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Article

A Comparative Analysis of Tencel-Polyester Blended Ring and Compact Spun Yarns

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A B S T R A C T

Compact-spun yarns are less hairy, more extensible, stronger, and more regular and have less imperfections than their ring-spun counterparts. A rise in yarn linear density rises evenness and hairiness but declines tenacity and breaking extension. Further, the consequence of twist factor on yarn characteristics, in general, depends upon the fibrous components and tencel content.

Keywords: Blended Yarn, Compact-Spun Yarn, Tencel-Polyester Yarn, Ring-Spun Yarn

Introduction

All important characteristics of staple yarns are decisively influenced by the constituent fibre characteristics and their spreading in yarn cross-section, which, in turn, is influenced by the technology of yarn production[1-3]. In ring spinning technology, the fibre stream coming out of the drafting unit is twisted, but it can't reach at the nip of the front roller. Consequently, the contribution of fibre strength to yarn strength decline. In compact spinning, the fibre stream coming-out of the drafting unit is condensed by means of pneumatic compaction. By this compaction, the size of spinning triangle is reduced and all the fibres lie close to each other and are twisted into the body of yarn, leading to significant rise in yarn tenacity, improved yarn evenness and fewer imperfections[4]. Though the compact spun yarn has gained considerable commercial success[4-7], but there has been no systematic study on the properties of quality compact-spun yarns produced from tencel and tencel-majority blends. This paper reports the results of an exploratory study of the characteristics of tencel-polyester blended yarns spun on ring and compact spinning systems.

Materials and Methods

Sample Preparation

Two sets of yarns of 20.1 and 24.5 tex were spun from blends of polyester and tencel fibres on the conventional ring and compact spinning machines with different twist factors ranging from 32.7 to 38.9. The specifications of the tencel and polyester fibres are given in Table 1. For blending tencel and polyester fibres, each of the two components was hand opened and sandwiched well to produce a homogeneous blend. Laps were made on Trutszler's blow room line and carded on LR C-1/3 card. The carded slivers were drawn on a Lakshmi Rieters' draw frame LRSB 851. Two passages were given to carded slivers to produce a finisher sliver of 4.89 ktex. For spinning, the drawn sliver was converted into a suitable roving and then spun on a Lakshmi Rieters' ring frame LR/S using a spindle speed of 14,500 rpm. The compact yarns were spun on LMW LR6/5 ring frame using elite compacting system.

Table 1.Specifications of Tencel and Polyester Fibres

Fibre	Length mm	Linear density Dtex	Tenacity cN/tex	Breaking elongation %
Tencel	38	1.33	29.73	6.97
Polyester	38	1.33	54.69	14.23

Tests

All the yarns were tested for single strand strength and breaking extension on Instron (Model 3365), 500 mm test specimens being elongated at 300 mm/min extension rate. The breaking strength and breaking extension were averaged from 50 observations for each yarn sample. Yarn unevenness, imperfections and hairiness were recorded by an Uster evenness tester-5 (UT-5). Yarn diameter was measured on projection microscope; average diameter was calculated by taking 50 observations for each sample.

Results and Discussion

The influence of all investigational factors, viz. blend proportion, tex twist factor and spinning system, on the yarn characteristics was analyzed with the help of ANOVA (Table 2); the confidence level used was 99%.

Tenacity

Table 3 shows that compact-spun yarns are stronger than the ring-spun yarns depending upon the twist factor and yarn composition. The higher strength of compact-spun yarns has been related to the smaller spinning triangle by several researchers[4-5]. For both ring and compact yarns, the tenacity is higher in polyester-majority yarns due to the higher breaking strength and extension at break of polyester fibre which ultimately lead to yarn breaking strength [6]. In both types of yarns, the tenacity is inferior at low twist factor. It first rises with rise in twist factor and then declines with further rise in twist factor due to obliquity effect[7]. However, the reduction being less in 35:65 tencel-polyester yarns than in 65:35 tencel-polyester yarns.

Breaking Extension

The values of breaking extension of tencel-polyester ring and compact yarns spun from different fibre –mix and twist factors are given in Table 3. Invariably, the compact yarns are more extensible than ring yarns. As regards the breaking extension of yarns at different levels of twist factor, it is observed that a higher twist factor leads to a higher breaking extension. Such a behavior of yarn breaking extension could be attributed to the above mentioned

Table 2.ANOVA test results

Process variable	Tenacity	Breaking extension	Unevenness	Imperfections	Hairiness	Diameter
Yarn tex	s	s	s	s	s	s
Blend ratio	s	s	S	s	s	s
Twist factor	s	s	S	ns	s	s
Spinning system	s	s	S	s	s	s

Table 3.Effect of twist factor on tenacity and breaking extension of tencel-polyester ring- and compact-spun yarns

Yarn tex	Blend ratio (tencel -polyester)	Tex twist factor	Ring-spun yarn		Compact-spun yarn	
			Tenacity, cN/ tex	Breaking extension, %	Tenacity, cN/tex	Breaking extension, %
20.1	35:65	32.7	26.22	7.29	29.15	8.82
		35.2	26.83	7.43	28.97	8.99
		38.9	23.67	7.54	26.85	9.04
20.1	65:35	32.7	16.87	5.33	20.57	5.92
		35.2	17.42	5.42	20.89	6.17
		38.9	15.97	5.71	18.90	6.28
24.5	35:65	32.7	28.67	7.67	30.53	9.11
		35.2	29.19	7.76	30.78	9.27
		38.9	27.68	7.91	28.78	9.49
24.5	65:35	32.7	18.69	5.69	21.07	7.23
		35.2	18.97	5.87	21.37	7.34
		38.9	17.27	6.07	19.67	7.41

factors[8]. Moreover, the values of breaking extension are significantly lower for fine yarns than for coarse yarns and these further decreases as the tencel content increases. The lower breaking extension of 65:35 tencel-polyester yarn compared to its 35:65 tencel-polyester counterpart arises as a result of widely differing breaking extension of the constituents fibres.

Mass Irregularity and Imperfections

The fact that the coarse yarns are more regular as compared to fine yarns also holds true for compact spun yarns. However, the evenness considerably deteriorates as the tencel content is augmented in the fibre-mix. As may be seen from Table 4, the use of higher twist factor produces more irregular yarns, the increase in irregularity being significant[8].Furthermore, compact spun yarns display less irregularity than ring spun yarns irrespective of yarn composition and twist factor.

Table 4 shows that compact spun yarns have fewer imperfections than ring -spun yarns irrespective of yarn composition and twist factor. The reduced spinning triangle and better integration of fibres in the yarn cross-section appear to be partly responsible for lower frequency of imperfections in compact yarns[4]. Further, an increase in imperfections with increase in tencel content can also be observed due to fibrillar nature of this fibre, which, in turn, leads to formation of fibre bunch during drafting.

Hairiness

The hairiness differences between ring and compact yarns of identical linear density determined on the Uster evenness tester are clearly seeming in Table 5 Invariably; compact-spun yarns exhibit less hairiness than the ring-spun yarns. Also, the change in hairiness related to twist factor is evident in both types of yarns, the lower the twist factor, the higher is the hairiness[6].Significantly, however, hairiness of both types of yarns displays a noticeable increase with change in tencel content. The hairiness data for both types of yarns show a marked increase in hairiness due to yarn structure.

Yarn Diameter

Table 5, shows the variation of diameter of tencel-polyester ring- and compact-spun yarns with yarn composition and twist factor. As expected, compact- spun yarns exhibit smaller diameter than their ring-spun counterparts. This can be accounted for by the role played by the spinning triangle, which, in turn, leads to better integration of fibres into the body of yarn[6]. For both types of yarns, the diameter reduces significantly with the increase in twist factor due to the expected increase in packing coefficient, which, in turn, reduces yarn diameter[6]. Moreover, the values of yarn diameter are significantly lower for fine yarns than for coarse yarns and these further reduces significantly as the tencel content increases due to high density fibre.

Conclusions

1. Ring yarns are less strong and less extensible as compared to compact spun yarns. The tenacity of all the yarns initially increases and then decreases with increase in twist factor. Both these yarn characteristics register lower values with increase in tencel content in the fibre-mix.
2. Compact yarns, at all levels of twist, are more regular and have fewer imperfections than ring-spun yarns.

Table 4.Effect of twist factor on unevenness and imperfections of tencel-polyester ring-and compact-spun yarns

Yarntex	Blend ratio (tencel -polyester)	Tex twist factor	Ring-spun yarn		Compact-spun yarn	
			Unevenness, U%	Imperfections/ km	Unevenness, U%	Imperfections/ km
20.1	35:65	32.7	11.2	199	10.3	82
		35.2	11.7	223	10.6	97
		38.9	12.1	297	10.9	116
20.1	65:35	32.7	14.6	763	11.6	159
		35.2	15.1	813	11.7	187
		38.9	15.7	854	11.9	228
24.5	35:65	32.7	8.9	51	8.7	28
		35.2	9.1	63	9.0	32
		38.9	9.6	72	9.2	41
24.5	65:35	32.7	13.6	201	9.5	57
		35.2	14.0	262	9.8	65
		38.9	14.2	283	10.0	79

Table 5.Effect of twist factor on hairiness and diameter of tencel-polyester ring-and compact-spun yarns

Yarn tex	Blend ratio (tencel-polyester)	Tex twist factor	Ring-spun yarn		Compact-spun yarn	
			Hairs/cm	Diameter, mm	Hairs/cm	Diameter, mm
20.1	35:65	32.7	4.83	0.2094	3.39	0.1747
		35.2	4.61	0.2057	3.32	0.1701
		38.9	4.47	0.1999	3.22	0.1689
20.1	65:35	32.7	4.87	0.1989	3.66	0.1689
		35.2	4.79	0.1976	3.57	0.1667
		38.9	4.71	0.1927	3.46	0.1623
24.5	35:65	32.7	5.17	0.2267	3.84	0.1837
		35.2	5.06	0.2197	3.73	0.1805
		38.9	4.96	0.2125	3.63	0.1783
24.5	65:35	32.7	5.59	0.2119	4.27	0.1793
		35.2	5.37	0.2078	4.09	0.1776
		38.9	5.19	0.2023	3.89	0.1747

For both ring- and compact-spun yarns, evenness deteriorates markedly with increasing twist factor; however, a decrease in tencel content minimizes the deterioration in quality of both types of yarns.

3. Ring spun yarns shows more hairy than compact spun yarns. Yarn hairiness reduces with increase in twist factor, it is an important factor in controlling hairiness; a lower value leads to more hairiness. An increase in tencel content, hairiness value for all type of yarns enhances.
4. Compact spun yarn exhibit less diameter as associated to equivalent ring spun yarns, with intensification in both twist factor and tencel content, diameter reduces for both type of yarns.

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