.82</td>
<td>14.70</td>
<td>16.23</td>
<td>10.50</td>
<td>18.97</td>
<td>4.89</td>
<td>1.27</td>
</tr>
<tr>
<td>40/60</td>
<td>60</td>
<td>60.49</td>
<td>15.10</td>
<td>12.62</td>
<td>12.23</td>
<td>29.85</td>
<td>4.57</td>
<td>1.23</td>
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<tr>
<th>Table 1—Raw material properties</th>
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<td>Fibre</td>
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<td></td>
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<tr>
<td>Wool</td>
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<td>Polyester</td>
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</tbody>
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| Table 2—Evenness and imperfection characteristics of 48Nm and 60Nm yarns |
48Nm, the number of fibres in the yarn cross-section is less in finer count, which results in the higher C.V.m% of the 60Nm yarn for each blend ratio.

In this study neps are measured at +200% levels. It is observed that neps content per kilometre is decreased with increase in wool content in the blend ratio for both the counts (Table 2). For the same blend composition, neps count is higher in 60Nm yarn than in 48Nm.

Polyester fibre used in this experiment is finer than the wool fibre and hence the flexural rigidity of the polyester fibre is lower than that of the wool fibre. Lower flexural rigidity makes polyester fibre easy to curl and hence forms neps after releasing from the high stress during processing. This might be the main reason behind the increase of neps count with increase in the polyester content in the blend ratio. Due to the lower strength of the wool fibre, neps formed by wool fibre are easily wears off, whereas neps formed by polyester fibre remain with the yarn structure due to its higher strength.

Yarn specific area increases with increase in yarn fineness which leads to increase in the percentage of fibres in the outer surface of the yarn structure and increases the chance of neps formation. This might be the main reason behind increase in neps content in 60Nm yarn for all the blend combinations compared to the 48Nm yarn. Again since dimension of the neps are referred to the mean diameter of the yarn, neps of a particular sizes are less significant in coarse yarns than in finer one.

It is also observed from Table 2 that in coarser count i.e. 48Nm count, number of thick places per kilometre is decreased with increase in wool content in blend combination and reverse is observed in the finer count i.e. in 60Nm yarn. It has also been observed that the occurrence of thick places increases in finer count again may be the main reason for this outcome.

Yarn with 60Nm yarn, it is found that index of irregularity decreases. In this study when we compare 48Nm and 60Nm yarns. This may be due to the variation in profile of the two fibres. The diameter of wool fibre is not uniform across its length unlike polyester fibre. The root of the wool fibre is coarser than its tip portion. Because of taper (only one end), the heavier root part of the wool fibre tends to come out as a protruding end. With man-made fibres, both ends have an equal probability of showing up as protruding ends or hairs.

From this study, it is also observed that 60Nm yarn shows less hairiness in all the blend compositions as compared to 48Nm yarn which is comparatively coarser. Coarser yarns have more hairiness than finer one, because of higher number of fibres in cross-section which leads to higher number of protruding ends of fibres in the yarn surface.

Theoretically, index of irregularity of any fibre strand depends on limit irregularity of the strand. In this study, it is observed that index of irregularity of yarn is slightly reduced with increase in the wool fibre content in the blend composition for both the counts. As the wool fibre used here is coarser than the polyester fibre, with the increase in wool content, the number of fibres in the yarn cross-section decreases, which ultimately increases the limit irregularity of the yarn. Index of irregularity is the ratio of actual irregularity and limit irregularity. So, if the limit irregularity increases, index of irregularity decreases. If yarn count is finer, than number of fibres in the yarn cross-section also decreases. In this study when we compare 48Nm yarn with 60Nm yarn, it is found that index of irregularity of 60Nm yarn is lower than 48Nm yarn for all the blend combinations. The probable reason...
behind this is the decrease in number of fibres in the cross-section.

It can be concluded that blending of wool and polyester at different ratios, affects the evenness and imperfection properties of the final yarn, as follows:
(i) If polyester content increases in the blend composition, then C.V.m% of the final yarn decreases and the yarn becomes more even, whereas C.V.m% increases as the yarn becomes finer.
(ii) In coarser count i.e. 48 Nm, thick places increases with increase in polyester content in the blend composition, whereas in finer count i.e. in 60 Nm, thick place increases with increase in wool content.
(iii) In both the counts, thin places increase with increase in the wool content. Finer yarn shows higher number of thin place/km than coarser yarn.
(iv) Neps content in the yarn per kilometre increase with increase in polyester content and the same decreases for coarser yarn count.
(v) Index of irregularity decreases with finer the yarn count and same increases with increase in the polyester content in the blend ratio.

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References