

# DEVELOPMENT OF ROTOR-SPUN YARNS FROM BLENDS OF SHORT-SHORN WOOL AND POLYESTER

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*The Texas Food and Fibers Commission provided funding for the project reported here.*

## INTRODUCTION

Yarns made from wool/polyester blends are well suited for a variety of woven and knitted textile products. Desirable characteristics of products made from these blends are comfort, strength, and wrinkle resistance. Market penetration of this blend is limited, however, by the fact that the yarns are typically spun on long staple spinning systems to accommodate the wool fibers. The global capacity of these spinning systems is small and the processing costs are relatively high. If yarn spinning could be accomplished on the short staple (cotton) spinning system, then the use of this blend could be increased.

There is no fundamental reason why the long staple spinning system must be used for wool/polyester blends. Polyester is commonly cut to lengths suitable for the cotton spinning system. Wool can be provided in these lengths by shearing the sheep twice a year instead of only once. Certainly this is feasible in sheep production areas with mild winter climates, as in the southern United States, Mexico, Australia, and South Africa. The term used for this fiber is "short-shorn wool," or SSW.

The feasibility of spinning wool blends on the ring spinning system has been demonstrated [1, 2, 3]. However, if the spinning could be successfully done on the rotor spinning system, then the manufacturing costs would be much lower and the pricing point needed for profitable production would enable greater market penetration. Past experience at the International Textile Center has shown that spinning this blend on the rotor spinning system is often not feasible [4, 5]. Nevertheless, we thought that the new Rieter R 20 spinning machine had potential for doing it, because the trash ejection channels associated with the combing rollers can be manipulated to prevent the loss of wool fibers before they pass into the rotor chamber. Even if a consistent rotor spinning process is achieved, the

ultimate challenge is to produce a yarn with sufficient strength to substitute for those produced on traditional, long staple systems. This article provides a short report on preliminary results obtained in producing 8 Ne rotor yarns.

## PROCEDURES

In tests to select appropriate machinery settings, two different polyester fibers were utilized: Wellman Type 315 and Celanese Type 221. The fineness of both was 2.25 denier and the staple length of both was 38.1mm. Texas short-shorn wool of U.S. grade 64 was used throughout the study. The mean length of the wool was 46.7mm, with a coefficient of variation of 41.4%. Intimate blends of the fibers were used throughout; in evaluating the machinery settings, the blend was 50:50 SSW/poly.

### Machinery Settings

Exhibit 1 outlines the machinery and some of the major settings used to process the fibers. All stages up to the spinning were handled in a typical fashion for this blend of fibers. It should be emphasized, however, that a well adjusted, cotton-system opening line operating on the short staple wool and polyester provides excellent cleaning and blending—both of which are critical for successful rotor spinning.

At the spinning machine numerous modifications were tested. The most important one was to partially close off the trash ejection channels below the combing rollers of the R 20. This proved to be necessary to facilitate the flow of wool fibers into the rotor. Following preliminary study of key machine variables, the major tests made are discussed below. (Note: Unless otherwise indicated, tests were done using the 50:50 blend containing Celanese T221 polyester.)

<b>TEXTILE TOPICS</b>	Published quarterly
a research bulletin on fiber and	Texas Tech University
textile industries.	International Textile Center
Fall 1999 - Issue 4	P.O. Box 45019
	Lubbock, TX 79409-5019

### Combing Rollers

Preliminary spinning was done using three different combing rollers: OS21DN (standard gage, diamond coated and nickel plated), OS21/6DN (6mm gage, diamond coated and nickel plated), and regular pin-type rollers. Results, summarized in Exhibit 2, revealed a slight advantage in yarn strength with the OS21DN; therefore, this combing roller was used to spin all the yarns for this study.

### Combing Roller Speeds

Preliminary spinning was done using three different speeds for the combing roller: 6,500 rpm, 7,000 rpm, and 7,500 rpm. Results, summarized in Exhibit 3, did not reveal any notable differences in yarn qualities among the speeds; therefore, 7,500 rpm was used for all yarns spun.

### Rotor Types and Speeds

Preliminary spinning was done using two different rotor speeds (70,000 rpm and 61,110 rpm) in combination with three rotors of differing diameters and/or surface finishes (35mm SB, 40mm SE, and 40mm SB). The speed of 61,110 rpm was too slow for the 35mm rotor, but all other speed/diameter combinations were feasible. Results are summarized in Exhibit 4. Clearly, at 70,000 rpm the 35mm SB rotor is best. However, at 61,110 rpm there are no significant quality differences between the two 40mm rotors. Comparing the results for 40mm rotors at 61,110 rpm with those for the 35mm rotor at 70,000 rpm, there are no significant differences except for CV%, thin places and thick places. For these three quality variables, the 40mm rotors run at the slower speed give better results.

Since, as expected, the yarns do not have great strength, it is likely that the thin and thick places would result in higher yarn breakage during weaving. For this reason, the decision was made to utilize the 40mm SB rotor and run at 61,110 rpm.

To summarize, the set-up selected for the R 20 machine is as follows:

Rotor	
Type	40mm SB
Speed	61,110 rpm

Navel type	4-grooved ceramic
Combing roller	
Type	OS21DN
Speed	7,500 rpm

### Yarn Twist

Using the 50:50 blend containing Wellman T315 polyester, along with the above machine set-up, spinning tests were run with alternative twist multipliers (TMs). As shown in Exhibit 5, the TM was varied from 4.2 to 4.8 in increments of 0.2. Since yarn strength and the thin and thick places improved somewhat with the higher TMs, it was decided to spin the yarns with a TM of 4.8. (By comparing yarn strength results in Exhibit 5 with those in Exhibits 2-4, the reader may observe that the Wellman fibers resulted in somewhat stronger yarns than did the Celanese fibers.)

### Yarns Spun

Using the machinery set-up given above, six different 8 Ne yarns were produced for testing (Exhibit 6). Each yarn represents a distinct combination of blend levels (50:50 SSW/poly or 60:40 SSW/poly), polyester brands (Wellman Type 315 or Dupont Dacron Type 54W SRW), and polyester deniers (1.5 or 1.0). The smaller denier values were used at this point in the study primarily to observe the impacts of the finer polyester fibers on yarn strength. The 10% increase for wool in the blend level was done to observe how great was the tendency for strength loss as wool is added.

## RESULTS

The focus is on the six yarns identified in Exhibit 6. Major results of the yarn testing are given below.

- Yarn strength results are summarized in Exhibit 7. For the 1.5 denier polyester fibers, the Dupont fibers produced a somewhat stronger yarn than did the Wellman fibers for the 50:50 blend (yarn #1 vs. yarn #2), but not for the 60:40 blend (#3 vs. #4). For the 1.0 vs. 1.5 denier Wellman fibers, the strength is greatly increased for the 50:50 blend (#5 vs. #1), but not for the 60:40 blend (#6 vs. #2). Clearly, the loss in strength occurs quickly when wool is increased beyond the 50:50 blend level (#1, #2 & #5 vs. #3, #4 & #6). On the average, a 20% loss in yarn strength resulted from the 10% increase

in wool fibers.

- Yarn Imperfection values are summarized in Exhibit 8. It reveals no significant differences in imperfections across the six yarns. All of the imperfection values are at good levels; furthermore, the visual appearance of these yarns was quite good.

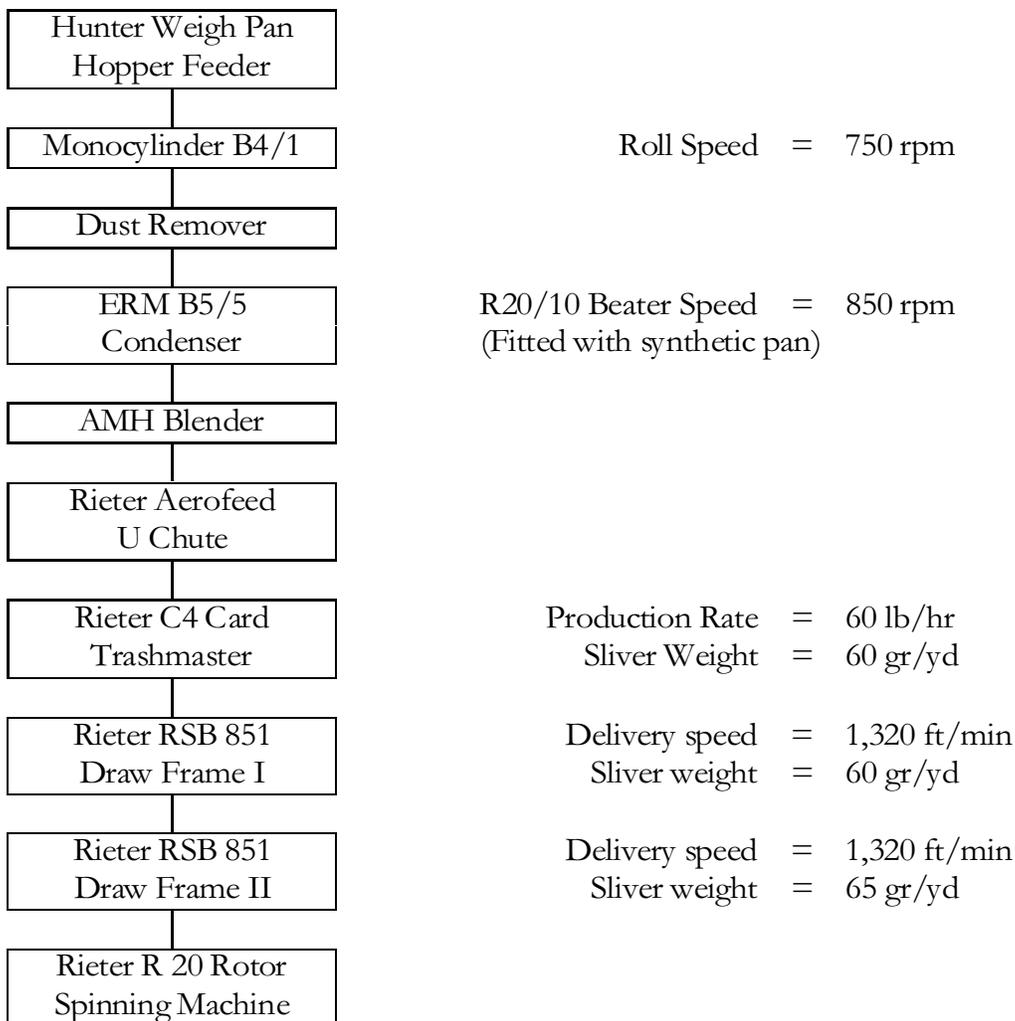
### CONCLUSION

This study indicates that there is potential for making high-quality yarns and fabrics with SSW/poly blends on the rotor spinning system. If so, the yarn manufacturing costs would be greatly reduced from those incurred with long staple spinning systems. At the time this study was done, the pricing point for wool/poly yarns

made from the long staple system was approximately \$5.00 /pound; for this rotor-spun yarn, we think a profitable pricing point would be approximately half that amount.

It seems that yarn and fabric appearance would be adequate with this process—if acceptable yarn strength and fabric durability can be achieved. Given the observed sensitivity of yarn strength to the wool content, further testing should explore the use of lower percentages of wool in the blend. Since 65:35 poly/wool blends have exhibited large-scale popularity in the clothing market, producing a comparable yarn and fabric using a 65:35 poly/SSW blend should be evaluated.

### EXHIBIT 1: OUTLINE OF MECHANICAL PROCESS FOR BLENDS OF SHORT SHORN WOOL AND POLYESTER



**EXHIBIT 2: EFFECTS OF COMBING ROLLERS ON YARN PROPERTIES**

Roller Type	CSP	Tenacity	Elongation	Mass CV	Thin Places	Thick Places	Neps	Hairiness
	(Ne • lb)	(cN/tex)	(%)	(%)	(no/ky)	(no/ky)	(no/ky)	
OS21DN	1822	11.03	21.15	15.30	29	103	6	7.61
OS21/6DN	1757	10.88	20.66	15.35	29	111	6	7.51
Pin Roller	1658	10.27	18.12	15.00	18	88	7	7.72

**EXHIBIT 3: EFFECTS OF COMBING ROLLER SPEED ON YARN PROPERTIES**

Roller Speed	CSP	Tenacity	Elongation	Mass CV	Thin Places	Thick Places	Neps	Hairiness
(rpm)	(Ne • lb)	(cN/tex)	(%)	(%)	(no/ky)	(no/ky)	(no/ky)	
6,500	1864	11.08	21.83	15.43	30	106	12	7.60
7,000	1811	10.88	21.20	15.30	27	98	8	7.65
7,500	1822	11.03	21.15	15.30	29	103	6	7.61

**EXHIBIT 4: EFFECTS OF ROTOR TYPE AND SPEED ON YARN PROPERTIES**

Rotor Type*	CSP	Tenacity	Elongation	Mass CV	Thin Places	Thick Places	Neps	Hairiness
	(Ne • lb)	(cN/tex)	(%)	(%)	(no/ky)	(no/ky)	(no/ky)	
<u>70,000 rpm</u>								
35mm SB	1823	11.03	21.15	15.30	29	103	6	7.61
40mm SE	1755	10.63	18.79	15.68	46	139	9	9.16
40mm SB	1771	10.54	19.43	15.58	32	142	13	8.38
<u>61,110 rpm</u>								
40mm SE	1856	11.23	21.14	14.68	15	70	6	8.47
40mm SB	1842	11.26	21.42	14.50	11	70	6	8.17

\* S denotes the type of rotor groove and the second letter denotes the material or coating for the rotor; B stands for boron and E identifies an experimental rotor.

**EXHIBIT 5: EFFECTS OF TWIST ON YARN PROPERTIES**

Twist Multiplier	CSP	Tenacity	Elongation	Mass CV	Thin Places	Thick Places	Neps	Hairiness
	(Ne • lb)	(cN/tex)	(%)	(%)	(no/ky)	(no/ky)	(no/ky)	
4.2	1922	11.81	14.91	15.12	18	74	7	7.67
4.4	1955	11.94	15.09	14.85	17	76	8	7.56
4.6	1989	12.02	15.43	14.80	13	62	6	7.46
4.8	2025	11.95	15.54	14.66	10	66	8	7.45

**EXHIBIT 6. VARIABLES INVOLVED IN SPINNING DIFFERENT YARNS**

Yarn ID	% Wool in Blend	Polyester Source	Polyester Denier
#1	50	Wellman	1.5
#2	50	Dupont	1.5
#3	60	Wellman	1.5
#4	60	Dupont	1.5
#5	50	Wellman	1.0
#6	60	Wellman	1.0

**EXHIBIT 7. YARN STRENGTH RESULTS FOR DIFFERENT YARNS**

Yarn ID	CSP	Tenacity	Elongation
	(Ne • lb)	(cN/tex)	(%)
#1	1839	10.30	19.17
#2	2017	11.48	23.14
#3	1569	9.46	18.55
#4	1591	9.66	21.80
#5	2037	12.38	14.37
#6	1555	9.63	13.49

**EXHIBIT 8. YARN IMPERFECTION VALUES FOR DIFFERENT YARNS**

Yarn ID	Mass CV	Thin Places	Thick Places	Neps	Hairiness
	(%)	(no/ky)	(no/ky)	(no/ky)	
#1	14.23	7	60	5	7.50
#2	14.01	4	51	6	7.12
#3	14.62	8	80	9	7.80
#4	14.41	11	62	11	7.62
#5	14.18	4	62	11	7.11
#6	14.71	11	82	11	7.67

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