STUDY OF A WIRE BRUSH GRID BAR REPLACEMENT FOR SAW-TYPE LINT CLEANERS

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Abstract

Saw type lint cleaners are commonly used to improve the overall quality of ginned lint through the removal of non-lint material and short fibers. A standard saw type lint cleaner is made up of several components: the feed works, saws, and grid bars. Slover Manufacturing (Lamesa, TX) has designed and built a wire brush replacement for the conventional grid bar to improve the efficiency of saw type lint cleaners. A study was conducted to determine the effect of the wire brush on the efficiency of the lint cleaner, as well as on the fiber properties of the cleaned lint. Yarn quality was also examined from cottons processed on both a traditional lint cleaner and a modified lint cleaner equipped with the wire brushes.

Introduction

Saw type lint cleaners are commonly used to improve the overall quality of ginned lint through the removal of non-lint material and short fibers. One drawback to saw type lint cleaners is that a certain amount of good lint is discarded along with the waste and short fiber. A standard saw type lint cleaner is made up of several components including the feed works, saws, and grid bars. The feed works consist of a condensing drum to form a batt of lint which is fed to the saws past a feed plate. The saw teeth grab the lint and sling off non-lint content via centrifugal force. Grid bars push the lint back onto the saws, while foreign matter is released through the openings between the grid bars. Devices, such as the louvered lint cleaner, have been developed to deactivate grid bars by selectively closing the openings between the bars. The closed louvers do not allow material to be slung off, thus reducing the amount of lint that may be lost. The amount of foreign material that may be removed by the lint cleaner is also reduced when louvers are employed. The louvers are opened when more cleaning is needed and closed when less cleaning is needed allowing for a balance between turnout and cleaning efficiency (Anthony, 2000).

Slover Manufacturing (Lamesa, TX) has designed and built a wire brush replacement for the conventional grid bar to improve the efficiency of saw type lint cleaners. The wire brushes are mounted in such a way as to push the lint onto the saw teeth while the foreign matter is ejected via centrifugal force. In addition to the wire brushes, the manufacturer recommends that spacing between the feed roller and saw teeth be increased and increase the saw speed. Gin trials were conducted at the Agricultural Research Service's Cotton Ginning Research Unit (Stoneville, MS) to compare the grid bar replacement with the conventional grid bar design. Textile processing trials were conducted at the Agricultural Research Service's Cotton Structure and Quality Research Unit (New Orleans, LA).

Five different cultivars were processed in the micro-gin facility at Stoneville, MS using a conventionally set saw type lint cleaner and a saw type lint cleaner equipped with the experimental wire brushes and modified settings. Two different drying conditions were also evaluated. The results of the lint cleaning have been examined for differences in cleaning and quality of the produced lint.

Materials and Methods

Ginning Machinery

The cottons in the study were saw ginned in the micro-gin facilities at the Cotton Ginning Research Unit in Stoneville, MS. The ginning sequence consisted of a shelf dryer, cylinder cleaner, stick machine, shelf dryer, cylinder cleaner, extractor-feeder, 20-saw (40.6 cm diameter) gin stand, followed by either a conventional saw type lint cleaner or an identical lint cleaner equipped with the experimental brushes. The conventional lint cleaner was equipped with five grid bars.

Installation of the wire brushes on the lint cleaner required removal of the first, third, and fifth grid bar. The first grid bar was replaced entirely by the brush assembly. Holes were drilled and tapped in the rear of the second and

fourth grid bar and the brushes were mounted behind the grid bars. The feed bar was raised to 4.76 mm off the saw. The saw speed was 875 rpm for the grid bar equipped lint cleaner and 1400 rpm for the wire brush equipped lint cleaner. The brush speed was increased to 1750 rpm for the wire brush equipped lint cleaner. Feed roller speed was 98 rpm for both lint cleaners. The installed wire brushes are shown in Figure 1.

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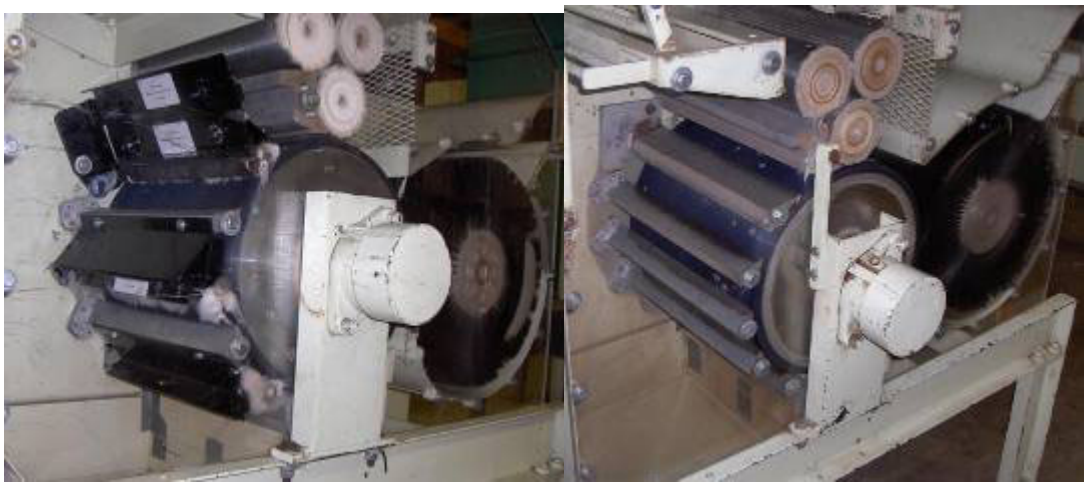

Figure 1. Wire brush equipped lint cleaner and grid bar equipped lint cleaner

Materials

Five cottons were employed in this study. Delta and Pine Land 555 (DPL 555) and Stoneville 4892 (STV 4892) from the 2006 crop year and Delta and Pine Land 117, 164, and 444 (DPL 117, DPL 164, and DPL 444) from the 2007 crop year were used in this study (Delta and Pine Land, Scott, MS and Stoneville Pedigreed, Bayer Crop Science, Research Triangle, NC). The cultivars processed represented a wide range of popular cultivars grown in the Mid-South Area (USDA-NASS, 2006 and USDA-AMS, 2006). Three replicates were processed for each cultivar and lint cleaner. The 2006 cottons were processed in two lots with amounts ranging from 13 to 23 kg. One lot with the first and second dryer turned off and then a second lot with the first dryer set to 65.6°C and the second dryer turned off. There were a total of 24 lots processed for the 2006 cottons.

The 2007 cottons were processed with the first dryer set to 65.6°C and the second dryer turned off. Three replicates were processed for each cultivar and lint cleaner with each sample ranging from 65 to 90 kg of seed cotton. There were a total of 18 lots processed for the 2007 cottons. The 2007 cottons were intended for textile processing trials.

Textile Machinery

The 2007 cottons were processed in 13.6 kg lots in the Cotton Structure and Quality Research Unit's textile pilot plant in New Orleans, LA. The cottons were processed at 27.2 kg/hr through an inclined cleaner and a finer opener before being carded and drawn to 1 hank roving in preparation of ring spinning. 22/1 Ne ring spun yarns were produced on a Saco-Lowell 240 spindle spinning frame.

Test Methods

Fiber quality was tested using an HVI-1000 and AFIS Pro (Uster Technologies, Inc., Charlotte, NC) and a Shirley Analyzer (SDL Atlas, Stockport, England). Yarn quality was examined via an Uster Tensorapid 4 and an Uster Tester 4. Fiber length, non-lint content, yarn strength and yarn uniformity were the primary measures of interest.

Results and Discussion

Data were collected during ginning to measure ginning efficiency and the effect of the lint cleaners on turnout. Table 1 shows the mean ginning data collected in the micro-gin trials. Lint cleaner waste was consistently lower for samples cleaned with the wire brush equipped lint cleaner and this resulted in an increased turnout for those lots. The wire brush lint cleaner resulted in an average of 0.72% greater turnout than the conventional lint cleaner with grid bars. The Shirley Analyzer was used to determine the non-lint content of the final lint turned out by the lint cleaners. The Shirley Analyzer separates lint from non-lint content, non-lint content is collected and weight balance

is calculated to provide a breakdown of visible and so-called invisible non-lint content. Invisible non-lint content is the fine dust and particulate which escapes from the sample during testing and is not captured by the instrument. Results from the Shirley Analyzer show a higher non-lint content for samples processed with the wire brush equipped lint cleaner (Table 2). The wire brush processed samples have an average of 3.76% non-lint content compared to 3.16% for the standard grid bar equipped lint cleaner samples.

Table 1. Means for micro-gin data

Variety	Treatment	Dryer Temp (°C)	Turnout (%)	Lint Cleaner Waste (%)
DPL 555	Grid Bars	Off	40.6	0.72
DPL 555	Wire Brush	Off	41.2	0.30
STV 4892	Grid Bars	Off	39.1	1.83
STV 4892	Wire Brush	Off	39.5	0.31
DPL 555	Grid Bars	65.6	40.3	0.92
DPL 555	Wire Brush	65.6	40.7	0.48
STV 4892	Grid Bars	65.6	38.2	1.32
STV 4892	Wire Brush	65.6	39.8	0.35
DPL 117	Grid Bars	65.6	35.9	1.03
DPL 117	Wire Brush	65.6	36.3	0.48
DPL 164	Grid Bars	65.6	33.3	1.21
DPL164	Wire Brush	65.6	34.2	0.52
DPL 444	Grid Bars	65.6	36.5	1.40
DPL 444	Wire Brush	65.6	37.3	0.64

Table 2. Mean for Shirley Analyzer data

Variety	Treatment	Dryer Temp (°C)	Lint (%)	Visible Non-Lint (%)	Invisible Non-Lint (%)	Total Non-Lint (%)
DPL 555	Grid Bars	Off	97.21	1.49	1.31	2.79
DPL 555	Wire Brush	Off	96.94	1.77	1.29	3.06
STV 4892	Grid Bars	Off	97.22	1.71	1.07	2.78
STV 4892	Wire Brush	Off	96.40	2.50	1.10	3.60
DPL 555	Grid Bars	65.6	97.47	1.19	1.34	2.53
DPL 555	Wire Brush	65.6	97.34	1.59	1.07	2.66
STV 4892	Grid Bars	65.6	97.22	1.17	1.08	2.78
STV 4892	Wire Brush	65.6	96.64	2.35	1.01	3.36
DPL 117	Grid Bars	65.6	95.92	2.58	1.50	4.08
DPL 117	Wire Brush	65.6	95.22	3.21	1.57	4.78
DPL 164	Grid Bars	65.6	96.25	2.04	1.71	3.75
DPL164	Wire Brush	65.6	95.29	2.71	2.00	4.71
DPL 444	Grid Bars	65.6	96.60	2.01	1.39	3.40
DPL 444	Wire Brush	65.6	95.84	2.63	1.53	4.16

The High Volume Instrument (HVI) is the standard cotton classification instrument used to assess the quality of lint in a bale. An HVI-1000 line was used to test the lint produced by both lint cleaners (Table 3). No clear differences in fiber length or length uniformity are apparent between the lint cleaners. The color differences between the samples are slight and not enough to result in different color grades, in most circumstances. The Rd value, a measure of whiteness, is slightly higher for the lint processed with the conventional grid bar equipped lint cleaner. The +b values, a measure of yellowness, tend to be slightly lower for the lint processed through the wire brush equipped lint cleaner indicating lint with a less yellow tint. The overall differences are slight, Rd being 0.70 higher for the grid bar equipped lint cleaner and +b averaging 0.10 lower for the wire brush equipped lint cleaner. Trash content, as measured by the HVI averaged 0.05% higher for the wire brush equipped lint cleaner.

Table 3. Mean for select HVI-1000 data

Variety	Treatment	Dryer Temp (°C)	UHML (mm)	Uniformity (%)	Rd	+b	Trash Area (%)
DPL 555	Grid Bars	Off	27.94	82.36	79.03	8.13	0.29
DPL 555	Wire Brush	Off	27.94	82.10	78.75	8.13	0.29
STV 4892	Grid Bars	Off	27.69	82.50	77.46	8.51	0.30
STV 4892	Wire Brush	Off	27.69	82.91	77.14	8.36	0.35
DPL 555	Grid Bars	65.6	28.19	82.15	78.92	8.19	0.26
DPL 555	Wire Brush	65.6	27.69	82.03	78.50	8.13	0.27
STV 4892	Grid Bars	65.6	27.96	82.78	78.01	8.58	0.27
STV 4892	Wire Brush	65.6	27.43	82.56	77.12	8.42	0.34
DPL 117	Grid Bars	65.6	29.72	82.59	73.08	8.00	0.67
DPL 117	Wire Brush	65.6	29.72	82.47	72.23	7.81	0.72
DPL 164	Grid Bars	65.6	29.21	81.81	75.19	8.31	0.44
DPL164	Wire Brush	65.6	29.21	81.97	73.88	8.24	0.63
DPL 444	Grid Bars	65.6	28.96	83.39	70.84	8.53	0.39
DPL 444	Wire Brush	65.6	28.96	83.41	70.04	8.46	0.40

AFIS instrumentation provides more detailed analysis of the length properties of fiber samples as well as the non lint content of the samples. An AFIS Pro instrument was used to examine samples from both lint cleaners (Table 4). No discernible difference in nep count, upper quartile length, short fiber content, or the coefficient of variation of length was measured by the AFIS. The visible foreign matter was higher for the wire brush samples with a 0.41% higher measurement on average.

Table 4. Mean for select AFIS data

Variety	Treatment	Dryer Temp (°C)	UQL(w) (mm)	%CV Length (w)	SFC(w) (%)	Nep Count	Visible Foreign Matter (%)
DPL 555	Grid Bars	Off	29.78	53.37	10.82	165	0.83
DPL 555	Wire Brush	Off	29.78	54.20	11.01	187	1.09
STV 4892	Grid Bars	Off	29.46	45.42	7.00	113	1.40
STV 4892	Wire Brush	Off	29.46	44.91	6.68	120	1.77
DPL 555	Grid Bars	65.6	29.78	53.13	10.79	172	0.75
DPL 555	Wire Brush	65.6	29.78	53.73	11.02	187	0.93
STV 4892	Grid Bars	65.6	29.46	46.32	7.36	119	1.35
STV 4892	Wire Brush	65.6	29.21	45.29	7.07	110	1.65
DPL 117	Grid Bars	65.6	31.50	31.60	5.93	176	2.50
DPL 117	Wire Brush	65.6	31.50	31.46	5.71	182	3.07
DPL 164	Grid Bars	65.6	30.73	33.42	7.58	274	1.58
DPL164	Wire Brush	65.6	30.99	32.90	7.28	266	2.56
DPL 444	Grid Bars	65.6	30.73	30.54	5.4	179	1.74
DPL 444	Wire Brush	65.6	30.73	30.77	5.4	188	1.94

The fiber testing did not detect major differences in the lint produced by the two lint cleaner methods. The length measurements, arguably the most important factor in marketing cotton, did not show any consistent differences. The non-lint content measurements are the only measurements to consistently identify a difference between the lint cleaners. Lint was spun into 22/1 Ne ring spun yarns to determine if differences in yarn quality would occur due to differences in lint quality (Table 5). All lots of cotton spun for yarn had the first dryer set at 65.6°C during ginning. Yarn strength did not reveal any consistent differences between the lint cleaners. No significant difference was found in yarn strength or evenness data for the lint produced by the different lint cleaners. The lint produced via the wire brush lint cleaner had less variation in its mass (CV_m) by 0.16% on average, however it is not a statistically significant difference. The lint produced via the wire brush lint cleaner had fewer thin and thick places in the yarn; however it tended to have more yarn neps.

Table 5. Means for ring spun yarn data

Variety	Treatment	Yarn Count (Ne)	Tenacity (cN/tex)	CV_m (%)	Thin -50% (/km)	Thick +100% (/km)	Nep +400% (/km)
DPL 117	Grid Bars	22.14	16.30	18.55	102.0	11.7	9.7
DPL 117	Wire Brush	22.34	16.75	17.88	72.7	8.0	14.7
DPL 164	Grid Bars	22.07	15.71	20.00	223.0	22.7	12.0
DPL 164	Wire Brush	22.38	15.47	19.80	200.0	22.0	15.3
DPL 444	Grid Bars	22.24	15.54	17.61	72.3	5.7	4.3
DPL 444	Wire Brush	22.07	15.68	17.51	61.0	5.3	4.3

Summary

Lint was produced via a conventionally grid bar equipped lint cleaner and a lint cleaner equipped with experimental wire brushes in place of conventional grid bars. The wire brush equipped lint cleaner had 0.72% greater turnout than the conventional lint cleaner. The lint produced via the modified lint cleaner did have 0.6% more non-lint content, as measured by the Shirley Analyzer; however, it does appear that some additional lint was retained. The HVI and AFIS instrumentation was unable to determine any statistically significant differences in the quality of lint produced by the lint cleaners. Textile processing trials were conducted to determine if the additional material retained by the wire brush equipped lint cleaner would affect yarn quality. No significant difference in yarn quality was observed between the lint cleaners. The lint processed through the conventional lint cleaner had a greater number of thin and thick spots in the yarn, but a lower occurrence of yarn neps. No differences in the reported yarn quality measurements were statistically significant.

The additional turnout provided by the wire brush equipped lint cleaner would translate to an added 1.6 kg (3.6 lb) of material per 226.8 kg (500 lb) bale. A portion of the additional turnout is attributable to non-lint content; however, a portion of the additional turnout is of lint which does not lower the overall quality of the bale.

Disclaimer

The use of a company or product name is solely for the purpose of providing specific information and does not imply approval or recommendation by the United States Department of Agriculture to the exclusion of others.

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References

Anthony, W.S. 2000. Methods to reduce lint cleaner waste and damage. Trans ASAE 43(2): 221-229.

USDA-AMS. 2006. Cotton Varieties Planted, 2006 Crop. Washington, D.C.: USDA Agricultural Marketing Service.

USDA-NASS. 2006. June 2006 Planted Acreage Report. Washington, D.C.: USDA National Agricultural Statistical Service.