CHAPTER 4

CHARACTERISTICS OF VARIOUS TYPES OF YARNS USED FOR KNITTING

4.1 INTRODUCTION

Combed ring spun and carded yarns are generally used for weft-knitting. The development of rotor fine count yarns from cotton has created much scientific and commercial interest over the past few years. This chapter is concerned with the production of ring and rotor spun yarns from cotton, polyester-cotton, and polyester fibres which were used for weft-knitting. Other commercial yarn samples are also described.

4.2 MATERIALS AND METHODS

4.2.1 Materials

Commercially available polyester fibres supplied by a leading Indian Manufacturing Company, were used in this study. Details of fibre properties are given in Table 4.1.

Cotton, which was used, was Shanker 4 whose fibre properties are given in Table 4.2.
Table 4.1  Polyester staple fibre properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibre length (mm)</td>
<td>38</td>
</tr>
<tr>
<td>Tenacity (CN/Tex)</td>
<td>63</td>
</tr>
<tr>
<td>Elongation %</td>
<td>5.0</td>
</tr>
<tr>
<td>Fibre denier</td>
<td>1.1 d tex</td>
</tr>
<tr>
<td>Lustre</td>
<td>Semi-dull</td>
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</table>

Table 4.2  Cotton fibre properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>2.5% span length (mm)</td>
<td>27.60</td>
</tr>
<tr>
<td>50% span length (mm)</td>
<td>13.10</td>
</tr>
<tr>
<td>Tenacity CN/tex</td>
<td>18.63</td>
</tr>
<tr>
<td>Elongation %</td>
<td>5.40</td>
</tr>
<tr>
<td>Micronaire value</td>
<td>3.40</td>
</tr>
<tr>
<td>Maturity coefficient</td>
<td>0.74</td>
</tr>
<tr>
<td>Uniformity ratio</td>
<td>47.50</td>
</tr>
</tbody>
</table>
4.2.2 Machines used for yarn production

Various machines were used, and they are given below:

i. Blow room
   Mixing Bale Opener - Lakshmi Rieter
   B2/2, Aero mixer
   Flock feeder with Kirschner Beater in Lakshmi Rieter

ii. Lakshmi Rieter Cl/2 Cristallina card

iii. Lakshmi Rieter DO/2S Draw Frame

iv. Lakshmi Rieter L1400 Speed Frame

v. Lakshmi Rieter G5/1 Ring Frame

vi. Lakshmi Rieter M1/2 Rotor Machine

4.2.3 Process parameters of the study

The process flow charts, involved in the production of ring and rotor spun yarns from cotton, polyester cotton and polyester, are given in Figs.4.1 to 4.5

4.2.4 Production of yarns

As one of the specific aims of the present investigation was to study the effect of direction of yarn twist and type of yarns on spirality of knitted fabrics, it was essential to make them from various spinning techniques.

With regard to cotton yarns, cotton was processed through blow room, card, comber and two draw frame passages. Drawn sliver was passed through high draft inter and spun into 30Ne (19.68 Tex) on conventional ring frame with Lakshmi Rieter top arm drafting system. For spinning carded yarns, a portion of the carded sliver was passed through two
FIGURE 4.1 FLOW-CHART FOR PRODUCING 100% POLYESTER RING YARN
Fibres Cotton

→

LR Lakshmi Rieter
Blow Room

→

Carding

→

Draw Frame

→

Draw Frame

→

Simplex

→

Ring Frame

→

One Passage of Pre-
Comber Drawing

→

Combing

→

Draw Frame

→

Draw Frame

→

Simplex

→

Ring Frame

FIGURE 4.2 FLOW-CHART FOR PRODUCING 100%
COTTON CARDED AND COMBED RING YARNS
FIGURE 4.3 FLOW-CHART FOR PRODUCING 100% COTTON FINE ROTOR SPUN YARNS

FIGURE 4.4 FLOW-CHART FOR PRODUCING 100% POLYESTER FINE ROTOR SPUN YARNS
FIGURE 4.5 FLOW-CHART FOR PRODUCING POLYESTER / COTTON FINE ROTOR AND RING SPUN YARNS
passages of drawing and then through the high draft inter; the roving was spun into 30's carded yarn on a ring frame.

Direction of twist was altered in ring frame for 30's combed yarn so as to make an 'S' twisted yarn.

4.2.5 Fine rotor spun yarns
4.2.5.1 The Machine

The machine used in this study was Lakshmi Rieter RU14A, which can run at speeds as low as 60,000 rpm to as high as 1,00,000 rpm. The maximum production rate is 200 metres/min. For a wide range of twist application, the machine is equipped with multistage step pulley. The machine can be fitted with fluted take-off tubes as well as false twist device, when processing low-twist yarns. Another extra fitting permits the yarn to be waxed before it is wound on to the package.

Yarns of linear density of 11.81 tex (50 Ne) from 100% combed cotton, polyester cotton blends of 67:33 and 100% polyester were produced using 35 mm rotor and operating at 80,000 rpm; comber noil extracted at comber was 15% for cotton. Twist factor used was 40 tpcm tex^{0.5}.

Corresponding ring spun yarns were produced by passing the draw frame sliver to high draft inter, and then spinning on the ring frame. In respect of 100% polyester, the material was treated like carded material, and by employing two draw frame passages following carding, the yarns were spun on rotor spinning.

100% acrylic yarns were obtained commercially from a reputed mill; these consisted of regular and hydrophilic acrylic fibres.
4.2.6 Yarn Treatment

4.2.6.1 Aqueous swelling and stretching

A small quantity of 30's combed yarn was swollen in boiling hot water for two hours, and then dried; this was subsequently wound onto cones to be used later for knitting.

Another portion of the yarn in the form of hanks was swollen, as indicated above, and then stretched to 100%. Following swelling in hot boiling water, it was noticed that there was shrinkage in the hanks; these were stretched to the original length and washed and dried. This treatment was intended to set the yarn, and then to stretch it which would result in a reduction in twist and also in torque. By doing so, the twisting forces are also compensated for by the treatment of the yarn.

4.2.7 Conditioning of Yarn Samples

Prior to the testing of physical and tensile properties, each yarn sample was kept in the atmosphere of relative humidity 65 ± 2 percent and temperature of 25 ± 2°C for 48 hours. This was done to condition the samples.

4.2.8 Determination of Physical Properties of Yarn

Yarn tex is the weight in grams of 1000 metre length of yarns. It expresses the linear densities of yarn. In order to express the yarn load in terms of specific stress (load/mass per unit length), it is necessary to know the linear density of the yarn. The knowledge of yarn tex is also useful to calculate specific volume of yarn. To determine yarn tex, six pieces each of 10 metre length were cut at random from every bobbin. Thus in all, 20 pieces were cut for each yarn sample; these were weighed on Mettler electronic balance, and yarn tex was calculated.
4.2.9 Measurement of Tensile Properties of Yarn
4.2.9.1 Measurement of breaking load and breaking elongation

The tensile testing of the yarn was carried out on Uster Tensorapid. It is easily programmable and the experiments are done automatically. The digital tensile testing installation determines the breaking force and breaking elongation of the yarns according to the principle of the constant rate of elongation. The installation consists of a tester, signal processor and a printer.

The tester lays the yarn automatically into the clamps and exerts a load until the yarn breaks. It transforms the force and elongation values into electrical signals, and transmits these to the signal processor. The signal processor, processes the electrical signals received from the tester. The results can be represented in numerical or graphical form at the video screen, or transmitted to the printer. The load that it can take ranges between 0.1N and 500 N. The clamp speed can be adjusted between 50 and 5000 mm/min. Its accuracy in measuring both the breaking load and breaking elongation is 1%. The tension can be adjusted between 0.7 to 200 cN. The testing length can be varied between 50 mm and 500 mm.

For each yarn sample, 20 tests were carried out to get a mean. The testing conditions are standardised and the testing parameters such as rate of traverse at 5 m/min., yarn tension at tex/2 and specimen test length of 500 mm were maintained.

4.3 MEASUREMENT OF YARN EVENNESS

The Uster Tester UT3, which uses modified optical system, measures three properties of a yarn at a time namely, evenness, imperfections and hairiness. The model consists of (a) a measuring unit, (b)
The measuring unit on capacitance principle can measure the linear densities of slivers, rovings and yarns. The condensers are of varying sizes, and can handle any thickness of textile material from the coarsest sliver to the finest yarn. A pair of rubber covered geared rollers pull the fibre assembly through the appropriate condensers. The instrument can test the material at speeds of 4, 8, 25, 50, 100, 200, 300 and 400 meters per minute. This instrument measures the change in the capacitance of the condenser, which is proportional to the change in cross section of the fibre assembly passing through it. The condensers are 8 mm. long and therefore the U% obtained is equivalent to the coefficient of variation obtained from cutting up the yarn to 8 mm bits and weighing them. An assumption of this mode of testing is that the dielectric constant of the material is constant.

The measuring unit converts the instantaneous thickness into a frequency modulated signal. This analog signals are converted by means of an analog digital converter, which is provided in the measuring unit. All the type of machine settings like speed, time etc. can be done through computer itself, with keyboard feeding. The machine compares the instantaneous thickness against the cumulative average. If the two differ by a pre-set value, the machine registers occurrence of an imperfection. Depending on the sign of the difference, this can be a thin place or a thick place. The machine makes a further discrimination between a thick place and a nep. Using the values of the testing speed set, it times the length of any thickening in the yarn, in excess of preset limit. If the thickening is less than 2 mm in length, it is counted as a nep. The values of the three classes of imperfections are reported as imperfections per kilometre. The test results which are provided automatically after a test, are U%, CV%, imperfections at various levels, histogram, frequency distribution and charts.
In this instrument, all the adjustments can be done through computer. Yarn from the bobbin holder is taken up through the guide, the tensioner and is passed through the photocell unit. Then it passes through the condenser, before passing through the nip of the driver rollers. The free end from the driving roller is introduced into the suctioning tube for waste collection. Except for the bobbin creeling, all the throwing operations are done automatically, by means of the hydraulic arm. Four cheeses were taken per sample, and from each bobbin, 100 metres were measured at a test speed of 100 mts/min.

4.4 RESULTS AND DISCUSSION

Table 4.3 gives the results of the yarns, namely, ring spun carded and combed and yarns with different directions of twist. Included in the Table 4.3 are also the results of the treated yarn samples.

It will be seen that in respect of 30's (19.6 tex), the direction of twist has affected neither the tenacity nor the elongation; there is no change in the other properties.

In the case of 30's carded and combed yarns, a distinct improvement in combed yarns, particularly in tenacity, elongation and imperfections is noticeable.

Yarn characteristics in respect of fine rotor spun yarns show many interesting features in that, the strength of these yarns is lower than those of their counterparts. However, in terms of their evenness and imperfections rotor spun yarns are superior compared to their counterparts.

As regards 30's combed yarns, which were subjected to aqueous swelling and stretching treatments, it is noticed that the strength improvement in swollen and stretched sample is quite significant; this is
## Table 4.3  Details of yarn samples

<table>
<thead>
<tr>
<th>Yarn type No.</th>
<th>Fibre content</th>
<th>Carded/Combed</th>
<th>Twist TPC</th>
<th>Count tex (Ne)</th>
<th>Tenacity cN/tex</th>
<th>Elongation @ break</th>
<th>U%</th>
<th>Thin</th>
<th>Thick</th>
<th>Neps</th>
<th>Treatment</th>
<th>TM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ring 1</td>
<td>100% C</td>
<td>Combed</td>
<td>6.65 S</td>
<td>19.68(30)</td>
<td>15.6</td>
<td>4.7</td>
<td>10.20</td>
<td>0</td>
<td>52</td>
<td>78</td>
<td>Untreated</td>
<td>29.50 (3.08)</td>
</tr>
<tr>
<td>Ring 2</td>
<td>100% C</td>
<td>Combed</td>
<td>6.65 Z</td>
<td>19.68(30)</td>
<td>16.2</td>
<td>4.5</td>
<td>10.20</td>
<td>2</td>
<td>52</td>
<td>100</td>
<td>Untreated</td>
<td>29.50 (3.08)</td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ring 3</td>
<td>100% C</td>
<td>Carded</td>
<td>7.76 Z</td>
<td>19.68(30)</td>
<td>13.6</td>
<td>4.07</td>
<td>12.3</td>
<td>8</td>
<td>266</td>
<td>310</td>
<td>Untreated</td>
<td>34.52 (3.0)</td>
</tr>
<tr>
<td><strong>Group C</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Ring 4</td>
<td>100% C</td>
<td>Carded</td>
<td>8.03 Z</td>
<td>19.68(30)</td>
<td>15.71</td>
<td>5.25</td>
<td>12.47</td>
<td>9</td>
<td>274</td>
<td>328</td>
<td>Untreated</td>
<td>35.62 (3.7)</td>
</tr>
<tr>
<td>Ring 5</td>
<td>100% C</td>
<td>Combed</td>
<td>7.39 Z</td>
<td>19.68(30)</td>
<td>16.11</td>
<td>5.16</td>
<td>9.83</td>
<td>1</td>
<td>23</td>
<td>48</td>
<td>Untreated</td>
<td>32.78 (3.4)</td>
</tr>
<tr>
<td><strong>Group D</strong></td>
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<td></td>
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</tr>
<tr>
<td>Ring 6</td>
<td>100% C</td>
<td>Combed</td>
<td>8.65 Z</td>
<td>19.68(30)</td>
<td>14.62</td>
<td>4.98</td>
<td>10.10</td>
<td>0</td>
<td>60</td>
<td>188</td>
<td>Untreated</td>
<td>38.37(3.99)</td>
</tr>
<tr>
<td>Ring 7</td>
<td>100% C</td>
<td>Combed</td>
<td>7.69 Z</td>
<td>18.59(31.78)</td>
<td>14.89</td>
<td>4.75</td>
<td>10.85</td>
<td>0</td>
<td>65</td>
<td>220</td>
<td>Untreated</td>
<td>33.16(3.45)</td>
</tr>
<tr>
<td>Ring 8</td>
<td>100% C</td>
<td>Combed</td>
<td>7.86 Z</td>
<td>19.37(30.49)</td>
<td>16.61</td>
<td>4.11</td>
<td>10.53</td>
<td>0</td>
<td>62</td>
<td>200</td>
<td>Untreated</td>
<td>54.60(3.60)</td>
</tr>
<tr>
<td><strong>Group E</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Ring 9</td>
<td>100% C</td>
<td>Combed</td>
<td>11.64 Z</td>
<td>11.81(50)</td>
<td>15.01</td>
<td>4.82</td>
<td>15.51</td>
<td>228</td>
<td>392</td>
<td>470</td>
<td>Untreated</td>
<td>40(4.2)</td>
</tr>
<tr>
<td>Ring 10</td>
<td>67P/33C</td>
<td>Combed</td>
<td>11.64 Z</td>
<td>11.81(50)</td>
<td>20.26</td>
<td>9.25</td>
<td>14.65</td>
<td>105</td>
<td>441</td>
<td>558</td>
<td>Untreated</td>
<td>40(4.2)</td>
</tr>
<tr>
<td>Ring 11</td>
<td>100% P</td>
<td>-</td>
<td>11.64 Z</td>
<td>11.81(50)</td>
<td>35.16</td>
<td>12.96</td>
<td>12.89</td>
<td>130</td>
<td>97</td>
<td>168</td>
<td>Untreated</td>
<td>40(4.2)</td>
</tr>
<tr>
<td>Rotor 12</td>
<td>100% C</td>
<td>Combed</td>
<td>11.64 Z</td>
<td>11.81(50)</td>
<td>11.09</td>
<td>5.39</td>
<td>13.88</td>
<td>232</td>
<td>322</td>
<td>356</td>
<td>Untreated</td>
<td>40(4.2)</td>
</tr>
<tr>
<td>Rotor 13</td>
<td>67P/33C</td>
<td>Combed</td>
<td>11.64 Z</td>
<td>11.81(50)</td>
<td>16.80</td>
<td>9.40</td>
<td>14.02</td>
<td>251</td>
<td>251</td>
<td>253</td>
<td>Untreated</td>
<td>40(4.2)</td>
</tr>
<tr>
<td>Rotor 14</td>
<td>100% P</td>
<td>-</td>
<td>11.64 Z</td>
<td>11.81(50)</td>
<td>22.62</td>
<td>11.10</td>
<td>13.09</td>
<td>124</td>
<td>78</td>
<td>110</td>
<td>Untreated</td>
<td>40(4.2)</td>
</tr>
<tr>
<td><strong>Group F</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ring 15</td>
<td>100% Acrylic (R)</td>
<td>-</td>
<td>9.96 Z</td>
<td>14.76(40)</td>
<td>12.66</td>
<td>14.46</td>
<td>12.87</td>
<td>100</td>
<td>50</td>
<td>70</td>
<td>Untreated</td>
<td>38.3(4)</td>
</tr>
<tr>
<td>Ring 16</td>
<td>100% Acrylic (H)</td>
<td>-</td>
<td>9.96 Z</td>
<td>14.76(40)</td>
<td>12.71</td>
<td>17.68</td>
<td>12.87</td>
<td>96</td>
<td>45</td>
<td>69</td>
<td>Untreated</td>
<td>38.3(4)</td>
</tr>
</tbody>
</table>

Twist direction: S or Z, TPC: Turns per centimeter, C: Cotton, P: Polyester
due to removal of convolutions in cotton fibres, increase in fibre strength and increase in packing coefficient of yarns; these results are in substantial agreement with the results obtained by Subramaniam and Thambidurai (1995). There is an increase in linear density of yarns, i.e. the count becoming finer accompanied by a drop in elongation. If the yarn has twist in Z direction, and if it is swollen, the twist gets reduced, which is the case; this would also imply that the level of torque is less in the stretched yarn.

It is noticed that the acrylic yarns, which have been produced from normal and hydrophilic fibres, show differences in their properties.

4.5 CONCLUSION

The direction of twist has no pronounced effect on the yarn characteristics. Combed yarns are superior to the carded yarns in all the properties. Aqueous swelling and stretching treatment of cotton yarns has led to a significant improvement in the yarn properties. Fine rotor spun yarns, although they have lower strength than those of their counterparts, have a lower U% and imperfections. Acrylic yarns also show differences in yarn characteristics.