AUTEX Research Journal, Vol. 3, No3, September 2003 © AUTEX

VORTEX SPUN YARN VS. AIR-JET SPUN YARN

Guldemet Basal and William Oxenham

College of Textiles, North Carolina State University, Raleigh, North Carolina, USA
gbasal@unity.ncsu, William_Oxenham@ncsu.edu

Abstract

Vortex spinning can be viewed as a refinement of jet spinning, or a natural development in fasciated yarn technology. As in all other fasciated yarns, the structure of vortex yarn consists of a core of parallel fibres held together by wrapper fibres. This has been revealed by examining an untwisted vortex yarn sample under the Scanning Electron Microscope. Subsequently, the physical properties of vortex and air-jet yarns produced from different polyester cotton blends were compared. Results indicated that vortex yarns have tenacity advantages over air jet yarns, particularly at high cotton contents.

Keywords:

yarn spinning, vortex spinning, air-jet spinning, vortex yarn structure

Introduction

Yarn structure is one of the primary factors which control the properties of spun yarns. Vortex-spun yarn has a two-part structure. This can be simply revealed by untwisting a vortex yarn by hand. Because the yarn is a relatively small component, any more reliable conclusion requires visual aid. As a first step in such study, a piece of vortex yarn was untwisted and viewed under the Scanning Electron Microscope. Since none of the conventional twist measurement methods are suitable for vortex spun yarns, the untwisting was performed with the aid of an optical microscope, and the completion of untwisting was visually confirmed. SEM images confirmed that vortex yarns consist of two distinctive parts: the core and the sheath. In the images, the sheath part appeared looser due to removed twist (Figure 1).

Only limited information was obtained through the SEM images. In order to broaden our knowledge about this new and fascinating yarn technology, the next logical step was to compare the properties of air-jet and vortex yarns. Although both systems are used to spin fasciated yarns, no work has been reported to date regarding the difference between these yarns. A study was conducted to reveal the difference between the properties and structure of the vortex and air-jet spun yarns. In the first part of this study, the properties of vortex and air-jet spun yarns made from various PES/cotton blends were compared. In the second part, vortex and air-jet yarns produced from three different blends of cotton and black polyester fibres were visually examined under an optical microscope.

Experimental

For the first part of the study, five different blend ratios (83/17, 67/33, 50/50, 33/67, and 17/83) were obtained from polyester and carded cotton slivers by blending them on the draw frame. Table 1 shows the properties of cotton and polyester fibres used in this study. After three passages of drawing, the slivers were transferred to MJS and MVS machines. Table 2 displays the process parameters used on the MJS and MVS systems.

Spinning pure cotton and the polyester/cotton blend with 83% of cotton ratio was not possible for MJS system. In fact, when the blend ratio of polyester was less than 50%, it was very difficult to spin yarn with an acceptable end-break level on this system. The MVS system successfully produced yarns from 100% polyester and polyester/cotton blends, but spinning 100% cotton was not successful. One possible reason is the high short-fibre content of cotton slivers.

The quality parameters of the yarns produced were evaluated on an Uster Evenness Tester, the Uster Tensorapid with a testing speed of 250 mm/m and the Uster Tensojet with a testing speed of 400m/m.

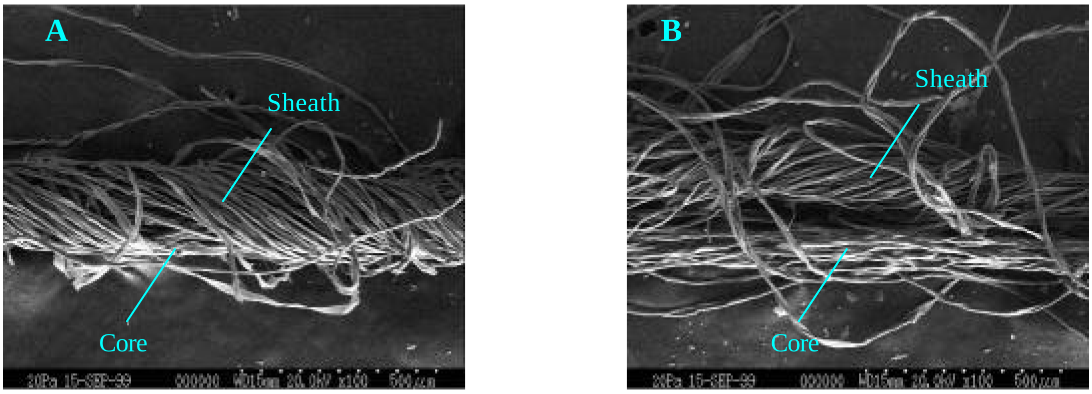

Figure 1. SEM pictures of vortex yarn (A- before untwisting; B-after untwisting)

Table 1. Fibre Properties

Fibre Type	Upper Quartile Length (mm)	Mean Fibre Length (mm)	Fineness	
			denier	micronaire
Cotton	27.2 mm			3.8
Polyester		38 mm	1	

Table 2. Process Parameters

Spinning System	MVS System	MJS System
Delivery Speed	325 m/m	195 m/m
Total Draft	151	151
Main Draft	51	44.87
Take-up Ratio	0.99	0.99
Nozzle Type	75, Holder 130d, 8.8	H26
Air Pressure (kg/cm^2)	N1 5.5	N1 2.5, N2 4.0
Feed ratio	1.00	0.97
Condenser/Spindle	Spindle 1.3 mm	Condenser 4 mm
Roller Settings	36-36-49	39-42
Yarn Count	36's Ne	36's Ne

In the second part of the study, in order to compare the basic structure of vortex and air jet yarns, blended yarns were produced from three different blends of black polyester (1.7 den, 1.5 in) and cotton fibres (4.1 mic., 0.91 in) (blend ratios: 33/67, 50/50, 67/33). These yarns were examined under an optical microscope to discover any possible tendencies of cotton or polyester fibres to become either wrapper or core fibres in blended yarns. Besides the visual examination of the yarn structure, the evenness and tensile properties of these yarns were tested on the Uster Evenness Tester and the Uster Tensorapid respectively.

Results and Discussion

An analysis of variance (ANOVA) was performed to determine the statistical significance of any differences observed between the properties of vortex and air-jet spun yarns. The ANOVA revealed that yarns made by the MVS had superior evenness, fewer thick places and lower hairiness values compared to those made by the MJS (Figure 2 and Table 3). Vortex yarns also presented higher tenacity values for every blend ratio except for 100% polyester, where yarns from both machines had the same strength. As the cotton content increased in the blend, the difference between the tenacity of the yarn from the two systems also increased (Figure 3 and Table 4). In the case of yarn elongation, the outcome was the opposite. Vortex yarns exhibited lower elongation values compared to air-jet yarns; this offset gains in tenacity and resulted in an insignificant difference in their work of rupture values.

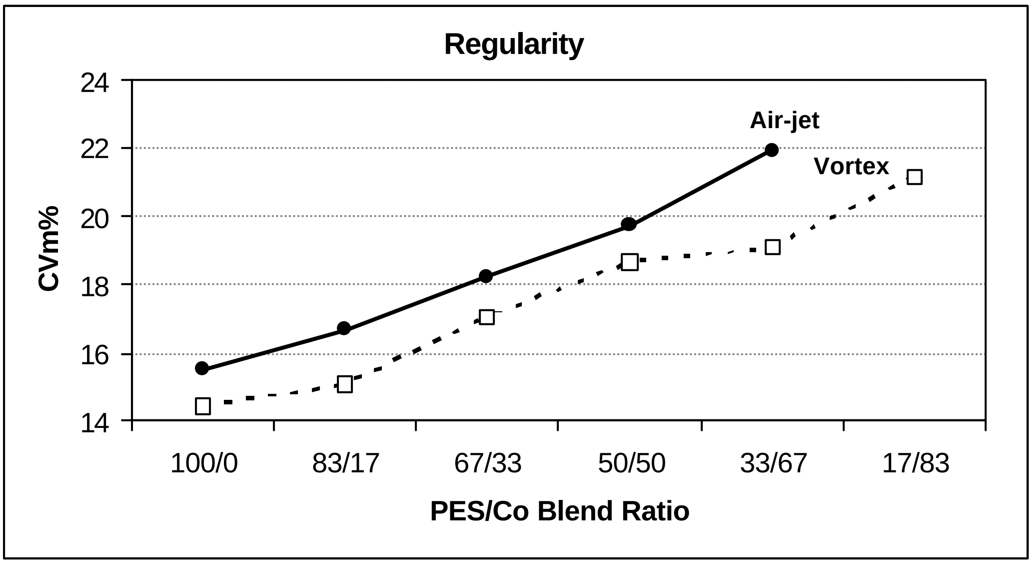

Figure 2. Comparison of evenness of vortex and air jet yarns

Table 3. Evenness, imperfection and hairiness values of vortex and air jet spun yarns

Blend Ratio PES/Co	CVm		Thin Places (-50%)		Thick Places (+50%)		Neps (+200%)		Hairiness	
	MVS	MJS	MVS	MJS	MVS	MJS	MVS	MJS	MVS	MJS
100/0	14.45	15.48	13	38	25	226	6	168	4.59	5.03
83/17	15.06	16.65	20	62	142	369	258	367	4.12	5.06
67/33	17.03	18.2	71	122	352	558	558	531	4.08	5.36
50/50	18.67	19.73	132	225	610	858	826	814	4.16	5.78
33/67	19.06	21.93	188	571	687	1164	971	1350	4.42	6.64
17/83	21.14		538		1010		1338		4.7	

Table 4. Tensile properties of vortex and air jet spun yarns

Blend Ratio (PES/Co)	Tenacity (cN/tex)				Elongation%				Work (cN.cm)			
	Tensorapid		*Tensojet*		*Tensorapid*		*Tensojet*		*Tensorapid*		*Tensojet*	
	MVS	MJS	MVS	MJS	MVS	MJS	MVS	MJS	MVS	MJS	MVS	MJS
100/0	23.43	23.4	24.95	24.03	9.57	12.87	9.29	10.47	1080.1	1281.4	1031.7	1123.8
83/17	22.07	18.95	22.52	20.49	9.63	11.37	8.85	9.71	1031	913.2	886.9	903.4
67/33	18.2	14.67	18.73	16.37	8.41	10.48	7.81	8.77	746.2	667.7	658.5	665.8
50/50	14.36	12.2	15.69	13.53	6.13	9.72	6.35	7.51	432	510.6	436.1	469.4
33/67	12.47	8.93	13.71	9.86	4.92	8.2	5.45	6.52	292.6	297.1	307.9	276.7
17/83	10.67		12.17		3.98		4.88		196.4		240.2	

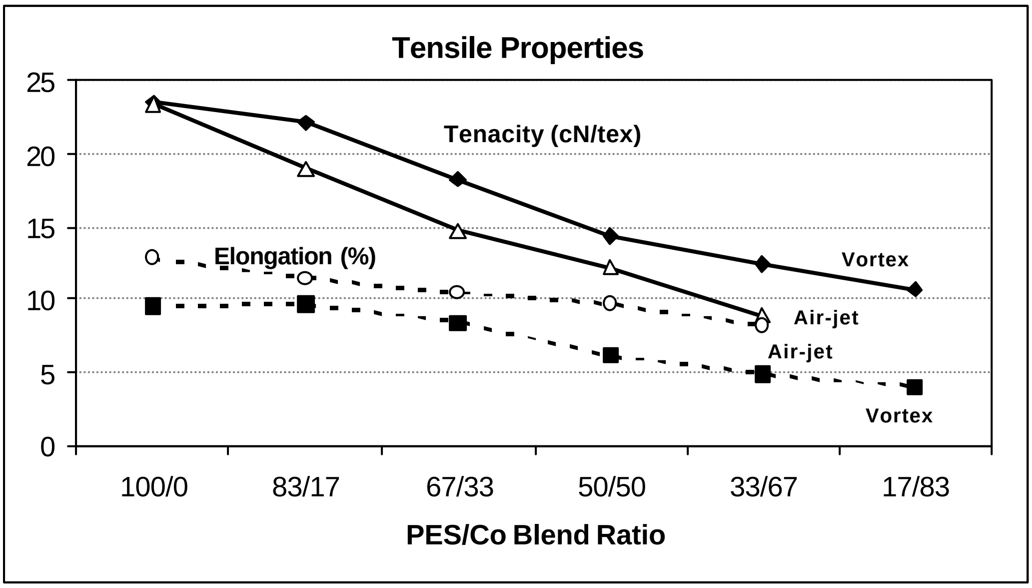

Figure 3. Comparison of tensile properties of vortex and air jet yarns (from Uster Tensorapid)

The unique structures associated with these yarns are a possible reason for the difference in yarn quality parameters. The higher tenacity values of vortex yarns can be attributed to the higher number of wrapper fibres in these yarns. The number of wrapper fibres is critical to yarn strength since they hold the internal parallel fibre bundle tightly together, and this effect is more critical for cotton fibres [2]. In air jet spinning, edge fibres ultimately produce wrapper fibres, and the number of edge fibres depends on the fibres at the outside [1,3]. On the other hand, in vortex spinning, the fibre separation from the bundle occurs everywhere in the entire outer periphery of the bundle [4]. This results in a higher number of wrapper fibres in the yarn. One possible explanation for the reduction in elongation is the decrease in fibre slippage due to better grip by wrapper fibres. Possibly the drop in hairiness values is another result of better wrapping.

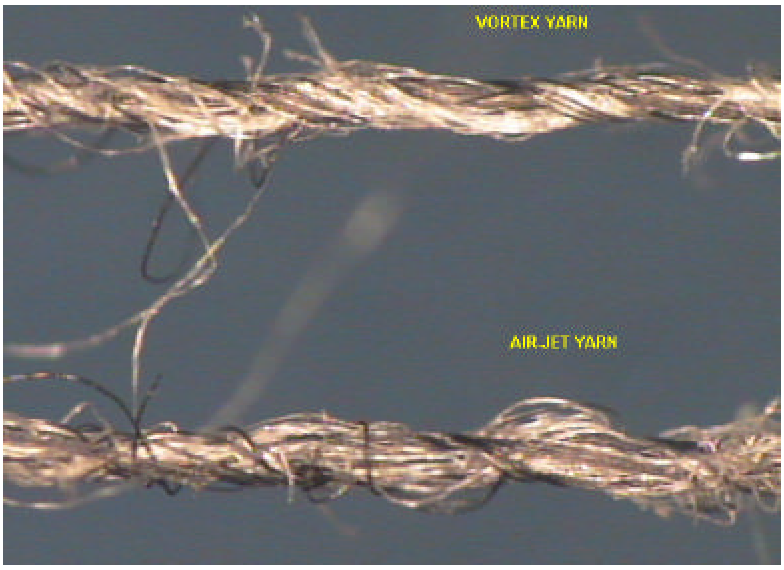

Figure 4. Vortex spun yarn versus air-jet spun yarn (28's Ne, 30/60 PES/Co)

Visual comparison of vortex and air-jet yarns showed that there were no apparent tendencies of cotton or polyester fibres to become either wrapper or core fibres in blended yarns. Although this study did not provide enough information to reach a consistent conclusion, examination of these yarns under the microscope showed that vortex yarns have a more ring-like appearance as well as a higher number of wrapper fibres compared to air jet yarns (Figure 4.)

The results from the evenness and tensile testing of these yarns confirmed the earlier findings that vortex yarns had better evenness and tenacity values compared to air-jet yarns (Figure 5 and Figure 6.)

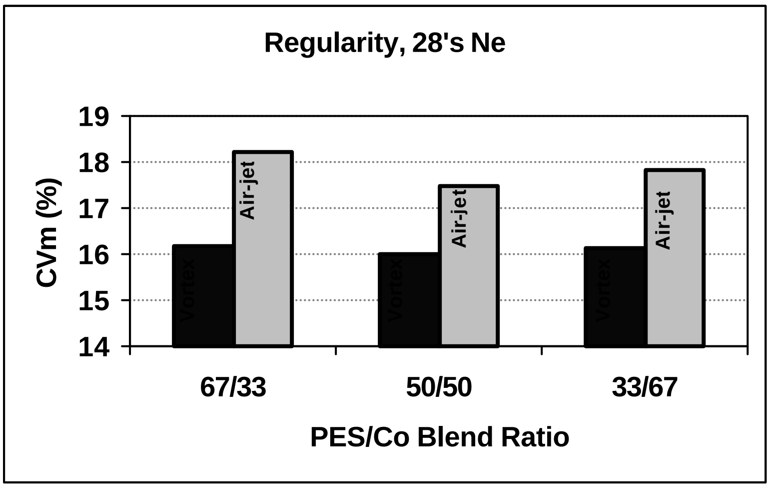

Figure 5. Yarn evenness: vortex yarn vs. air-jet yarn

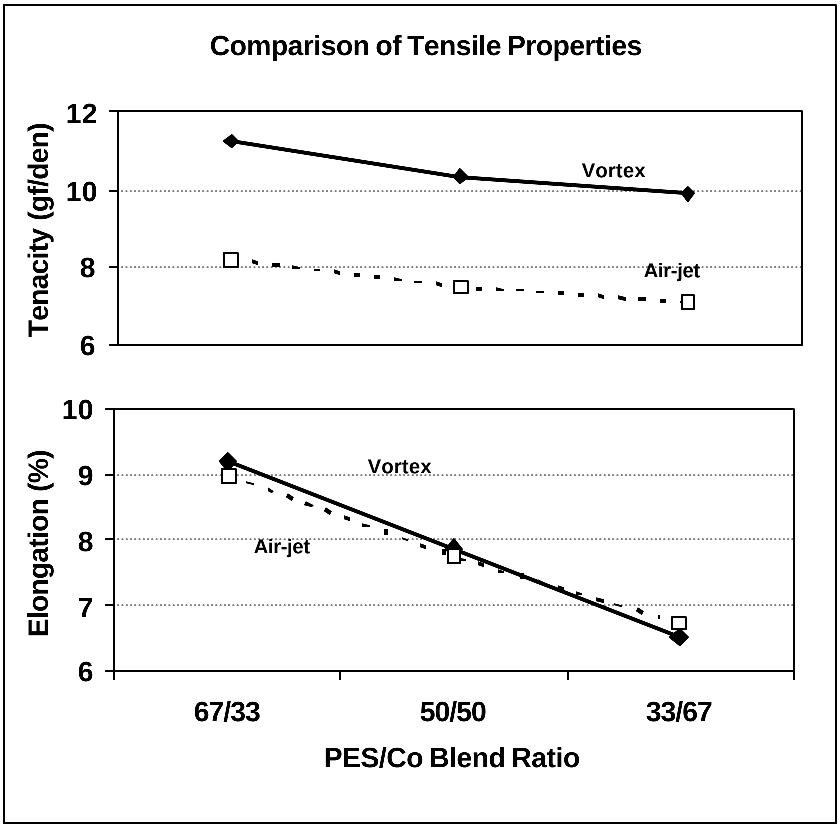

Figure 6. Yarn tensile properties: vortex yarn vs. air-jet yarn

Conclusion

This study revealed that MVS spinning technology is favourable for cotton spinning and produces a yarn with more ring-like appearance compared to MJS spinning technology. However, more in-depth study is required to understand the structure of vortex yarns.

Acknowledgements

The authors wish to thank to Dr. A. Basu, director of SITRA, for his contributions to the first part of this study. Appreciations are also extended to the National Textile Center (NTC) for their financial support (NTC Project: F99-NS06), and Cotton Incorporated for providing their facilities.

References

[1] Klein, W., New Spinning Systems. The Textile Institute Manual of Textile Technology, Stephen Austin and Sons Limited, UK, 1993.
[2] Oxenham, W. and Basu, A., 'Effect of Jet Design on the Properties of Air-jet Spun Yarns.' Textile Res. J, 63(11), 674-678(1993)
[3] Nakahara, T., 'Air-jet Spinning Technology.' Text. Tech. Int., (1988): 73-74
[4] U.S. Patent 5,528,895.