TECHNICAL BULLETIN

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TRI 1007

PRODUCTION AND EVALUATION OF COMBED ROTOR SPUN YARNS AND FABRICS

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INTRODUCTION

The total engineering of a product, from fiber selection all the way through the textile processing sequence to a finished fabric, has always been the optimum approach for producing a quality development at Cotton Incorporated. In this bulletin, we see the results of an objective to produce a very high quality fine count, rotor yarn with a lower twist to produce a softer hand, while maintaining good spinning efficiency and strength. Our total engineering production follows.

COTTON FIBER SELECTION

Acala 1517 cotton with good fiber properties was selected to spin high quality 40/1 Ne yarn. The fiber characteristics were:

HIGH VOLUME INSTRUMENT (HVI) DATA[1]					
Mic	Length (Inches)	Uniformity %	Strength (G/T)	Color Grade	SFC (W) % < ½ inch
4.0	1.18	84.1	31.1	21	5.0
FIBER MATURITY TEST DATA[2]					
Mic	Maturity Ratio				Fineness (Millitex)
4.07	0.84				180.45
ADVANCED FIBER INFORMATION SYSTEM (AFIS) DATA[3]					
Neps/0.5 grams			Nep Diameter (mm)		
109			0.79		
MICRODUST & TRASH MONITOR (MTM) DATA[4]					
Total Foreign Matter (%)	Visible Foreign Matter (%)	Fiber Fragments (%)	Dust (%)	Invisible (%)	
1.85	0.66	0.38	0.02	0.79	

[1]HVI - Test equipment made by Zellweger Uster Corporation, P.O. Box 51270, Knoxville, TN 37950-1270; and Peyer Corporation, P.O. Box 6446, Spartanburg, SC 29304-6446.
[2]Fiber Maturity Tester - Shirley Dev. Ltd., distributed by Crosrol, Inc., P.O. Box 6488, 21 Tower Drive, Greenville, SC 29606.
[3]AFIS - Zellweger Uster Corporation (same as 1, above).
[4]MTM - Zellweger Uster Corporation (same as 1, above).

The trash content in this cotton was remarkably low which enhanced the spinnability of fine rotor yarn, resulting in improved yarn quality.

The calculated fibers in the yarn cross section, based on fineness in millitex and micronaire, are 82 and 94 fibers, respectively. These calculations indicate the number of fibers in the cross section of the 40/1 Ne rotor yarn to be on the low side for best spinning potential. However, it has been our experience that additional length, the removal of short fiber by combing, high length uniformity and fiber strength tend to offset fewer fibers in the yarn cross section.

CARD SLIVER FORMATION

Opening, cleaning and preparation into card sliver was performed by American Truetzschler, Incorporated in Charlotte, North Carolina. We are grateful to them for their cooperation and assistance in the excellent preparation of cotton fiber, resulting in quality fine count spun yarns for this project.

Cleaning and carding were on a modern, short cleaning line with Cleaner RN (porcupine), RST (sawtooth), and Card DK 740 at a carding rate of approximately 50 lbs/hr. and producing a sliver weight of 55 gr/yd.

Further details on these processes can be obtained from Cotton Incorporated.

Further Processing in Cotton Incorporated's Fiber Processing Center

Card sliver was processed into combed sliver at 15% comber noil removal after prep drawing and lap winding. One processing of drawing after combing was sufficient to produce quality rotor yarn compared to two processes of drawing for ring yarn. Yarn processing data are shown below.

Fine rotor yarn of 40/1 Ne was successfully produced at a twist multiple of 3.6 using the Schlafhorst SE-9 spin box. This Autocoro is designed to meet the demand for improved quality and higher production, particularly in fine count ranges. The 40/1 rotor yarn was processed with a T (31mm) rotor at a speed of 92000 rpm. This rotor type and speed were selected to produce quality yarn. Also, a twist trap exit tube and an eight-groove navel were used to produce softer yarn.

Ring spun yarn of 40/1 was produced at a twist multiple of 3.8 using a Rieter G5/ID frame. This yarn was processed for use as a control to compare with the open-end. Yarn quality test results are shown below. These results show that strong and uniform ring and rotor yarns were produced with few yarn imperfections. Yarn spinnability was excellent for both rotor and ring yarns. The ends down rates of 10 and 22 ends/100 lbs were recorded for ring and rotor yarns, respectively.

The production rate of rotor yarn in this study at 0.200 lbs/hr is considerably greater than the ring yarn at 0.021 lbs/hr. This increased production rate and the additional cost advantages for the rotor yarn in one less process of drawing and elimination of roving and winding gives added emphasis for selection of a higher quality or premium cotton to produce and maintain quality rotor yarns.

FIBER PROCESSING DATA

FINAL BLEND: 100% Acala 1517 Cotton **COUNT:** 40/1 Ne

Fiber Data	MIC LEN STR UNIF ELONG	4.0 1.18 31.1 84.1 6.1		GRADE NON-LINT INVISIBLE TOTAL	21 1.04 0.81 1.85	
Drawing	Roller Settings		PREDRAW	BREAKER		FINISHER
	1st to 2nd 2nd to 3rd 3rd to 4th Machine Used FNT Roller Spd		41 mm 42 mm --- DO/5 300 m/min	39 mm 42 mm --- RSB 851 350 m/min		39 mm 42 mm --- RSB 851 350 m/min
Drawing Cont.	Other		PREDRAW	BREAKER		FINISHER
	ENDS UP GRS/YD DEL TOTAL DRAFT % CV		8 43 10.6 3.59	6 45.6 7.2 2.83		8 48 7.6 2.9
Combing	GRS/YD DEL: 55 GRS/YD LAP: 860 TYPE FEED: Backward % NOIL: 15%			NIPS/MIN: 190 CTRL WHEEL: -.75 % CV: 4.0		
Roving	GRS SLIVER-CREEL: 4.8 HANK DEL: 1.5 RPM FNT ROLL: 181 BACK DRAFT: 1.19 TOTAL DRAFT: 8.6			TURNS/IN: 1.55 TWST MULT: 1.30 Roller Settings: 1st to 2nd: 52 mm 2nd to 3rd: 66 mm		

FIBER PROCESSING DATA
(cont'd)

Ring Spinning	**PRODUCTION RATE - 0.021 lbs./hr.**	
	Frame Type	Rieter
	Hank Roving Used	1.5
	Yarn Count	40/1
	T.P.I.	24
	T.M.	3.8
	Spindle Spd.	10,300 rpm
	Back Draft	1.14
	Intermed Draft	23.4
	Total Draft	26.6
	Roll Settings:	
	1st to 2nd	43mm
	2nd to 3rd	60mm
	Ends Down	2 ends / K. spdl. hr.
Open End Spinning	**PRODUCTION RATE - 0.200 lbs./hr.**	
	Yarn Count	40/1
	T.M.	3.6
	Frame Type	Autocoro
	Grain Sliver	45
	Take-Up Spd	102 m/min
	Comb Roll Spd	7800 rpm
	Rotor Spd	92000 rpm

AUTOCORO SET UP DATA (FPC)		
Date		July, 1991
Mach. Type/Mill No.		SE 9
Yarn Count, Ne		40/1
Yarn End Use		Knit
STOCK (100% COTTON)		
Sliver	Carded/Combed	Combed
	No. of Drawings	1
	Grain	45
	Uster CV%	2.8
CHANGE GEARS		
Twist	Twist Multiple TM ($\propto e$)	3.6
Draft	Draft	218

SPINNING COMPONENTS AND SETTINGS	
Rotor Type + Dia. (mm)	T 231-D
Rotor RPM	92000
Navel Type	KN-8
Washer	1.5 mm
Torque Stop Type	Twist trap
Combing Roll Type	B174-DN
Combing Roll RPM	7800
Comb. Roll Housing Type	Coroset
Feed Table Setting	0.3 mm
Condenser Insert Color	Natural
Take-Up Speed (m/min)	102
Spinning Vacuum mbar	95

COTTON INCORPORATED Engineered Fiber/Yarn/Fabric Yarn Quality Test Results		
Spinning System	Open End	Ring
Twist Multiple	3.60	3.80
Bobbins Tested	10	10
Cotton Count	39.77	39.64
Percent C.V.	2.33	2.01
TEX	14.85	14.90
Twist	n/a	n/a
Twist per Inch	21.03	24.47
Percent C.V.	9.23	5.07
Twist Multiple	3.33	3.89
Skein Strength		
Lbs.	57.36	88.47
Percent C.V	3.91	2.79
Actual Break Factor	2281	3507
Adjusted Break Factor	2277	3500
Single End Breaking Strength		
Grams	213	307
Percent Vo	6.07	6.75
Percent Vw	4.20	5.16
Percent Vb	4.39	4.35
G./TEX (RKM)	14.36	20.62
Single End Elongation		
Percent	5.27	5.91
Percent C.V.	3.43	3.31
Uster Evenness		
Percent C.V.	16.37	12.99
Percent Vo	1.87	1.70
Uster Imperfection Counts		
Thin Places	112	3
Thick Places	170	32
NEPS	17	37
Total	299	72
Hairiness		
Average	3.60	4.05
SH	1.01	0.94

Following our initial objective to produce finished fabric from both yarns, interlock knit fabrics were made from both the rotor and ring yarns and evaluated in the greige state, in a finished white and in a navy shade. Procedures and test results are shown below.

FABRIC CONSTRUCTION SPECIFICATIONS	
FABRIC DESCRIPTION	24 Cut Interlock
FIBER CONTENT	100% Cotton
YARNS	DK 2496 - 2 40/1 Combed Acala 1517Open End DK 2496 - 3 40/1 Combed Acala 1517Ring Spun
MACHINE	Mayer OVJA-36
CYLINDER DIAMETER	30 inches
FEEDS	36
SPEED	18 rpm
GAITING	Interlock
TIMING	Delayed
NEEDLES	2232 x 2
DIAL HEIGHT	0.045 inch
YARN TENSION	2-3 grams
TAPE FEED	Yes
TAKEDOWN TENSION	Medium
SPREADER WIDTH	31 inches
INCHES PER REVOLUTION	257 inches

GREIGE FABRIC DATA		
SAMPLE	**DK 2496-2 (OE)**	**DK 2496-3 (Ring)**
Weight Oz/Yd² Oz/Yd	 4.8 9.0	 5.0 9.1
Width, Inches	68.0	66.0
Stitch Count, CPI x WPI	42 x 33	40 x 33

DYEING AND FINISHING PROCEDURES

I. DYEING

A. Finished White

1. Scoured for knitting oils and waxes at 120°F in an overflow jet (Brazzoli).
2. Scoured for natural oils, waxes, pectins and soils with a caustic soda and detergent formulation at 170°F.
3. Bleached with a formula containing hydrogen peroxide and an optical brightener at a strength for finished whites at 210°F.
4. Centrifugally extracted and slit.
5. Dried on a tenter frame.

B. Dyed Navy

1. Slit.
2. Pad batch bleached with a hydrogen peroxide formulation at room temperature (80°F) and batched for 16 hours.
3. Beam washed until neutral and clean with 190°F water.
4. Pad extracted and dried on a tenter frame.
5. Pad batch dyed with reactive dyes into a navy shade and dwelled overnight (16 hours).
6. Beam washed cold (80°F) until neutral and washed hot (200°F) until clear.
7. Pad extracted and dried on a tenter frame.

II. FINISHING

Formula - all samples and shades

1. Chemicals* — % OWB

   - Sulfanole 634 (Wetting Agent) Sequa Chemical — 0.3
   - Mykon HD (High Density Polyethylene) Sequa Chemical — 2.0
   - Sequasoft 69 (Silicone Softener) Sequa Chemical — 5.0

2. Procedures - all samples and shades

   - Padded at 60% wet pickup
   - Dried with overfeed on a relaxation drier (Ruckh) at 300°F
   - Steamed and framed to width on a tenter frame

*__Note:__ The chemicals listed are those used by Cotton Incorporated in this study. Products from other suppliers may also be satisfactory.

III. PHYSICAL TEST DATA (Finished Fabric)

	WHITE		NAVY	
Test	2 OPEN END	3 RING SPUN	2 OPEN END	3 RING SPUN
Weight, oz/yd² , oz/yd	5.2 8.7	5.2 8.4	5.1 8.5	5.1 8.3
Width, inches	60.5	58.3	60.3	58.8
Shrinkage, %(1 x w) 5 HLTD's	4.5 x 4.9	5.7 x 8.5	3.5 x 6.8	4.6 x 8.3
Durable Press Rating	3.0	3.0	3.0	3.0
Bursting Strength, Mullen, psi	80.6	97.2	75.3	97.2
Stitch Count, CPI x WPI	39 x 36	40 x 37	39 x 36	39 x 37
% Fabric Skew	0.3+	2.1*	0.2*	1.4*
+ Represents left hand skew.		* Represents right hand skew.		

IV. EVALUATION

A. Appearance - The appearance was best for the open end spun samples, whether jet dyed or pad batch dyed. When comparing dyeing methods, the pad batch method had the best appearance.

B. Hand - The hand for the ring-spun samples was judged to be very soft and slightly better than the open-end samples. However, the open end samples were judged to be very soft and like that of typical ring spun fabrics. The pad batch samples had a softer hand than the jet processed samples.

C. Physical Performance -
- The shrinkage results were good for all fabrics.
- Mullen bursting strengths were acceptable for all samples but higher for the ring spun samples.
- The open end fabrics exhibited lower fabric skew than did the ring spun samples. However, none of the values were significant, partly because interlock fabrics do not normally have a torquing problem.
- The durable press ratings were equal and typical of knit fabrics without resin finishing.

Note: The open-end fabrics were wider than the ring spun fabrics, with better width shrinkage.

RESEARCH AND TECHNICAL SERVICES

Cotton Incorporated is a research and promotion company representing cotton worldwide. Through research and technical services, our company has the capability to develop, evaluate, and then commercialize the latest technology to benefit cotton.

- Agricultural research leads to improved agronomic practices, pest control and fiber variants with properties required by the most modern textile processes and consumer preferences. Ginning development provides efficient and effective machines for preservation of fiber characteristics. Cottonseed value is enhanced with biotechnology research to improve nutritional qualities and expand the animal food market.

- Research in fiber quality leads to improved fiber testing methodology and seasonal fiber analyses to bring better value both to growers and then mill customers.

- Computerized fiber management techniques result from in-depth fiber processing research.

- Product Development and Implementation operates programs leading to the commercialization of new finishes and improved energy and water conserving dyeing and finishing systems. New cotton fabrics are engineered -- wovens, circular knits, warp knits, and nonwovens -- that meet today's standards for performance.

- Technology Implementation provides comprehensive and customized professional assistance to the cotton industry and its customers -- textile mills and manufacturers.

- A fiber to yarn pilot spinning center allows full exploration of alternative methods of producing yarn for various products from cotton with specific fiber profiles.

- The Company operates its own dyeing and finishing laboratory, knitting laboratory, and a laboratory for physical testing of yarn, fabric, and fiber properties including High Volume Instrument testing capable of measuring micronaire, staple length, strength, uniformity, color, and trash content.

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