(REFEREED RESEARCH)

THE INFLUENCE OF SPINNING PARAMETERS ON POLYESTER/VISCOSE DREF-3 YARN UNEVENNESS, IMPERFECTION AND HAIRINESS PROPERTIES

EĞİRME PARAMETRELERİNİN POLYESTER/VİSKON DREF-3 İPLİKLERİN DÜZGÜNSÜZLÜK, HATA VE TÜYLÜLÜK ÖZELLİKLERİ ÜZERİNDEKİ ETKİSİ

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ABSTRACT

In this study polyester staple fiber core/viscose sheath yarns were produced in order to understand the influence of spinning parameters on DREF-3 yarn unevenness, imperfection and hairiness properties. Yarns having 65 tex linear density, were produced with using three different core/sheath ratio level × three different spinning drum speed × three different air suction pressure at 4200 rpm constant opening roller speed and 100 m/min constant production speed. The unevenness, imperfection and hairiness properties of experimental yarns were tested with Uster Tester 3, at a speed of 200 m/min for 5 minute. Obtained results were evaluated with regression analysis using SPSS statistical pocket program at 0.05 significance level.

According to analysis results, the air suction pressure is a significant factor for yarn hairiness. The increase of air suction pressure decreases the slippage between spinning drum cylinders and fibers (2). For this reason, at higher air suction pressure, the sheath fibers wrap better around core and yarn hairiness decreases. The wrapper fibers cause hairiness, due to their buckling form in the yarn. With the increase of sheath ratio, the number of wrapper fibers increase thus yarn hairiness increases. At higher spinning drum speeds the fibers in the sheath are damaged and the number of hooks at the end of fiber increases (2). As a result of this, yarn hairiness increases. On the other hand, the core/sheath ratio, spinning drum speed and air suction pressure are not significant factors for unevenness, the number of thin places, thick places and neps properties of polyester staple fiber core/viscose sheath yarns.

Key Words: DREF-3 friction spinning, Yarn unevenness, Yarn imperfections, Core/sheath ratio, Spinning drum speed, Air suction pressure.

ÖZET

Bu çalışmada, eğirme parametrelerinin DREF-3 ipliklerinin düzgünsüzlük, hata ve tüylülük özellikleri üzerindeki etkisini anlamak için polyester kesikli elyaf özlü/viskon mantolu iplikler üretilmiştir. 65 tex numaralı iplikler, üç farklı öz/manto oranı × üç farklı eğirme silindir devri × üç farklı hava emiş basıncı kullanarak, 4200 tur/dk sabit açıcı silindir devri ve 100 m/dk sabit üretim hızı ile üretilmiştir. İncelenen ipliklerin düzgünsüzlük, hata ve tüylülük özellikleri Uster 3 test cihazı ile, 200 m/dk test hızında, 5 dakika süreyle test edilmiştir. Elde edilen sonuçlar SPSS istatistiksel paket programı kullanılarak 0.05 önem düzeyinde regresyon analizi ile değerlendirilmiştir.

Analiz sonuçlarına göre, hava emişi basıncı iplik tüylülüğü için önemli bir faktördür. Hava emiş basıncındaki artış, eğirme silindirleri ve lifler arasındaki kayma miktarını azaltmaktadır (2). Bu sebeple, yüksek hava emiş basıncında, mantodaki lifler öz etrafına daha iyi sarılmakta ve iplik tüylülüğü azalmaktadır. Mantodaki lifler, kıvrımlı yapılarından ötürü iplikte tüylülüğe neden olmaktadır. Manto oranının artması ile birlikte; sarılan liflerinin oranı artmakta ve bunun sonucunda iplik tüylülüğü artmaktadır. Yüksek eğirme silindir devirlerinde, mantodaki lifler zarar görmekte ve liflerin ucundaki kancaların sayısı arttırmaktadır. Bunun sonucunda iplik tüylülüğü artmaktadır. Diğer taraftan, öz/manto oranı, eğirme silindir devri ve hava emiş basıncının polyester kesikli elyaf özlü/viskon mantolu ipliklerin düzgünsüzlük, ince yer, kalın yer ve neps sayısı özellikleri üzerinde önemli etkisi yoktur.

Anahtar Kelimeler: DREF-3 friksiyon eğirme, İplik düzgünsüzlüğü, İplik hataları, Öz/manto oranı, Eğirme silindir devri, Hava emiş basıncı.

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1. INTRODUCTION

Core spinning is a technique used to produce core sheath composite yarns. The main purpose of using core yarns is to take advantage of the different properties of components. Core yarns have a structure consisting of two components. One of the components is the core of the yarn and the other is the outer covering. While the staple fiber is used for the outer covering, the core could be continuous filament or staple fiber. The sheath of the yarn provides the staple fiber yarn's appearance and surface physical properties. The core of the yarn improves yarn tenacity and also permits the use of lower twist levels. (1).

The DREF-3 friction spinning machine has two drafting units. The first drafting unit provides core fiber lay-out through yarn axis. The second drafting unit locates wrapper fibers at right angles to the spinning drum. The sheath fibers are fed in sliver form and opened by a carding roller. The opened fibers are held on the surface of the perforated spinning drum by air suction. The perforated spinning drums move in opposite directions in contact with the yarn surface. This creates torque, thus sheath fibers wrap around the core and the core yarn structure is formed. The fibers in the core part of the yarn are almost parallel to each other and untwisted form along the yarn axis. Only wrapper fibers hold the core tightly (2). The picture of DREF-3 friction spinning system is given in Figure 1.

Spinning drum speed and the air suction pressure have important roles in the friction yarn spinning. The spinning drum alters the torque of wrapper fibers. The air suction pressure transports the fibers to the yarn formation zone and holds fibers on the surface of the perforated spinning (3).

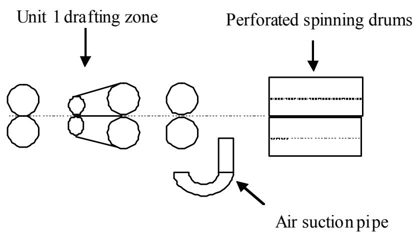

Figure 1. Dref-3 friction spinning system

Yarn unevenness can be defined as the variation in weight per unit length of the yarn or as the variation in its thickness. In addition to the overall variability of yarn thickness, the larger short-term deviations from the mean thickness are known as imperfections and they comprise thin places, thick places and neps. The hairiness of a yarn can be defined as the total number or total length of the fibres which leave from the unit yarn's surface (4).

There are many studies about the tensile properties of DREF-3 yarns but almost none of them especially focus on the unevenness, imperfections and hairiness of these yarns (2, 5 and 6). In this study, different DREF-3 core yarn structures are produced with changing core/sheath ratio, spinning drum speed and air suction pressure in friction spinning system. With the experimental results of this study we tried to understand the influence of spinning parameters on yarn unevenness, imperfection and hairiness properties.

Table 1. Experimental table of the study

Yarn linear density	Core	Sheath	Core/sheath ratio	Spinning drum speed (rpm)	Air suction pressure (mbar)
65 tex	Polyester sliver	Viscose sliver	40/60, 50/50, 60/40	2500,3000,3500	20,28,37

Table 2. Linear density of experimental yarns

Spinning drum (rpm)	Core/sheath ratio	Air suction (mbar)					
		20		28		37	
		Yarn linear density (tex)		Yarn linear density (tex)		Yarn linear density (tex)	
		Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
2500	40/60	65.29	1.52	66.21	1.53	65.59	1.75
	50/50	66.27	1.62	66.41	1.61	66.69	1.59
	60/40	66.13	1.65	66.82	1.65	66.18	1.63
3000	40/60	64.87	1.44	65.73	1.63	67.06	1.67
	50/50	67.54	1.75	68.23	1.82	65.15	1.45
	60/40	68.20	1.79	68.83	1.91	65.81	1.58
3500	40/60	65.85	1.54	66.12	1.71	65.19	1.57
	50/50	65.30	1.51	66.85	1.73	65.69	1.63
	60/40	65.55	1.58	67.28	1.84	65.70	1.53

Table 3. Uster hairiness properties of experimental yarns

Spinning drum (rpm)	Core/sheath ratio	Air suction (mbar)		
		20	28	37
		Average values of Uster hairiness	Average values of Uster hairiness	Average values of Uster hairiness
2500	40/60	11.01	10.15	10.09
	50/50	11.05	10.41	9.79
	60/40	11.07	10.15	9.23
3000	40/60	11.99	10.57	9.60
	50/50	11.59	10.54	9.97
	60/40	11.11	10.66	9.75
3500	40/60	12.99	11.54	10.47
	50/50	12.26	10.79	10.27
	60/40	11.63	10.35	9.74

Table 4. The results of regression analysis for yarn unevenness and imperfections

Yarn properties	Spinning parameters	Coefficient	Significance	R² %	ANOVA
Yarn unevenness	Core/sheath ratio (R)	0.0683	0.324	20.6	0.158
	Spinning drum speed (S)	-0.0004	0.442		
	Air suction pressure (P)	-0.0043	0.902		
Thin places	Core/sheath ratio (R)	0.651	0.218	23.6	0,110
	Spinning drum speed (S)	-0.023	0.030		
	Air suction pressure (P)	0384	0.531		
Thick places	Core/sheath ratio (R)	-0.684	0.712	2.2	0.918
	Spinning drum speed (S)	-0.019	0.603		
	Air suction pressure (P)	0.497	0.819		
Neps	Core/sheath ratio (R)	-0.698	0.543	25.7	0.83
	Spinning drum speed (S)	-0.041	0.083		
	Air suction pressure (P)	2.677	0.056		
Hairiness	Core/sheath ratio (R)	-0.026	0.004*	86.2	0.0001*
	Spinning drum speed (S)	0.0007	0.0001*		
	Air suction pressure (P)	-0.1033	0.0001*		

**Statistically significant*

2. MATERIAL AND METHOD

In this study, polyester staple fiber core/viscose sheath yarns were produced with using different spinning parameters in order to understand the influence of spinning parameters on DREF-3 yarn unevenness, imperfections and hairiness. Friction spun 65 tex yarns were produced with three different core/sheath ratio × four different spinning drum speed × three different air suction pressure, with 4200 rpm constant opening roller speed and 100 m/min constant production speed. The experimental table of the study is given in Table 1.

The polyester fibers and viscose fibers which were used in the study had 38 mm and 35.48 mm fiber lengths with 1.2 denier and 1.42 denier finenesses. Both polyester and viscose fibers were second drawframe slivers with 2.65 ktex and 4.85 ktex linear densities respectively.

The production of experimental yarns was done at DREF-3 friction spinning machine at Textile Technique Institute of RWTH University. All yarn samples were tested for unevenness, thin places, thick places, neps and hairiness with Uster Tester 3, at a speed of 200 m/min for 5 minutes.

In one of previous researches, it is indicated that the sliver feeding position influences the core yarn twist structure. Owing to this, the feeding position of polyester and viscose slivers were kept same in the production of whole experimental yarns of our study (7).

3. RESULTS AND DISCUSSION

The linear densities, standard deviation values and hairiness results of polyester staple fiber core/viscose sheath DREF-3 yarns are given in Table 2 and Table 3 respectively.

In order to understand the influence of spinning parameters on yarn unevenness, imperfections and hairiness the experimental results were evaluated with regression analysis using SPSS statistical program at 0.05 significance level. In the regression analysis; while core/sheath ratio, spinning drum speed and air suction pressure are independent parameters, yarn hairiness, unevenness, the number of thin places, thick places and neps are dependent parameters.

According to regression variance analysis; core/sheath ratio, spinning drum speed and air suction pressure are not significant factors for the unevenness, the number of thin places, thick places and neps. However; core/sheath ratio, spinning drum speed and air suction pressure have significant influence on hairiness property of yarns. The coefficients and significance levels of independent parameters which were found with regression analysis for yarn unevenness and imperfections are given in Table 4.

Obtained relation between yarn hairiness and spinning parameters is given in Equation 1. The relation between observed spinning parameters and yarn hairiness are presented in Figure 1 and Figure 2.

$$\text{Yarn hairiness} = [12.56 - 0.026(R) + 0.0007(S) - 1.033(P)] \quad (1)$$

The influence of core/sheath ratio: In core yarns, most wrapper fibers are in buckling and helically wound position due to wrapper fiber feeding system (2) and this creates more hairiness in yarn. Based on the regression analysis, the core/sheath ratio is a significant factor on hairiness. At higher core ratio levels, sheath ratio decreases and thus yarn hairiness decreases.

On the other hand the core/sheath ratio does not have any significant influence on unevenness, the number of thin places, thick places and neps.

The influence of spinning drum speed: The spinning drum speed is a highly significant factor for physical properties of yarn as it provides the radial force to wrap sheath fibers around core (2). Based on the statistical analysis, the spinning drum speed has a significant influence on hairiness; at higher spinning drum speed yarn hairiness increases. This could be explained by the wrapper fibers; at higher spinning drum speed, the hooked wrapper fibers in the yarn increase. As a result, wrapper fibers could not be wound around the core, protrude from the yarn body and cause hairiness.

The spinning drum speed was found as a non-significant factor on the unevenness, the number of thin places, thick places and neps in this study. However, in one of the previous researches, it is found that in polyester staple fiber core/polyester sheath yarn spinning, the speed of spinning drum

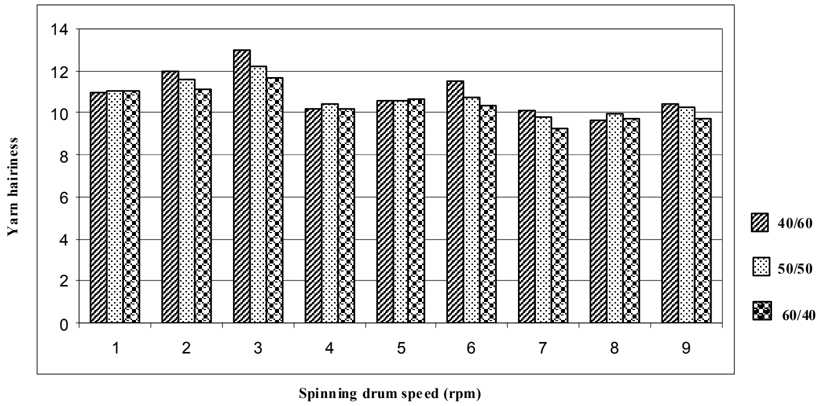

Figure 2. The relation between spinning drum speed and yarn hairiness for three different

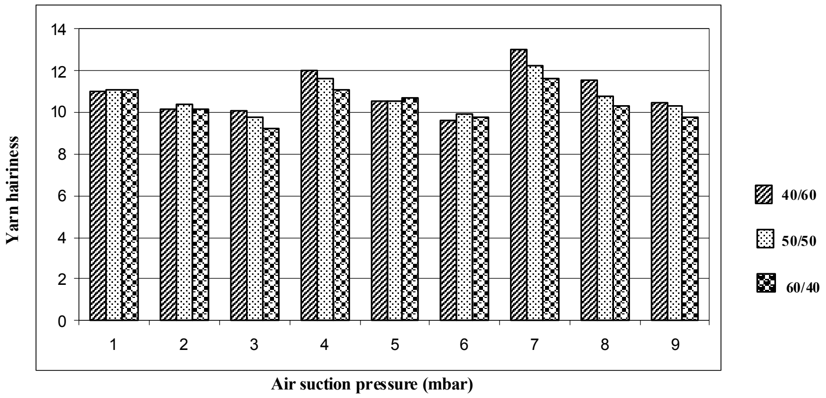

Figure 3. The relation between air suction pressure and yarn hairiness for three different core/sheath ratios

is a highly significant factor for the number of thick places. The number of thick places was significantly higher at higher spinning drum speeds (2). It is assumed that, the relation between spinning parameters and friction spun core yarn imperfections changes according to sheath material type.

The influence of air suction pressure: The air suction pressure has a significant influence on hairiness. At higher air suction pressure the slippage between fibers and spinning drum decreases (2) and wrapper fibers wound better around core and as a result yarn hairiness decreases.

Based on the statistical analysis, the air suction pressure is not a significant factor on the unevenness, the number of thin places, thick places and neps.

4. CONCLUSION

- According to statistical analysis; the air suction pressure has the most significant influence on yarn hairiness compared to other parameters which were observed in this study. At higher air suction pressure, yarn hairiness decrease due to better wrapping of sheath fibers around yarn.
- The increase of core/sheath ratio decreases yarn hairiness due to less wrapper fibers in the yarn.
- At higher spinning drum speed, yarn hairiness increases due to increase of the short hooked wrapper fibers in the yarn.
- Core/sheath ratio, spinning drum speed and air suction pressure are not significant factors on the unevenness, the number of thin places, thick places and neps of the polyester staple fiber core/viscose sheath yarn.

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