(REFEREED RESEARCH)

A RESEARCH ON 100% PES SIROSPUN YARNS

%100 PES SIROSPUN İPLİKLERİ ÜZERİNE BİR ARAŞTIRMA

Tuba BEDEZ ÜTE*, Hüseyin KADOĞLU

Ege University, Department of Textile Engineering, İzmir, Turkey

Received:10.02.2012 Accepted:15.02.2013

ABSTRACT

Sirospun spinning system enables two-folded yarn production in a single step process and this system can be installed on conventional ring spinning system with low investment costs. Sirospun yarns have higher tenacity, lower hairiness and better evenness values compared to conventional ring spun yarns. Besides, system offers advantages such as eliminating doubling and twisting processes. System provides increase in the production, production costs, savings on place and staff due to eliminating some processes. In this research, properties of 100% PES ring spun and sirospun yarns were compared and the influences of spindle speed and twist coefficient on the properties of 100% PES sirospun yarns were investigated.

Key Words: PES yarns, Short staple spinning, Sirospun, Spindle speed, Two-strand spinning, Twist multiplier, Yarn properties.

ÖZET

Sirospun iplik eğirme sistemi, tek adımda çift katlı iplik üretimine imkân sağlamakta ve konvansiyonel ring iplik makinesine düşük bir yatırım maliyeti ile kurulabilmektedir. Siro iplikleri, konvansiyonel ring iplikleri ile kıyaslandığında daha yüksek iplik mukavemeti, düşük iplik tüylülüğü ve daha iyi iplik düzgünsüzlüğü değerlerine sahiptir. Bunun yanında, sistem katlama ve büküm işlemlerinin kullanılmaması gibi birçok avantaj sunmaktadır. Bu sayede daha düşük enerji ve klima giderleri, düşük üretim maliyeti, yerden ve personelden tasarruf, üretim artışı, bazı proseslerin ortadan kaldırılması ile taşımadan ve işlemlerden oluşabilecek muhtemel hataların önlenmesi gibi avantajlar da sağlamaktadır. Yapılan çalışmada, kısa lif iplikçiliğinde sağladığı çeşitli avantajlarıyla giderek yaygınlaşan siro iplik eğirme sistemi ile üretilen %100 PES iplikleri ile konvansiyonel ring iplik makinesinde üretilen %100 PES ipliklerinin özellikleri karşılaştırılmıştır. Bunun yanında iğ devrinin ve büküm katsayısının siro ipliklerin özelliklerine etkisi incelenmiştir.

Anahtar Kelimeler: PES iplikleri, Kısa lif iplikçiliği, Siro eğirme, İğ devri, Çift katlı eğirme, Büküm katsayısı, Iplik özellikleri.

* **Corresponding Author:** Tuba Bedez Üte, tuba.bedez@ege.edu.tr, Tel. +90 232 311 27 69, Fax. +90 232 339 92 22

1. INTRODUCTION

Sirospun process was invented in 1975-76 by the laboratories of CSIRO for worsted spinning and this system was commercialized in 1980 by a consortium comprising IWS and CSIRO. Since 1981, Zinser has been licensed to sell Sirospun spinning frames and to convert the existing machinery to the new system (1). The Sirospun system enables to produce a spin-twisted yarn directly on a conventional ring spinning machine (2, 3). Two rovings per spindle are fed to the drafting system within specially developed condensers separately, drafted simultaneously and twisted together. (2). This results in a two- ply yarn with the same twist direction as that of the component single yarns (4). However, in terms of the fiber orientation along axis of the yarn, sirospun yarn surface will closely resemble a single yarn (5). Strand spacing and twist factor are significant factors that affect the properties of sirospun yarns. For stable spinning, the strand length should be smaller than the mean fiber length (6). Spinning performance of sirospun yarns can be improved by decreasing the strand spacing and increasing the twist coefficient (2, 7).

A Sirospun yarn is less hairy and more extensible compared to a two-plied yarn. It has better evenness, hairiness, abrasion resistance and tenacity properties compared to a single yarn with the same linear density (8). Fabrics knitted from Sirospun yarns are more suitable for summer wear because of cooler feeling and better thermal conductivity in comparison with the fabrics knitted from two-fold yarns (9).

Subramaniam et al, studied the effects of strand spacing, twist multiplier and spindle speed on the double-rove yarns by using factorial-analysis technique. Two groups of yarns were spun from cotton fibres and 67/33 polyester/cotton blend. The spindle speed was changed between 8320 rpm and 11000 rpm. The results have shown that yarn hairiness increased with increasing twist levels till the critical twist. After that, a contrary situation was observed. Results about spindle speed showed that up to a spindle speed of 10200 rpm, hairiness increased with increasing spindle speed whereas in higher spindle speeds yarn hairiness decreased with increasing spindle speed (10).

Temel et al, investigated the yarn properties of PES/cotton blended sirospun yarns. They have studied the influence of raw material, yarn count, twist multiplier and strand spacing on the yarn properties of %100 polyester and polyester/cotton blend yarns. For this purpose, they have produced 100% cotton, 67/33 Co/PES, 33/67 Co/PES and 100% polyester sirospun yarns. Besides, ring spun yarns were produced for comparison with same raw materials. After statistical analysis, the effects of raw material, yarn count, twist multiplier and strand spacing on the yarn properties were found to be statistically significant. It was found that, when the polyester ratio in the blend increased, yarn tenacity, yarn elongation and yarn liveliness also increased but on the other hand yarn hairiness values decreased for both sirospun and ring spinning methods (12).

The objective of this work was to investigate the differences between the properties of 100% PES sirospun and ring spun yarns produced with the same parameters. Furthermore, the effects of spindle speed and twist factor on the properties of sirospun yarns were analyzed.

2. MATERIAL AND METHOD

In this study 100% PES sirospun and ring spun yarns were produced on Pinter Merlin ring spinning machine (Figure 1). According to previous studies, optimum strand spacing was set as 5 mm. As the yarn count was the same for all trials, the same traveler type, C type ISO 5 was used. Experimental plan is given in Table 1.

Sirospun and conventional ring spun yarns were conditioned for 24 hours under 20°C±2 temperature and 65±5 % relative humidity. Subsequently, yarns were tested and evaluated for important physical and mechanical properties such as evenness, imperfections, tenacity, breaking elongation and hairiness. Yarn twist was measured according to TS 247 EN ISO 2061 Standard, with Zweigle D315 twist tester, yarn strength and breaking elongation values were determined on a Lloyd Tester according to TS 245 EN ISO 2062 Standard, which measures according to CRE: Constant rate of elongation principle. Yarn uniformity, the IPI values and yarn hairiness values were measured on an Uster Tester 5.

Test results were evaluated statistically with SPSS software. With the aim of determining the statistical importance of the differences between the characteristics of 100% sirospun and ring spun yarns, paired samples t tests were applied and p values were analyzed.

Multivariate analysis and Tukey tests were done for sirospun yarns to evaluate the effects of spindle speed and twist coefficient on the yarn characteristics such as yarn strength, breaking elongation, yarn evenness and hairiness. F values obtained from analysis of variance and their statistically significance were evaluated (p>0,05).

Table 1. Experimental plan for 100% sirospun and ring spun yarn production.

Material	Yarn count	Spindle speed (r/min)	Twist coefficient (α_e)
100% Polyester	Ne 40/2	9000	4.2
	Ne 40/2	11000	
	Ne 40/2	13000	
	Ne 40/2	9000	3.9
	Ne 40/2	11000	
	Ne 40/2	13000	
	Ne 40/2	9000	3.6
	Ne 40/2	11000	
	Ne 40/2	13000	

Figure 1. Pinter – Merlin ring spinning machine.

3. RESULTS AND DISCUSSION

100% PES sirospun and conventional ring spun yarns' properties (yarn count, yarn twist, breaking strength, breaking elongation, Uster %CV, number of thin places, number of thick places, number of nep and yarn hairiness) were tested.

4. CONCLUSIONS

In this paper, the differences between the properties of 100% PES sirospun and ring spun yarns were investigated. Furthermore, the effects of spindle speed and twist factor on the properties of 100% PES sirospun yarns were analyzed. The results of statistical analysis for 100% PES sirospun yarn properties were given in Table 4.

Yarn hairiness values (H) of the mentioned yarns are shown in Figure 2.

Table 2. Yarn count, yarn twist, yarn strength and breaking elongation values of 100% PES sirospun and ring spun yarns.

			α_e 3,6 (T/m=634)		α_e 3,9 (T/m=687)		α_e 4,2 (T/m=740)	
			Ring	Siro	Ring	Siro	Ring	Siro
Spindle Speed (rpm)	9000	Yarn count (Ne)	20,2	20,3	19,9	20	19,8	20
		Yarn twist (T/m)	577,7	576,8	654,1	631,8	677,3	690,6
		Strength (cN/tex)	28,4	30,26	27,57	30,46	28,61	30,86
		Break. Elong. (%)	37,14	39,18	35,85	39,71	40,04	40,24
	11000	Yarn count (Ne)	20,1	20,2	20	20	19,9	20
		Yarn twist (T/m)	579,5	556,7	632,2	619,5	691,9	632,1
		Strength (cN/tex)	29,17	30,43	28,86	30,71	29,76	30,99
		Break. Elong. (%)	39,34	40,96	39,31	39,92	40,18	40,35
	13000	Yarn count (Ne)	20	20,2	20,1	20,4	20	20,1
		Yarn twist (T/m)	571,6	571,3	632	562,6	636,1	661,7
		Strength (cN/tex)	29,36	32,12	29,27	31,29	30,02	31,18
		Break. Elong. (%)	40,98	41,03	41,43	41,68	41,22	41,42

Yarn evenness test results of 100% PES sirospun and conventional ring spun yarns are given in Table 3.

Table 3. Yarn evenness test results of 100% PES ring and sirospun yarns.

			α_e 3,6 (T/m=634)		α_e 3,9 (T/m=687)		α_e 4,2 (T/m=740)	
			Ring	Siro	Ring	Siro	Ring	Siro
Spindle speed (rpm)	9000	CV%	10,19	9,39	10,09	10,22	10	9,35
		Thin places (-%50)	0	0	0	2	0	0
		Thick places (+%50)	9	6	8	21,5	12,5	8,5
		Neps(+%200)	10,5	1,5	4,5	24	11,5	8
	11000	CV%	9,98	9,4	10,68	9,39	10,07	9,41
		Thin places (-%50)	0	6	0,5	0	0	0
		Thick places (+%50)	9	5,01	7	17	7	22,5
		Neps(+%200)	8,5	5,01	7,5	20	4	19,5
	13000	CV%	10,27	9,27	10,27	9,53	10,12	9,39
		Thin places (-%50)	0	0	0	0	0	0
		Thick places (+%50)	12	7,5	9,5	18	6,87	23
		Neps(+%200)	11,5	9	8	18,5	9,37	21,5

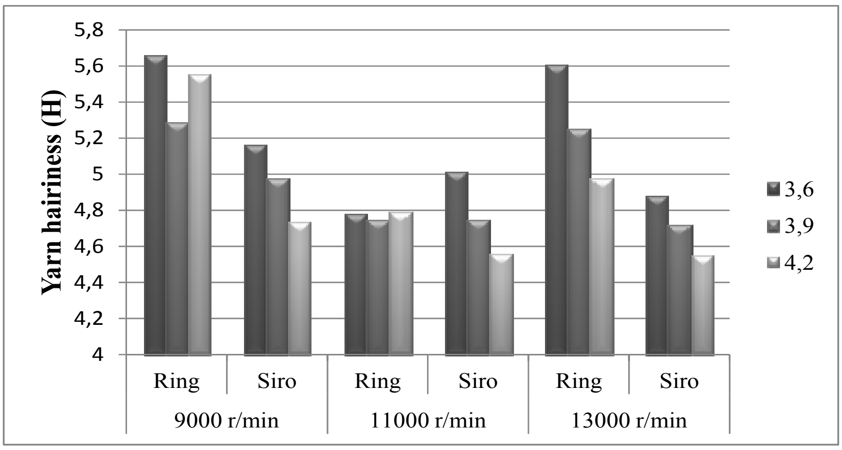

Figure 2. Yarn hairiness (H) values of 100% PES ring and sirospun yarns.

Table 4. Analysis of variance table for 100% PES sirospun yarns.

Factor	Yarn properties	F	Significance
Twist coefficient (α_e)	**Yarn strength**	**5,897**	**0,003***
	Breaking elongation	**4,953**	**0,007***
	CV %	**16,234**	**0,000***
	Number of thin places	**11,174**	**0,000***
	Number of thick places	**34,749**	**0,000***
	Number of nep	**27,973**	**0,000***
	H	**106,814**	**0,000***
	sH	**5,260**	**0,006***
Spindle speed	Yarn strength	0,070	0,933
	Breaking elongation	0,770	0,464
	CV %	**8,333**	**0,000***
	Number of thin places	**11,174**	**0,000***
	Number of thick places	**3,429**	**0,033***
	Number of nep	**3,994**	**0,019***
	H	**41,593**	**0,000***
	sH	**83,178**	**0,000***
Twist coefficient (α_e)* Spindle speed	Yarn strength	1,291	0,273
	Breaking elongation	**7,054**	**0,000***
	CV %	**8,952**	**0,000***
	Number of thin places	**11,124**	**0,000***
	Number of thick places	**7,290**	**0,000***
	Number of nep	**4,396**	**0,002***
	H	1,126	0,344
	sH	**5,108**	**0,000***

***: Significant for α = 0,05.**

Twist coefficient has a statistically significant effect on yarn strength, breaking elongation, yarn evenness, number of thin/thick places, neppiness, yarn hairiness and variation of hairiness of 100% PES sirospun yarns. As expected, yarn strength and elongation values of sirospun yarns increased whereas yarn hairiness decreased with the increasing of twist coefficient. In terms of yarn evenness, values of sirospun yarns produced with α_e 3,9 were higher than values of the others.

Spindle speed has a statistically significant effect on yarn evenness, number of thin places, thick places, nep, yarn hairiness (H and sH values) of 100% PES sirospun yarns. Generally, working with higher spindle speeds, influences the yarn evenness positively. Regarding the yarn evenness, values of sirospun yarns produced with α_e 3,9 were higher than values of the others. In terms of yarn hairiness, higher spindle speeds result in lower yarn hairiness but only the differences between the hairiness values of the yarns produced with 9000 rpm and 13000 rpm was statistically significant. Furthermore, the variation of yarn hairiness decreased with increasing spindle speed, significantly. Decrease in the yarn hairiness in relation with the increase in the spindle speed depends on the centrifugal force. This increasing centrifugal force causes more fibres being thrown away from the yarn body. Besides, at higher spindle speeds, traveler can cut off protruding fibres (11).

With the aim of investigating the effect of the spinning method, on the properties of %100 PES sirospun and ring spun yarns, paired samples t test was done and results are given in Table 5.

Table 5. Paired samples t tests results for sirospun and ring spun yarns.

	9000 rpm			11000 rpm			13000 rpm		
	α_e 3,6	**α_e 3,9**	**α_e 4,2**	**α_e 3,6**	**α_e 3,9**	**α_e 4,2**	**α_e 3,6**	**α_e 3,9**	**α_e 4,2**
Strength(cN/tex)	0,000*	0,347*	0,059	0,010*	0,013*	0,003*	0,000*	0,130*	0,067
Elongation (%)	0,001*	0,000*	0,045*	0,022*	0,350	0,799	0,937	0,654	0,432
Evenness (%CV)	0,000*	0,597	0,000*	0,000*	0,000*	0,000*	0,000*	0,000*	0,000*
Thin places/1000m	-	0,001*	-	-	0,001*	-	-	-	-
Thick places/1000m	0,012*	0,000*	0,296	0,000*	0,000*	0,000*	0,000*	0,001*	0,000*
Nep/1000m	0,000*	0,000*	0,656	0,000*	0,000*	0,000*	0,000*	0,000*	0,014*
Yarn hairiness (H)	0,000*	0,000*	0,185	0,000*	0,000*	0,000*	0,000*	0,000*	0,000*
sH	0,000*	0,000*	0,195	0,000*	0,000*	0,000*	0,000*	0,000*	0,000*

***: Significant for α = 0,05.**

Regarding the effect of the spinning method, sirospun yarns produced with lower twist coefficient (α_e 3,6) had higher yarn strength and breaking elongation for all spindle speeds. In terms of yarn evenness, number of thick places, thin places, nep and yarn hairiness, sirospun yarns had lower values than ring spun yarns in general. For all spindle speeds, sirospun yarns produced with the twist coefficient α_e 3,9 had higher yarn strength whereas lower yarn evenness and yarn hairiness than ring spun yarns. Sirospun yarns produced with higher twist coefficients (α_e 4,2) again have higher yarn strength and breaking elongation but lower yarn hairiness and yarn evenness values. However, the differences between the values of the yarns were statistically significant only for evenness and hairiness.

The images of sirospun yarns and conventional ring spun yarns produced with the same twist coefficient and spindle speed were taken with Leica S8APO stereo microscope by enlarging approximately 26 times (Figure 3). It is obviously seen that the sirospun yarns have much less hairiness than conventional ring spun yarns.

In conclusion, with the increasing of twist coefficient of 100% PES sirospun yarns, yarn strength and breaking elongation increased, whereas number of thin places, thick places, nep and yarn hairiness decreased. Spindle speed did not affect yarn strength and breaking elongation significantly, but with the increasing spindle speed yarn evenness, yarn hairiness and number of thin places decreased, besides number of thick places and nep increased. In terms of spinning method, generally speaking sirospun yarns have higher yarn strength, lower yarn evenness and hairiness than conventional ring spun yarns.

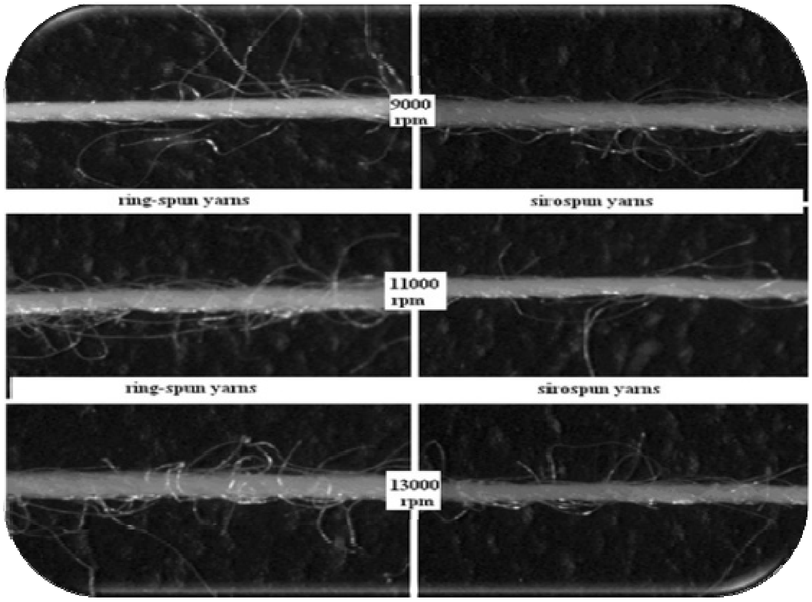

Figure 3. Ring-spun and sirospun yarns produced with different spindle speeds.

REFERENCES

1. Bedez Ute T. and Ureyen M.E., 2007, “Sirospun yöntemi ile kısa ştapelli liflerin eğrilmesi”, *Tekstil ve Konfeksiyon*, Vol: 17(1), p: 31.
2. Cheng, K.P.S. and Sun, M.N., 1998, “Effect of Strand Spacing and Twist Multiplier on Cotton Sirospun Yarn”, *Textile Research Journal*, Vol: 68(7), pp: 520-527.
3. Miao M., Cai Z., Zhang Y., 1993, “Influence of process variables on two-strand yarn spinning geometry”, *Textile Research. Journal*, Vol: 63, pp: 116-120.
4. http://www.swicofil.com/siro_spinning.html. (13.12.2011)
5. Brunk N., 2006, “EliTwistQ –Three Years after Market Introduction”, *Spinnovation,* Vol: 22(07), pp: 10-17.
6. Dorlastan, in the Field of Weaving, Dorlastan Product Information – Weaving, Dormagen Germany.
7. Sun, M.N. and Cheng, K.P.S., 2000, “Structure and Properties of Cotton Sirospun Yarn”, *Textile Research Journal*, Vol: 70(3), pp: 261–268.
8. Sun, M.N. and Cheng, K.P.S., 2000, “The Quality of Fabric Knitted From Cotton Sirospun Yarn”, *International Journal of Clothing, Science and Technology*, Vol: 12 (5), pp: 351-359.
9. Zinser- SiroSpun Operating manual
10. Bedez Ute T., 2007, “A Research on Spinning of Short Staple Fibers by Sirospun System”, Master’s Thesis, 168 pages.
11. Subramaniam V. and Mohammed A.P., 1991, “A Study of Double-rove Yarn Hairiness in the Short-staple-spinning Sector”, *Journal of Textile Institute*, Vol: 82(3), pp: 333-340.
12. Temel E. and Çelik P., 2010, “A Research on Spinnability of 100% Polyester and Polyester - Cotton Sirospun Yarns”, *Tekstil ve Konfeksiyon*, Vol: 20(1), pp: 23-29.