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Yarn Properties of Dual-Feed Rotor Spinning of Viscose Fibers.

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ABSTRACT

Opening of the fibers is performed by an opening roller, in which sliver is fed from a single place, in standard rotor spinning machines. In our previous work, we have designed a system with two feed roller that can take advantage of dual-feed rotor spinning system and extract the cotton trash. In this study, a modified Laboratory RU11 rotor spinning unit of Rieter that was fed to two separate sliver were utilized. In the experiment, 2^{nd} draw frame viscose sliver was used as raw materials. Produced yarn count was 36.2 tex. One sliver was fed from each of the two feed rollers for the new dual-feed design, and in the case of original yarn, two slivers were fed to the conventional feed roller. Tenacity, strain at peak, energy at peak, hairiness, evenness and imperfections of the produced yarns were tested and compared. To compare the properties of yarns with different spinning systems (i.e., dual-feed and conventional rotor spinning), a paired *t*-test analysis was conducted. Tenacity, strain at peak and energy at peak of the TF (Dual-feed rotor spun) yarn were more than that of the CF (conventional rotor spun) yarn. Mass CV%, thin places, thick places and neps of the TF yarn were less than that of the conventional rotor yarn. Hairiness of the TF yarn not improved in comparison with CF yarn. Finally, the dual-feed rotor spinning system could produce a yarn with better quality.

Keywords: Rotor spinning, Dual-feed system, Feed roller, Tenacity, viscose fibers

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INTRODUCTION

Important aspects of any spinning system are the fibre types that can be spun, the spinnable count range, the economics of the process and the suitability of the resulting yarn structure to a wide range of end uses. The commercial spinning of cotton yarns is performed mainly on ring and rotor spinning systems. Open end spinning has several advantages over ring spinning, such as increased production rate, separation of twisting and winding, possibilities of full automation of yarn spinning, and elimination of speed frame and winding [1]. Rotor spinning has the largest market share of the world spun yarn production after ring spinning. In the open-end (OE) spinning systems, rotor spinning is the more widely used commercially, because a wider range of yarn counts can be spun with suitable yarn properties [2]. In industrial rotor spinning machines, opening of the fibers is performed by an opening roller, in which sliver is fed from a single point [3-6]. Hajilari et al. studied the effect of applying two feed roller system in rotor spinning on yarn properties. They reported that, increasing number of feed rollers on the opening roller from one to two has improved yarn properties. In their experimental rig, it was not possible to process cotton fibers, because the trash removal zone was used for feeding a second sliver [7]. In our previous work, we have designed a system that can take advantage of dual-feed rotor spinning system and also extract the trash. The experimental rig was a modified RU04 rotor spinning unit of Rieter. Raw material used and yarn count were cotton and 29 tex respectively. Extracted trash and yarn properties produced with dual-feed system were compared with that of the original unit. We have reported that the separation of impurities and the yarn mechanical properties were improved, and imperfections were reduced [8].

MATERIALS AND METHODS

A modified Laboratory RU11 rotor spinning unit of Rieter that was fed to two separate sliver were utilized for this study. In the experiment, 2nd draw frame viscose sliver of 4.52 ktex was used as raw materials. Produced yarn count was 36.2 tex. The Opening roller and rotor speeds used in this study were 7800 and 48400 rpm, respectively. All yarn samples were spun and tested under standard conditions at 22±2°c and 65±2% RH. One sliver was fed from each of the twin feed rollers for the new dual-feed design, and in the case of original yarn, two slivers were fed to the conventional feed roller. Therefore, two yarn sets were produced. The yarns were coded as TF (dual-feed rotor spun) and CF (conventional rotor spun) yarns. Physical properties (tenacity, strain at peak, energy at peak, hairiness, evenness and imperfections) of the produced yarns were tested and compared. To measure yarn strength, we used a Testometric yarn strength tester with constant rate of extension (CRE), at a clamp speed of 600 mm/min and gauge length of 500 mm. In each case, thirty samples were tested. The yarn evenness (percentage coefficient of variation of fibre mass), imperfections and hairiness were obtained on a Changling CT200 yarn evenness tester at a speed of 200 m/min. Five samples of 200 m length, a total of 1000 m of each yarn was tested.

RESULTS AND DISCUSSION

The average test results and CV% of yarn physical properties, irregularity and imperfections for both the TF and CF yarns are summarized in Table 1. Figures 1 and 2 shows the average values of yarn properties. The detailed results are discussed below.

Table 1: Yarn properties results*

Yarn characteristic	Yarn code	
	TF	CF
Tenacity (cN/tex)	12.88(4.9)	12.03(11.7)
Strain at peak (%)	14.18(6.4)	12.36 17.4)
Energy at peak (N.m)	0.20(10.5)	0.17 (25.3)
Mass CV%	11.88(2.3)	12.35(1.4)
Thin (-40%)	6.4 (40.7)	12.0 (34.9)
Thick (+35%)	22.8 21.8)	35 (25.1)
Neps (+140%)	22 (16.7)	69 (15.0)
Hairiness (H)	4.50 (1.4)	4.61(3.2)
Yarn count (tex)	36.19(1.22)	36.22 1.95)

*the CV% values are indicated in parentheses.

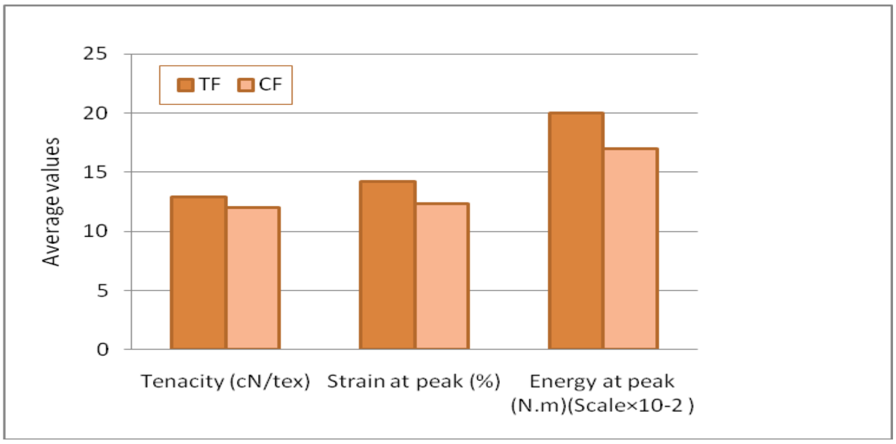

Figure 1: Average values of yarn physical properties.

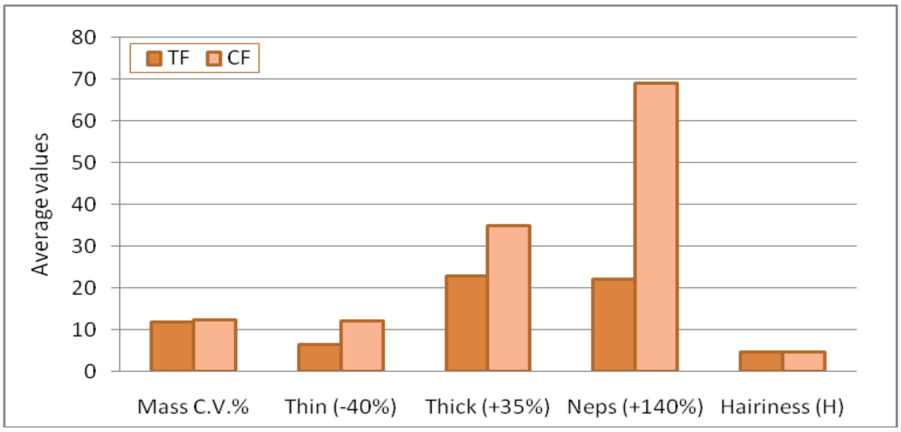

Figure 2: Average values of yarn irregularity and imperfections.

To compare the properties of yarns with different spinning systems (i.e., dual-feed and conventional rotor spinning), a paired *t*-test analysis was conducted. Table 2 shows results of *t*-test for the samples.

Table 2: Results of *t*-test

Yarn characteristic	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Tenacity (cN/tex)	11.294	.001	2.971	58	.004*
			2.971	40.370	.005**
Strain at peak (%)	9.062	.004	4.279	58	.000*
			4.279	39.161	.000**
Energy at peak (N.m)	8.863	.004	3.540	58	.001*
			3.540	42.277	.001**
Mass CV%	2.155	.180	-3.170	8	.013*
			-3.170	6.777	.016**
Thin (-40%)	.391	.549	-2.540	8	.035*
			-2.540	6.701	.040**
Thick (+35%)	3.090	.117	-2.698	8	.027*
			-2.698	6.315	.034**
Nep (+140%)	2.351	.164	-9.554	8	.000*
			-9.554	4.989	.000**
Hairiness	7.386	.026	-1.496	8	.173*
			-1.496	5.372	.191**

*: Equal variances assumed **: Equal variances not assumed.

Sig. level of all test results were less than 0.05 which means that there is significant difference between the mean values of yarn properties. The results of the analysis indicate that differences in the tenacity, strain at peak and energy at peak values of dual-feed rotor spun (TF) yarn and conventional rotor spun (CF) yarn were statistically significant at the 5% level and the tenacity, strain at peak and energy at peak of TF yarn was higher than that of CF yarn. A paired *t*-test analysis of the mass CV%, thin places, thick places and neps results in Table 2 shows that the differences in mass irregularity and imperfections of TF yarn and CF yarn were statistically significant at the 5% level and the mass irregularity and imperfections of TF yarn was less than that of CF yarn. Table 1 give the hairiness values of TF and CF yarns. Statistical analysis (paired *t*-test) reveals that the difference between the hairiness values of TF yarn and CF yarn was not statistically significant at the 5% level.

Overall results indicated that, tenacity, strain at peak and energy at peak of dual-feed rotor spun yarn (TF) was significantly higher than conventional rotor spun yarn (CF). Tenacity, strain at peak and energy at peak of TF yarn increased significantly by 7%, 15% and 18% respectively in comparison to CF yarn. Mass CV%, thin, thick places and neps of the TF yarn improved significantly in comparison to CF yarn. Mass irregularity, thin and thick places and neps of TF yarn decreased significantly by 4%, 47%, 35% and 68% respectively in comparison to CF yarn. The difference between hairiness of the TF yarn was not significant in comparison to CF yarn.

CONCLUSION

In this work, according to the test results it was concluded that, tenacity, strain at peak and energy at peak of the TF (Dual-feed rotor spun) yarn were more than that of the CF (conventional rotor spun) yarn. Mass CV%, thin places, thick places and neps of the TF yarn were less than that of the conventional rotor yarn. Hairiness of the TF yarn not improved in comparison with CF yarn. Finally, the dual-feed rotor spinning system could produce a yarn with better quality.

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