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The Effect of the Ring Spinning Machine Top Drafting Roller Hardness and the Fiber Blend Ratio on the Quality of Yarn

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ABSTRACT

In the ring-spinning machine, where the fibers are transformed from roving form into yarn, a higher draft is applied when compared to the draw frame and roving frame. Controlled transfer of fibers exposed to this draft is important in terms of reducing draft irregularities. For this purpose, the effect of changing the roller hardness on the yarn quality was investigated. Two different experimental factors were chosen to investigate: the effect of roller hardness and fiber type on yarn quality. The first factor was the top roller hardness at three different lower levels, 70, 76 and 83 Shore (A). The second factor, the fiber type, had two levels as acrylic and acrylic-cotton. In this context, two different Ne 20/1 100% acrylic and Ne 20/1 50-50% cotton-acrylic yarns had produced. Unevenness, thin/thick place, neps, hairiness and strength tests had carried out on the spun yarns. When the results obtained were examined, it was determined that acrylic blended yarns had better unevenness values and more strength than cotton-acrylic blended yarns. As a result of this study, it was found that the roller hardness was a parameter affecting fiber transfer, the upper roller hardness and the fiber type affected the yarn quality.

Ring İplik Makinesinde Manşon (Üst Silindir) Sertliğinin Farklı Elyaf Karışımlarında Üretilmiş İplik Kalitesine Etkisinin Araştırılması

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ÖZ

Liflerin fitil formundan ipliğe dönüştürüldüğü ring iplik makinasında, cer ve fitil makinasına göre daha yüksek çekim uygulanır. Bu çekime maruz kalan liflerin kontrollü transferi çekim düzensizliklerinin azaltılması açısından önemlidir. Bu amaçla silindir sertliğinin değiştirilmesinin iplik kalitesine etkisi araştırılmıştır. Silindir sertliği ve elyaf tipinin iplik kalitesi üzerindeki etkisini araştırmak için iki farklı deneysel faktör seçilmiştir. İlk faktör, 70, 76 ve 83 Shore (A) olmak üzere üç farklı alt seviyedeki üst silindir sertliğiydi. İkinci faktör olan elyaf türü, akrilik ve akrilik/pamuk olmak üzere iki seviyeye sahipti. Bu kapsamda iki farklı Ne 20/1 100% akrilik ve Ne 20/1 50-50% pamuk-akrilik iplik üretildi. Eğrilen iplikler üzerinde pürüzlülük, ince/kalın yer, neps, tüylülük ve mukavemet testleri yapılmıştır. Elde edilen sonuçlar incelendiğinde, akrilik karışımlı ipliklerin, pamuk/akrilik karışımlı ipliklere göre daha iyi düzgünsüzlük değerlerine ve daha fazla mukavemete sahip olduğu anlaşılmıştır. Bu çalışma sonucunda merdane sertliğinin elyaf transferini etkileyen bir parametre olduğu, ön üst silindir sertliğinin ve elyaf tipinin iplik kalitesini etkilediği tespit edilmiştir.

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1. Introduction

Many methods have been developed for short fiber spinning from past to present, and in this context, ring spinning has been the most preferred short fiber yarn production method. The conventional ring spinning technique, which constitutes approximately 80-90% of the spinning machines in the global market, is the first spinning technique that actually works according to the real twist principle. The yarn industry of the early 1900s, which considered the success as the producing the target yarn count only, now attempts to incorporate many desired features in the yarn with the help of the technological progress it has today.

Many of the studies on ring spinning so far had focused on drafting roller properties. The effect of front and rear top drafting roller diameters on carded ring yarn quality was investigated and reported that various types of top front roller coatings could affect the final yarn quality significantly (Zeybek, 2020;2). Besides, the fiber type, yarn count, usage area of the yarn, machine construction and the quality control tests carried out in the factories play an important role in the selection of the upper front roller coatings (Akbar et al., 2017). In another study, the effects of traveler, upper front roller and clip types on various ring yarn properties were investigated. It has been found that the components of the drafting process, especially the top rollers and the clip, have a significant impact on yarn quality and production costs in ring spinning (Kahraman, 1999).

Another key factor is determining which fibers used in the yarn blend to obtain multiple properties in the same structure. These properties can be physical, structural and easy-to-process features. In addition, the fibers can be mixed for better quality, further cost-effectiveness and improved appearance. These blends can be formed as natural-natural, synthetic-synthetic or natural-synthetic fibers in which the disadvantages of synthetic fibers can be reduced by using the advantages of natural fibers.

The aim of this study is to investigate the effects of top roller stiffness on the quality of 100% acrylic and 50-50% cotton-acrylic ring yarns in order to improve yarn quality by changing top roller hardness.

2. Material and Methods

2.1. Material

In this study, the effect of the three different top roller hardness on the quality parameters of the yarn produced from two different raw materials as 100% acrylic 50-50% cotton-acrylic and fibers was investigated. In total, six different yarn samples (3 roller hardness levels x 2 fiber raw material levels) were spun and tested. The materials used in this study are acrylic fiber, 40 mm long and 1.3 dtex thin, Dralon brand. HVI properties of cotton fiber obtained from Şanlıurfa region are given in Table 1.

Table 1. HVI properties of the cotton fiber

Fiber Property		Value
Micronaire	MIC	4.90 mic
Spinning Consistency Index	SCI	157
Maturity	Mat	%0.87
Upper Half Mean Length	UHML/Len	29.02 mm
Uniformity Index	UI	%85.5
Reflectance	Rd	71.6
Yellowness	+b	9.6
Color Grade	C Grd	42-1
Trash Count	Tr Cnt	115
Short Fiber	SF	%5.7
Strength	Str	36.7 g/tex
Elongation	Elg	%7.2

The twist levels of Ne 0.65 rovings were 26 T/m for 100% acrylic, 30 T/m for 50-50% cotton-acrylic blends. The unevenness values of both rovings are given in Table 2, and the production parameters of the ring-spinning machine are given in Table 3.

Table 2. Unevenness values of the rovings

Fiber composition	U (%)	CVm	CV 1m	CV 3m
100% acrylic	2.84	3.56	1.21	0.5
50-50% cotton-acrylic	4.01	5.03	1.34	0.7

Table 3. The production parameters of the ring-spinning machine

	100% acrylic	50-50% cotton-acrylic
Yarn count (Ne)	Ne 20/1	Ne 20/1
Twist (T/m)	515	600
Twist coefficient (αe)	2.92	3.40
Spindle speed (rpm)	15500	15500

2.2. Method

The yarns samples were produced by using Zinser RM 351 Ring spinning machine at Bulut Tekstil San. ve Tic. Ltd. Şti. in Gaziantep (Fig. 1). The spinning machine had a back roller diameter of 27 mm, a middle roller diameter of 30.5 mm and a front roller diameter of 27 mm. The setting distances in the break and the main drafting zones were chosen as 65 and 44.5 mm, respectively (Schlafhorst, 2002). The break draw ratio was selected as 1.17.

Figure 1. Zinser RM 351 ring yarn spinning machine

The roller hardness were manufactured between 66-85 Shore in short fiber spinning (Saurer Group Company, 2013). For this reason, 3 different hardness levels were selected as 70, 76 and 83 Shore (°A) in 19 mm inner diameter, 30 mm outer diameter and 28 mm width dimensions. The top rollers and their coatings used in this research were produced by Bulut Tekstil (Figs. 2, 3 and 4.).


Figure 2. The green (Shore 70) roller


Figure 3. The blue (Shore 76) roller


Figure 4. The grey (Shore 83) roller

In order to avoid machine-induced differences, all the sample productions were spun on the same spindle with the same pressure arm and the drafting rollers. The experimental plan is given in Table 4. Then the sample yarns were tested at Uster Tester 4SE unevenness tester and Uster Tensorapid strength tester equipment in the quality control testing lab.

Table 4. Experimental plan

Experiment No	Fiber Type	Top Roller Hardness
1	100% acrylic	70
2	100% acrylic	76
3	100% acrylic	83
4	50-50% cotton-acrylic	70
5	50-50% cotton-acrylic	76
6	50-50% cotton-acrylic	83

3. Results and Discussion

In this study, the effects of 70, 76, 83 Shore top roller hardness on the quality of 100% acrylic and 50-50% cotton-acrylic ring spun yarns were investigated. When the results were analyzed, the top roller hardness had a linear increasing effect with yarn unevenness for 100% acrylic yarns (Table 5). The highest unevenness values of 100% acrylic yarns produced with gray roller coating, which is the hardest among the coatings used, were determined as 83 Shore.

This was followed by the blue roller with 76 Shore and then the green roller with 70 Shore. However, the highest unevenness value was measured at 76 Shore, followed by 83 Shore hardness for 50-50% cotton-acrylic yarn.

Table 5. Physical properties of the yarn samples spun with different top roller shore values

	100% acrylic			50-50% cotton-acrylic		
	70 Shore	76 Shore	83 Shore	70 Shore	76 Shore	83 Shore
U	8.01	8.24	8.7	8.86	9.3	8.51
-50	0	0	0	0	0.5	1
+35	13	15	32	166	233	284
+50	1	1	1.5	24	28	36
+200	0.5	1.5	0.5	44	54	60
Hairiness	8.49	8.47	8.61	7.02	7.34	7.2
RKM	21.18	21.01	20.46	13.17	12.63	12.95

While the +35% thick place values of the 100% acrylic yarns produced with 70-76-83 Shore cots increase with hardness, -50% thin place, +50% thick place and +200% nep values were measured close to zero. However, 50-50% cotton-acrylic blends compared to pure acrylic yarns had much higher values as seen in Figures 5 and 6. In addition, -50, +35 and +50 imperfection values were found to be highest for roller with the hardest surface of 83 Shore for 50-50% cotton-acrylic blends.

Despite of no neps in 100% acrylic yarn, there were significant nep values in cotton blended yarn. The effects of hardness became significant for cotton-acrylic blend yarn where the harder the surface, the higher the nep number (Fig 6). However, the hairiness values higher for acrylic yarns compared with cotton-acrylic blend yarn may be caused by lower twist level.

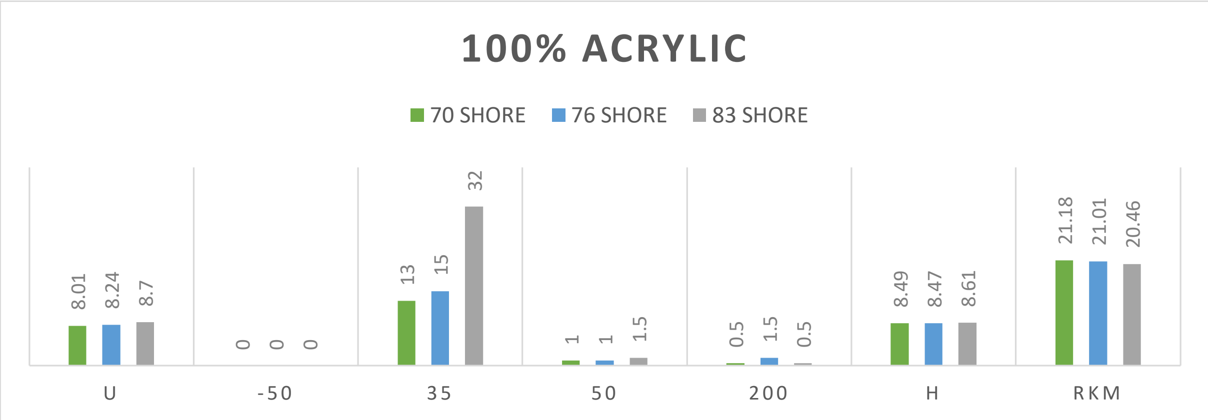

Figure 5. Unevenness and strength values of acrylic yarn

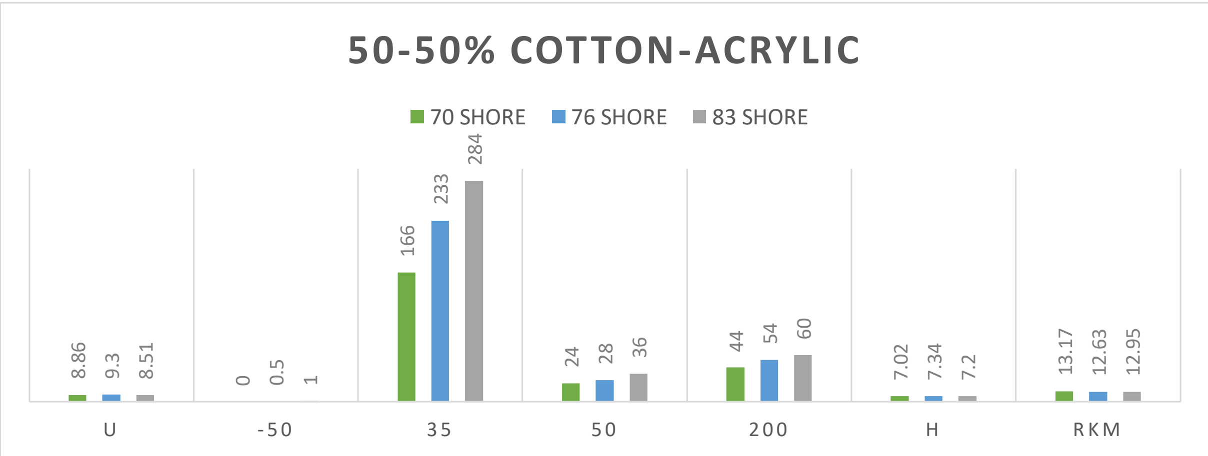

Figure 6. Unevenness and strength values of 50-50% cotton-acrylic yarn

Although 100% acrylic yarn had lower twist level, the strength of 100% acrylic yarn was measured around 21 RKM, while cotton-acrylic blended yarn had approximately 13 RKM. The strength and unevenness had similar behavior indicating that acrylic fibers were transferred more evenly and regularly between the drafting zones than fibers in cotton-acrylic blend. The softest 70 Shore green top roller exhibited the highest strength because the fibers could become more arranged and parallel to be as they pass through the draft zone.

The ring spinning machine, in which the fibers are converted from roving form to yarn, applies higher draft than the draw frame and roving frame. The controlled application of this high amount of draft significantly affects the quality of the yarn to be produced (Çolak, 2020; Akbar et al, 2017). In our study, It was determined that the roller surface hardness affected the arrangement of the fiber bundles in the drafting region. Besides differences between properties of cotton and acrylic fibers such as length, fineness, surface friction, cohesion etc. change fiber transferring behavior in the drafting zone.

4. Conclusion

The top roller types of the ring-spinning machine drafting system can cause very different effects on the yarn. Most of the studies on ring spinning systems so far have focused on top roller covering hardness of the drafting system. In this study, interaction between top roller hardness and yarn structures on quality parameters were investigated. From the data set obtained under completely controlled conditions the hardness of the top roller was one of the parameters that effect the fiber traction in the drafting zone. Therefore, fiber type, final yarn count and the operating conditions play an extremely important role in determining the type of top roller covering. Considering these factors, selection should be made according to the hardness and type of the top roller covering.

Statement of Conflict of Interest

Authors have declared no conflict of interest.

Author's Contributions

The contribution of the authors is equal.

References

Akbar AR., Zeshan M., Neaz M., Cai Y., Lin L. Effect of ring machine front roller rubber cot hardness on properties of coarser yarn. MATEC Web of Conferences 2017; 130(2): 278-291.

Çolak SS. Kesikli akrilik lif ve karışımlı ipliklerin üretim parametrelerinin iplik ve kumaş özelliklerine etkisi. Uludağ Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi, Bursa, Türkiye, 2020.

Erkan M. Pamuk lifi ile uyumlu sentetik lif karışımlarından iplik ve kumaş üretilip özelliklerinin karşılaştırılması. Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, Isparta, Türkiye, 2013.

Kahraman Ş. Ring iplik makinalarinda bazi üretim parametrelerinin iplik özelliklerine etkilerinin incelenmesi. Uludağ Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi, Bursa, Türkiye, 1999.

Mangut M., Karahan N. Doğal lifler. Bursa: Ekin Kitabevi Yayınları; 2017.

Schlafhorst S., Zinser RM 351 ring iplik eğirme makinesi el kitabı. Schlafhorst Sourer. Almanya, 2002; 1p.

Saurer Group Company, Zinser 350/450 El kitabı. DocID: D-999.08.0497. İsviçre, 2013; 22-25.

Saurer Saurer Spinning Solutions GmbH & Co. KG. Schlafhors Zinser Müşteri Dergisi 2018.

https://schlafhorst.saurer.com/fileadmin/Schlafhorst/pdf/express/ SHS18031_Expr ess_1_18 (Erişim Tarihi: 04.06.2021)

Zeybek A. Ön ve arka manşon çapı farklılıklarının karde ring iplik kalite parametreleri üzerine etkisi. Uluslararası Doğu Anadolu Fen Mühendislik ve Tasarım Dergisi 2020; 2(2): 380-400.