WEAVING PERFORMANCE FROM THE COUPLED LINT CLEANER: A PRELIMINARY REPORT

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Abstract

A mill study determined the spinning and weaving performance of fiber produced by the Coupled Lint Cleaner. This report discusses the spinning results only. Fiber was processed into carded and combed ring and rotor yarns. When compared to a standard saw gin stand followed by two saw-type lint cleaners, fiber from the Coupled Lint Cleaner produced yarn that was stronger (carded and combed rotor and ring yarn), and had fewer irregularities and imperfections (carded and combed ring yarn).

Introduction

The cotton ginning industry is continually looking for new and improved methods of separating seed cotton into fiber and seed. One machine that has shown considerable potential is the Coupled Lint Cleaner. This machine was developed at the USDA-ARS Southwestern Cotton Ginning Research Laboratory in Mesilla Park, New Mexico. The latest prototype of the Coupled Lint Cleaner consists of a standard Lummus Imperial 108 saw gin stand coupled directly to two saw-type lint cleaners. The lint cleaning section of the machine was originally built by the Lummus Corporation, but modifications have been made to the machine while at the Cotton Ginning Laboratory. Figure 1 shows a section view of the Coupled Lint Cleaner.

The configuration of the Coupled Lint Cleaner has several advantages. First, less energy is required to gin and clean the fiber since some of the fans and condensers that transported the fiber are no longer needed. Secondly, fewer components of air pollution control equipment are needed since considerably less air is used to transport the fiber between the gin stand and lint cleaners. And lastly, the traditional feed bar that sets the fiber on the saw cylinder has been replaced with a mechanism that causes less fiber damage.

The superior quality of fiber produced by the Coupled Lint Cleaner is well documented. When compared to a standard high-capacity saw gin stand followed by two saw-type lint cleaners, the Coupled Lint Cleaner produces fiber that is longer, has fewer short fibers, and contains less trash (Hughs et al, 1990). However, it is unknown how fiber from the Coupled Lint Cleaner performs with respect to spinning and weaving. This paper discusses the results of the carded and combed rotor and ring spinning tests that were performed on fiber produced by a standard saw ginning/lint cleaning setup, and the Coupled Lint Cleaner.

Discussion

The ginning test was run in the Spring of 1995 and consisted of two treatments times three replications for a total of six one-half bale-sized lots. The control treatment consisted of a high-capacity saw gin stand followed by two saw-type lint cleaners. The experimental treatment consisted of the Coupled Lint Cleaner. All cotton used on the test was first-pick Acala 1517-91. The six ginning lots were sent to the Southern Regional Research Center (SRRC) for fiber testing and then processing into yarn and cloth.

The fiber properties were determined by the High Volume Instrument (HVI) and Advanced Fiber Information System (AFIS). Sliver preparation included processing each of the lots through opening and cleaning machinery emerging from a single card as sliver. All wastes were collected and weighed.

After one pass of drawing, about one third of the sliver was retained for lap forming prior to combing. After combing, two passes of drawing were performed prior to the production of roving. Residual combed sliver from the roving process was retained for rotor spinning. The remaining carded sliver was drawn a second time, then split into two approximately equal quantities. One half was converted into roving in preparation for ring spinning. The other half provided feedstock for rotor spinning.

Nominal yarn numbers of Ne16, Ne22, Ne30, and Ne36 were spun from the carded sliver by both ring and rotor methods. Combed stock was spun into nominal yarn numbers Ne22, Ne30, Ne36, and Ne42 by rotor spinning, whereas Ne30, Ne36, Ne42, and Ne50 were produced by ring spinning. Yarns were characterized in terms of Skein strength, single yarn tensile properties (Uster Tensorapid), and non-uniformity and imperfection properties (Uster Evenness).

Summary

Table 1 lists the fiber properties on fiber after lint cleaning (in the bale). The only properties significantly different due to ginning treatment were length and short fiber content with the Coupled Lint Cleaner being better in both cases. The HVI upper half mean length averaged 1.095 and 1.129 inches, and the AFIS upper quartile length averaged 1.137 and 1.180 inches for the control and experimental treatment,

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respectively. Short fiber content averaged 14.6 and 11.4 percent for the control and experimental treatment, respectively. Other fiber quality measurements showed advantages to the Coupled Lint Cleaner but the differences were not statistically significant. These measurements included strength, elongation, nep count, and seedcoat nep count. These results are consistent with other experiments of the Coupled Lint Cleaner (Hughs et al, 1990).

Table 2 lists the fiber properties on fiber after the card and comber slivers. Some of the results are the same as those found on fiber in the bale. Fiber from the Coupled Lint Cleaner had an increased upper quartile length and a reduction in short fiber content after the card sliver and comber sliver. The number of seed coat neps were reduced to almost zero by combing for both treatments. There were no changes in terms of nep or seed coat fragment size due to combing.

Table 3 lists the waste products from the cleaners. The wastes are calculated as percentages of the total collected material. With the exception of sweepings, all of the waste products were different between treatment. The Coupled Lint Cleaner had reduced wastes extracted at each major cleaning point, reduced total process wastes extracted, and reduced combing noils.

Tables 4 through 7 list the yarn properties. The tables are divided up according to sliver and spinning-frame type. The treatment means that are significantly different due to ginning treatment are shown in bold print. In general, the Coupled Lint Cleaner is more favorable with respect to yarn properties, but because of the greater dispersion in most of the data most of the differences are not statistically significant. Therefore, only general observations can be made.

The Coupled Lint Cleaner produced fiber with the following yarn properties:

- An increase in Skein strength (CSP) in carded and combed ring and rotor yarns. The strength increase in carded ring yarns was proportionately greater than other increases in strength (3.9% versus about 2.2%). The increases in strength are probably due to the difference in fiber length distribution between combinations of gin and mill treatments. Ring spinning is acknowledged to be more sensitive to fiber length than rotor spinning.
- An increase in yarn elongation at break in carded and combed rotor yarns, but not in ring yarns.
- An increase in the specific work to break (SWR) yarns, the exception possibly being carded ring yarns.
- A reduction in the irregularity (CV of evenness) of carded and combed ring yarns.
- A reduction in the total number of neps and imperfections in carded and combed ring yarns (total imperfections = thin places + thick places + neps). Several of these differences were significantly different.
- No improvement in either irregularity or imperfections on rotor yarns. This is possibly due to the fact that neps can be ejected at the rotor spinning machine, or they can be buried in the yarn structure. Also, rotor yarns are more regular and less sensitive to changes in fiber length.

Work yet to be completed includes spinning performance data in the production of warp and filling yarns (Ne36) for high speed weaving, and weaving performance of carded and combed ring and rotor yarns.

References

Hughs, S. E., M. N. Gillum, C. K. Bragg, and W. F. Lalor. 1990. Fiber and yarn quality from coupled lint cleaner. Transactions of the ASAE. Vol. 33(6):1806-1810.

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Table 1. Fiber properties, after ginning, from conventional ginning and the Coupled Lint Cleaner.

Fiber Property	Conventional	Experimental	OSL
HVI:			
Strength, g/tex	28.9	29.9	NS
Elongation,	4.90	4.90	NS
Upper Half Mean Length,	1.095	1.129	0.0352
Uniformity, %	81.5	82.1	NS
Micronaire reading	4.3	4.3	NS
Reflectance, % Rd	77.2	77.6	NS
Yellowness, +b units	9.84	10.0	NS
Leaf, grade	3.4	3.4	NS

Table 2. Fiber properties after the card sliver and comber sliver.

Fiber Property (AFIS)	Conventional	Experimental	OSL
Card Sliver:			
Mean Length, in	0.887	0.923	0.0015
Length Coeff. of Var., %	39.9	37.7	0.0350
Upper Quartile Length, in	1.113	1.153	0.0011
Short Fiber Content, %	14.5	12.0	0.0045
Nep Count, per grain	45.7	45.0	NS
Nep Size, μm	490	474	NS
Seedcoat Nep Count, per gram	8.7	5.0	NS
Seedcoat Nep Size, μm	592	602	NS
Comber Sliver:			
Mean Length, in	0.987	1.007	0.0132
Length Coeff. of Var., %	34.8	33.7	0.0131
Upper Quartile Length, in	1.207	1.227	0.0013
Short Fiber Content, %	7.7	6.5	0.0028
Nep Count, per grain	16.7	18.7	NS
Nep Size, μm	468	468	NS
Seedcoat Nep Count, per gram	2.0	1.7	NS
Seedcoat Nep Size, μm	512	514	NS

AFIS = Advanced Fiber Information System
OSL = Observed Significance Level
NS = Non Significant at the 5% level

Table 3. Waste materials collected prior to carding.

Cleaning Point	Conventional	Experimental	OSL
Cleaning Line:			
Superior, %	0.28	0.12	0.0015
Fine Opener, %	1.30	0.88	0.0079
Total Cleaning	1.58	1.00	0.0029
Filter:			
Card and Airborne Wastes, %	3.35	2.68	0.0072
Sweepings, %	0.42	0.48	NS
Total Extract, %	5.35	4.16	0.0010
Combing:			
Noils, %	17.8	15.8	0.0037

OSL = Observed Significance Level
NS = Non Significant at the 5% level

Table 4. Yarn properties after the carded sliver and ring frame. Treatment means shown in bold print are significantly different due to treatment at the 5% level.

	Nominal Yarn Size			
	Ne16	Ne22	Ne30	Ne36
Property	Con. Exp.	Con. Exp.	Con. Exp	Con. Exp.
Skein CSP	2306,2448	2304,2381	2149,2176	1953,2042
Tensorapid:				
Tenacity,g/tex	14.3,14.5	14.1,14.3	13.4,13.6	**11.8,12.6**
Elongation,%	5.55,5.40	5.08,4.89	4.93,4.76	4.33,4.24
SWR,%	.394,.383	.353,.339	.324,.314	.245,.258
CV of Work,%	15.0,16.2	17.4,16.8	19.5,18.8	20.3,21.3
Modulus,g/tex	411,444	461,474	442,490	467,500
Evenness:				
CV of Even,%	16.9,15.9	17.4,17.0	19.7,18.7	21.3,20.7
Thin,/1000yd	141,78.4	87.4,71.7	**235,161**	410,337
Thick,/1000yd	348,238	631,511	1172,921	**1601,1277**
Nep,/1000yd	23.1,16.0	64.7,59.6	**142,95.8**	**214,163**
Imp./1000yd	512,332	783,642	**1550,1178**	**2224,1777**

Con. = Conventional Saw Ginning System
Exp. = Experimental Coupled Lint Cleaner
CSP = Count Strength Product
SWR = Specific Work of Rupture
CV = Coefficient of Variation
Imp. = Total Imperfections

Table 5. Yarn properties after the carded sliver and rotor frame. Treatment means shown in bold print are significantly different due to treatment at the 5% level.

	Nominal Yarn Size			
	Ne16	Ne22	Ne30	Ne36
Property	Con. Exp.	Con. Exp.	Con. Exp	Con. Exp.
Skein CSP	2261,2292	2112,2145	**1895,1939**	1783,1816
Tensorapid:				
Tenacity,g/tex	13.6,13.8	12.9,13.1	11.8,11.7	**11.3,11.7**
Elongation,%	4.64,4.81	4.58,4.76	4.27,4.39	4.12,4.25
SWR,%	.334,.352	.305,.322	.255,.262	.233,.249
CV of Work,%	14.9,13.6	17.4,15.8	19.1,19.0	20.5,19.0
Modulus,g/tex	581,543	526,506	540,500	521,483
Evenness:				

CV of Even,%	11.6,11.5	12.3,12.2	13.7,13.7	14.5,14.5
Thin,/1000yd	1.60,0.93	3.83,2.77	25.8,24.4	53.1,42.4
Thick,/1000yd	9.93,7.20	14.5,12.0	40.0,45.9	71.6,72.4
Nep,/1000yd	4.87,2.27	13.0,7.87	38.8,34.4	71.3,64.5
Imp./1000yd	16.4,10.4	**31.3,22.6**	105,105	196,179

Con. = Conventional Saw Ginning system
Exp. = Experimental Coupled Lint Cleaner
CSP = Count Strength Product
SWR = Specific Work of Rupture
CV = Coefficient of Variation
Imp. = Total Imperfections

Table 6. Yarn properties after the combed sliver and ring frame. Treatment means shown in bold print are significantly different due to treatment at the 5% level.

	Nominal Yarn Size			
	Ne30	Ne36	Ne42	Ne50
Property	Con. Exp.	Con. Exp.	Con. Exp	Con. Exp.
Skein CSP	2340,2413	2266,2321	2187,2188	**2037,2099**
Tensorapid:				
Tenacity,g/tex	14.7,15.2	13.9,14.4	13.5,14.0	**12.8,13.3**
Elongation,%	4.88,4.94	4.63,4.60	4.51,4.44	4.17,4.18
SWR,%	.352,.364	.306,.317	.289,.298	.267,.264
CV of Work,%	17.8,17.6	18.5,20.4	**18.4,22.3**	20.9,21.9
Modulus,g/tex	532,552	561,531	599,592	588,690
Evenness:				
CV of Even,%	14.7,14.3	15.9,15.6	16.9,16.3	**18.1,17.4**
Thin,/1000yd	17.1,14.9	46.1,40.9	89.0,66.4	**201,118**
Thick,/1000yd	162,114	292,236	431,335	**659,504**
Nep,/1000yd	17.7,13.3	**36.0,24.2**	**44.1,32.5**	**67.8,48.9**
Imp./1000yd	197,142	374,301	564,434	**928,672**

Con. = Conventional Saw Ginning system
Exp. = Experimental Coupled Lint Cleaner
CSP = Count Strength Product
SWR = Specific Work of Rupture
CV = Coefficient of Variation
Imp. = Total Imperfections
Table

Table 7. Yarn properties after the combed sliver and rotor frame. Treatment means shown in bold print are significantly different due to treatment at the 5% level.

	Nominal Yarn Size							
	Ne22		Ne30		Ne36		Ne42	
Property	Con.	Exp.	Con.	Exp.	Con.	Exp	Con.	Exp.
Skein CSP	2192,2250		1984,2026		1863,1911		1735,1788	
Tensorapid:								
Tenacity,g/tex	13.5,13.8		12.7,12.8		12.2,12.4		11.5,11.6	
Elongation,%	4.75,4.77		**4.48,4.57**		4.26,4.40		4.10,4.21	
SWR,%	.333,.329		.287,.296		.263,.271		.233,.240	
CV of Work,%	16.1,15.6		18.1,17.6		19.6,18.9		24.0,22.0	
Modulus,g/tex	590,564		**536,502**		571,577		555,614	
Evenness:								
CV of Even,%	**12.6,12.4**		13.9,13.8		14.7,14.8		15.7,15.6	
Thin,/1000yd	5.03,4.70		23.5,29.0		64.4,64.6		129,134	
Thick,/1000yd	22.1,17.7		45.4,44.6		**71.4,83.8**		122,119	
Nep,/1000yd	9.53,12.1		26.6,26.9		50.7,50.9		87.4,100	
Imp./1000yd	36.6,34.4		95.4,100		186,199		339,354	

Con. = Conventional Saw Ginning system
Exp. = Experimental Coupled Lint Cleaner
CSP = Count Strength Product
SWR = Specific Work of Rupture
CV = Coefficient of Variation
Imp. = Total Imperfections

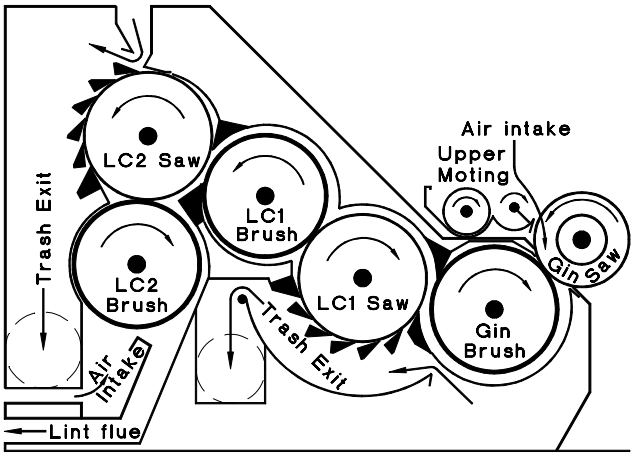

Figure 1. Section view of the Coupled Lint Cleaner.