COMPARISON OF QUALITY PARAMETERS FOR RING AND OPEN-END ROTOR SPUN YARNS

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Abstract: Spinning is a major part of the textile manufacturing process where among all these are ring spinning and open-end rotor spinning which are widely used in production of textiles. In this study, cotton (CO) and polyester (PES) fibers were used with various blends to produce both ring and open-end rotor spun yarns. These 3 different blends (33/67% PES/CO, 50/50 % PES/CO and 67/33 PES/ CO) of Ne 30/1 yarns were later knitted on a plain knitting machine. The physical properties of these produced spun yarns were studied i.e. evenness, hairiness, breaking strength and elongation with additionally pilling properties of the produced fabrics. It was observed that as the blend ratio of the PES fiber increases within the yarn structure the both breaking strength and elongation gets higher on the ring-spun and open-end rotor spun yarns. Among all these produced blended spun yarns, the highest breaking strength and elongation is 21.79 cN/tex and 8.96% respectively. Evenness test results showed that ring spun yarns presented better values than the open-end rotor spun yarns; the lowest %CV %90 was obtained on the %67/33 PES/CO ring spun yarns. Both imperfection values and hairiness gets better as the PES ratio increases within the both yarn types. On the other hand, better pilling resistance was obtained on the OE-rotor spun than the ring spun yarns. The pilling values also indicate that as the PES fiber ratio increases within the open-end rotor spun yarns it shows better pilling (pilling scale 4-5).
Keywords: Ring, Open-end, Rotor, Imperfections, Mechanical properties, Hairiness

Introduction

Staple yarns are constructed from the bundle of fibers, which are twisted together during the spinning process. The widely used ones are ring spinning and open-end rotor spinning technologies. If one would like to have a brief look to these techniques are given below:

The ring spinning machine was first invented by Thorp in 1828 and later Jenk added the traveler rotating around the ring in 1830. In the intervening period of more than 170 years the ring spinning machine has undergone considerable modification in detail, but the basic concept has remained the same. For many years any noteworthy further development hardly seemed possible, yet a significant process of evolution took place during this time (Ahmed, 2016). The principle of ring spinning is illustrated in Figure 1. A bundle of parallel fibers which are roving slivers fed to the drafting zone. The difference in surface velocity are obtained with the help of roller speeds; the front roller is faster and back roller is slower ones, hence drafting rollers will attenuate the roving to a thinner strand of parallel fibers, under the control of the double aprons. The thin strand of parallel fibers emerging from the front rollers is then simultaneously twisted and wound onto a yarn package (i.e., cop) mounted on a driven spindle. The twisted thin strand of fibers, now called a yarn, is threaded through a traveller and a yarn guide and balloons out between these two elements during spinning. The twisted yarn is then wound onto the bobbin or yarn package (Tang, 2006).

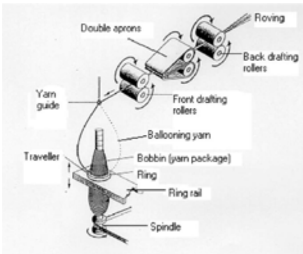


Figure1. The ring spinning process (Tang, 2006)

On the other hand, commercial open end-rotor spinning was first developed in 1967 in Czechoslovakia. Open-end rotor spinning has been characterized from the outset by incomparably higher production potential than ring spinning. This potential has been increased by the higher rotor speeds and winding up speeds and also there is no need for roving process. Therefore, rotor-spun yarns are also can manufactured much cheaper than the ring-spun yarns. Rotor spinning combines in two process stages namely spinning and winding at the same single machine. Additionally the rotor spinning system is able to process carded or draw frame slivers directly. Last but not least, the rotor spinning system has benefited from the fact that operator functions on the rotor spinning machine were much easier to automate than those on the ring spinning machine. After the sliver has been opened on the opening roller are fed through the fiber transport channel individually to the collecting groove of the rotor itself. The rotor itself is also a twisting device of this spinning system. Since the individual fibers are released from a compact fiber bundle to the individually ones, this can here refer to an open-end yarn. This brief explanation of the process is also presented in the Figure 2.

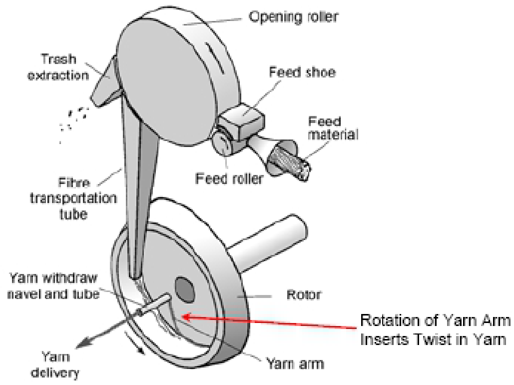


Figure 2. Principle of Rotor spinning (Sheikh and Emeritus, 2013)

One of the major distinctions between OE-rotor-spun yarns and ring spun yarns is the difference between the hairiness in the yarn. This was also studied by Tyagi et. al.(Tyagi, 2009) and they observed that open-end rotor spun yarns show less hairiness than the ring spun yarns which is related to twist factor. Strumillo et. al. (Strumillo, 2007) worked on quality parameters that may affect from different linear densities of cotton yarns on both ring and open-end rotor spun yarns; they determined various mathematical models on tenacity, elongation at break, unevenness, hairiness and the number of faults on the yarn's linear density.

Materials and Methods

In this study, polyester and cotton fibers and its different blends (PES/CO 33/67% -PES/CO 50/50 % - PES/CO 67/33%) were used at twist constant of α_e 3.3 and Ne 20 ring-spun carded yarns and open-end rotor-spun yarns were produced. The yarn tests were carried out at 20 ± 2 ^{0}C, 65% ± 2 RH conditions after the samples reaching equilibrium. The fibers properties of these materials are measured on the Spinlab HVI 900 and their results are given in Table 1, the specification of the machines are all presented in Table 1-5. The produced yarns were then knitted on the Dubied knitted machine with a knitting structure of supreme fabrics.

Table 1: Fiber parameters

Measured fiber parameters	Fiber used in the study	
	Cotton	**Polyester**
Cotton fiber fineness (micronaire)	4.74	-
Fiber length (ML) (mm)	28.2	-
Fiber strength (g/tex)	32.9	-
Fiber elongation (%)	9.4	-
(UR%)	50.4	-
Polyester fiber fineness (denier)	-	1.4
Fiber length (mm)	-	38

Table 2: Carding machine specifications

Technological/machine set parameters	Values
Main cylinder speed (rpm)	650
Production rate (m/min)	210
Sliver count (Ne)	0.120

Table 3: Draw-frame machine specifications

Technological/machine set parameters	Values
Rotor speed (rpm)	86000
Total draft	8
Roller Distance in break-draft zone (mm)	52
Number of fed slivers	8
Sliver count (Ne)	0.120

Table 4: Ring machine specifications

Technological/machine set parameters	Values
Ring yarn type	Conventional
Spindle speed (rev/min)	14500
Ring diameter (mm)	42
Type of traveler and ISO No	C1 UL udr and 31.5
Theoretical twist coefficient (α_e)	3.5
Theoretical twist (turns/inch)	19

Table 5: OE-Rotor machine specifications

Technological/machine set parameters	Values
Rotor speed (rev/min)	86000
Rotor diameter (mm)	32
Nozzle	Plain with 8 groves, ceramic (KK8K)

Results and Discussion

1. Yarn count, twist parameters, yarn breaking tenacity and elongation

In this study, 3 different blends of materials were produced on the ring and OE-rotor spinning machines with the total of 6 yarns at the same your count Ne 30. Table 6 presents the parameters of these produced yarns.

Table 6: Yarn parameters

Yarn abbreviations	Yarn count	Production type	Yarn types
M	Ne 30	Ring	PES/CO (33/67%)
N			PES/CO (50/50%)
O			PES/CO (67/33%)
P		OE-Rotor	PES/CO (33/67%)
R			PES/CO (50/50%)
S			PES/CO (67/33%)

Yarn counts, twist parameters and yarn breaking tenacity with elongation are tabulated in the Table 7. Breaking tenacity and elongation of these yarns were determined according to TS 245 standard by using Uster Tensojet 4. All tests were carried out in the standard atmosphere conditions (20 ± 2 C^0 and % 65 ± 2 RH) after 48 hours of equilibrium was reached.

Table 7: Yarn specifications

Yarn type	Abbreviations	Measured yarn count (Ne)	Measured yarn twist (turns/inch)	Measured breaking strength (cN/tex)	Measured elongation (%)
Ring	M	30.6	19,4	15.20	6.01
	N	30.4	19.8	19.39	7.54
	O	30.8	19.6	21.19	8.96
OE-Rotor	P	30.7	-	11.80	5.04
	R	30.5	-	12.10	7.02
	S	30.6	-	12.92	8.02

It can be seen from the results that as the PES ratio increases the breaking strength and elongation gets better. It is thought that PES is much stronger fiber than the cotton, therefore as the PES ratio increases within the blended yarns the overall fiber length also increases.

2. Yarn irregularity, imperfections and hairiness

Yarn irregularity, imperfections and hairiness were tested on the USTER TESTER 3. All samples run through the tester at 400 m/min. The results of these yarns are listed in the Table 8.

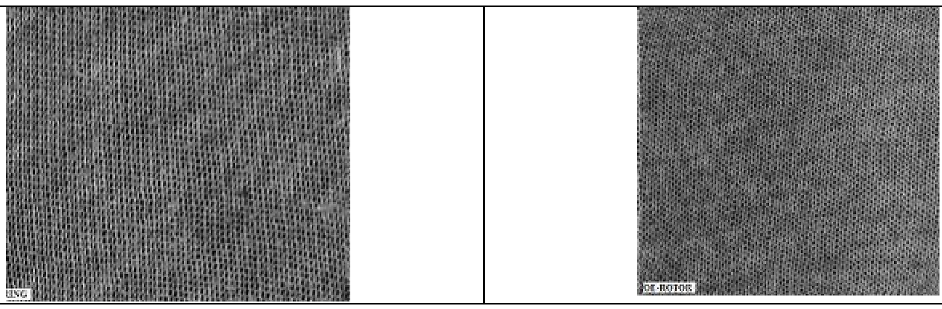
Table 8: Yarn irregularity, imperfections and hairiness values

Yarn type	Yarn Abbreviations	Mean linear irregularity, (U)	Thin places, (-50%)	Thick places, (+50%)	Neps,	Hairiness, (H)
Ring	M	12.92	11	208	250	4.64
	N	12.52	10	148	151	4.24
	O	12.18	8	102	120	3.94
OE-Rotor	P	14.80	230	300	988	4.44
	R	13.96	150	213	902	4.00
	S	13.18	105	185	671	3.77

It can be seen from the results that as the PES ratio increases the imperfections, irregularity and the hairiness of the yarns have shown improved parameters; this is due to the PES fiber length increment which is all same lengths of bundle in the blended yarns of cotton/polyester.

3. Fabrics production and pilling

The knitted supreme fabrics were measured on the Nu-Martindale tester for their pilling. The samples were conditioned under the standard atmosphere for 48 hours. Testing period was set 2000 rubs and later the samples were compared with the K3 EMPA Standard photographs [SN. 1985-25] for their pilling. Pilling values of the knitted fabrics are classified from worse to best as 1-3, 2-3, 3-4, 4-5 and the images of these samples are given as an example at the Figure 3. The pilling test results of these samples are given in Table 9.



Ring knitted fabric OE-Rotor knitted fabric

Figure 3. 67/33 % PES/CO ring and OE-rotor knitted fabric pilling images

Table 9: Pilling data of the knitted fabrics

Yarn type	Yarn Abbreviations	Pilling values
Ring	M	1-2
	N	1-2
	O	2-3
OE-Rotor	P	3-4
	R	3-4
	S	4-5

From both Figure 3 and Table 9, it can be seen that as the PES ratio increases the hairiness of the yarns gets less hairy therefore the fiber protruding ends are much lesser on the surface of the yarn structure and this leads to less pilling on the knitted fabric surfaces.

Conclusion

The overall results are presented at the following conclusions:

1. Generally, as the PES ratio increases slight lower values occur on the linear irregularity of the yarns. This indicates that the produced yarns improved in means of regularity.

2. Overall ring and OE-rotor yarns presented enhance imperfection results as the PES ratio increases within the blends of the yarns.

3. All the ring and OE-rotor yarns offered an increase on both breaking strength and elongation of the samples as the PES ratio increases within the blends.

4. Ring yarns have lower irregularity than the OE-Rotor yarns.

5. Ring yarns have lower thick places (+ 50%), thin places (-50%) and neps than the OE-Rotor yarns.

6. Both ring and OE-Rotor yarns presented low hairiness values as the PES ratio increases.

7. Both ring and OE-Rotor yarns offered low neps values as the PES ratio increases.

8. Ring yarns produced better breaking strength and elongation values than the OE-rotor yarns.

9. OE-Rotor yarns presented better pilling than the ring yarns.

10. Both ring and OE-Rotor yarns show higher pilling values as PES ratio increases within the blends; this points out that the knitted fabrics do present better pillings.

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