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THE EFFECTS OF PEPPER TRASH ON FIBER QUALITY AND SPINNING PERFORMANCE

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Abstract

Material accumulation in the rotor groove causing the yarn to break is a serious spinning efficiency problem for the open-end spinning industry. Fine trash, sometimes called pepper trash, is blamed for this rotor buildup and subsequent ends down. The origin of this pepper trash has been blamed on various foreign materials from soil to small-leaf particles and other plant materials. There is currently some indication that the origin of the material building up in the spinning rotor groove may derive from broken pieces of hull. Specially processed test cotton was produced at the Southwestern Cotton Ginning Research Laboratory that contained known high quantities of soil particles, and small leaf and hull fragments. This cotton was provided to the Cotton Quality Research Station to be processed through their open-end spinning line. Material was collected from rotor grooves for further analysis to determine its origin. Once the origin of the problem material is determined, then the problem of removal can be addressed during the ginning process.

Introduction

One of the items of interest for the National Cotton Council's Quality Task Force is the effect of pepper trash on open-end spinning performance. Small trash particles (pepper trash) become embedded in the groove of the spinning rotor during the spinning process. This material eventually fills the groove so that the rotor does not function properly, and the quality of the yarn is degraded or the yarn breaks causing an ends down and loss of spinning efficiency. A task force has recently been assembled by the National Cotton Council to conduct research to determine, among other things, the actual size range of the offending particles and their origin(s). Other researchers have indicated that small particles derived from cotton hulls may be one of the primary sources of the pepper trash filling the rotor grooves. This is a brief report of research conducted to determine the source and the effect on spinning of selected pepper-trash material. The objective of this research was to produce ginned fiber containing various levels of both fine trash and hulls for use in determining their effects on open-end spinning ends down.

Materials and Methods

Open-end spinning normally utilizes upland cottons of various qualities to produce yarn. The raw-fiber quality selected depends on the specifications of the yarn being produced. The length and strength, among other fiber properties, of the raw fiber sets the upper limits of the quality of the yarn that can be produced before yarn quality deteriorates or ends down get excessive. For this test, we did not want the fiber length or fiber strength to be significant factors contributing to spinning ends down. It was also desirable that the seed cotton have high initial fine-trash content. Otherwise, the cotton would have to be inoculated with different levels of selected materials during the ginning process in order to produce ginned fiber with sufficient "pepper trash" to test in the spinning plant.

Serendipity is sometimes the best test planner. A module of first-pick Pima cotton became available which was very high in initial leaf-trash and fine-soil content. Pima cotton is very long and strong, and so these two factors would not be limiting in open-end spinning. The module was one of several that was harvested in early November, 2000, after a freak, late-season, heavy rain and hail storm. The cotton was grown on a heavy-clay soil and had not been defoliated. The resulting storm of combined rain and hail thoroughly contaminated the seed cotton with ground in leaf particles and splashed on fine-clay-soil particles. Small leaf (pepper trash) and fine-soil particles are two possible constituents of the rotor-groove material. The contamination was heavy enough to reduce the gin turnout from an expected normal of 35% for Pima cotton to 23%. This cotton provided a good test base to which other contaminating materials could be added as desired. It was decided to add cotton trash with a high hull content as a third contaminating material to the seed cotton as it was being processed.

For the purposes of this test, the testing materials were as follows:

1. Pima module “excessively” contaminated with fine-leaf trash and soil.
2. Additional cotton trash collected from stick machines that contained a high percentage of hulls.
3. Continental rotary-knife roller gin and Continental 93 saw-gin stands.
4. Twelve (12) ginning lots of approximately 1,120 pounds of seed cotton each.

There were four (4) test treatments and each test treatment was replicated three (3) times for a total of twelve ginning lots. The test machinery treatments were as follows:

1. One 6-cylinder cleaner, gin feeder, rotary-knife roller gin stand and no lint cleaning.
2. Two 6-cylinder cleaners, one stick machine, gin feeder, rotary-knife roller-gin stand, and one Aldrich beater super-jet lint cleaner.
3. One 6-cylinder cleaner, gin feeder, saw-gin stand, (30 pounds of hulls added per ginning lot), and no lint cleaning.
4. Two 6-cylinder cleaners, one stick machine, gin feeder, saw-gin stand (30 pounds of hulls added per ginning lot) and one saw-type lint cleaner.

The four different ginning machinery sequences were selected to give as wide a range as possible of fine-trash content and fiber properties. The 30 pounds of hulls that were added per ginning lot in treatments 3 and 4 were fed directly in to the seed cotton, as it came down the feeder apron of the Continental 93 saw-gin stand and entered the huller front. The huller front did remove a small fraction of the hulls fed, but most were pulled into the rollbox. The feeding rate of the hulls was timed so that hulls were fed into the gin stand during the entire ginning lot. The hulls were added to provide additional hull fragments in the ginned lint for spinning evaluation of rotor-dust buildup.

Each ginning lot produced a bale of lint that weighed from 231 to 287 pounds, depending on the ginning treatment. These 12 bales were shipped to the USDA, ARS, Clemson Cotton Quality Research Station, Clemson, SC, for textile processing and testing. These cotton lots were processed through open-end spinning. using a rotor speed of 80,000 rpm and a yarn twist multiplier of 3.75 to produce a 20-count yarn. Each ginning lot was processed for a total of 72 rotor hours. Ends down and other yarn and fiber data were taken during the spinning phase of the testing program for evaluation.

Results and Discussion

Tables 1 through 5 give selected data from the spinning tests. These data were statistically analyzed against ginning treatments 1 through 4 that were earlier described. Measurement averages reported in the tables that are succeeded by different letters were determined to be statistically different at the 5% level by Duncan’s Multiple Range Test.

Table 1 gives average AFIS and Shirley Analyzer data for the raw fiber before spinning. There was some trend for fiber length to decrease as the ginning and cleaning treatment became more severe. However, Pima fiber is so strong that the UQL was not significantly changed, and the short fiber was only increased a small amount. The largest significant ginning effect was on nep counts, which tripled in going from Treatment 1 to Treatment 4. This was not unexpected and is an illustration of why Pima cotton is normally roller ginned. Both AFIS and the Shirley Analyzer showed ginning Treatment 3 to have the highest non-lint content. This higher foreign-matter content is probably the result of the added hulls and no lint cleaning.

The same measurements for raw fiber given in Table 1 are repeated for card sliver in Table 2. There is a non-significant trend for further shortening of overall fiber length due to cleaning and carding, as well as a small increase in short-fiber content. Carding tended to decrease the overall nep levels of the cottons from all four ginning treatments, such that there were no longer significant differences between ginning treatments at this stage. Carding had reduced the foreign-matter content in the card sliver, so that the differences in non-lint content between treatments were no longer significant. The differences in foreign-matter content at the card sliver were expressed by the significant differences in the Shirley Visible determination for the card waste.

There were significant differences between treatments in the waste levels collected during spinning (Table 3). Treatments 1 and 3 had the highest levels of spinning waste and were the ginning treatments that had the lowest amount of cleaning.

Table 4 gives the calculated ends down per 1000 spindle hours, which is of particular interest for this study. There are statistical differences between treatments, with Treatment 3 having the highest ends-down rate. This treatment had hulls added and no lint cleaning. It remains to be determined from further analysis of rotor dust what the rotor dust is composed of.

Average yarn measurements shown in Table 5 indicate that Treatment 3 had significantly the most uneven yarn. The separation in yarn quality tended to be between roller- and saw-ginning treatments, with the saw-ginning treatments with hulls added having the most uneven yarn. It is apparent from the data, that raw fiber was produced that resulted in significant performance differences during textile processing.

Summary and Conclusions

There was a need for ginned fiber with unusual properties for a specific open-end spinning test. A first-pick Pima module with high soil and leaf content was selected for testing. Pima cotton is not normally used in open-end spinning because of its premium length and strength characteristics. However, it was desired that fiber length and strength not be a limiting factor for this particular test, so the Pima cotton was utilized in this special test application. This module of Pima was processed in the Southwestern Cotton Ginning Laboratory to produce ginned fiber with a range of foreign-matter contamination levels. A specific contaminant of interest was hull fragments as a possible major source of rotor-dust buildup. This fiber was then sent to the Cotton Quality Research Station for further testing.

Open-end spinning tests show that the Pima cotton produced significantly different results as related to ginning treatment. In particular, there was a wide range in ends down during rotor spinning. It is assumed that the differing ends-down results are due to varying degrees of material buildup in the rotor grooves. This material in the rotor grooves was collected and will be analyzed to determine its constituent source. Further work and conclusions will depend on the outcome of the ongoing analysis of rotor-groove dust.

Disclaimer

Table 1. Average lint fiber properties.

Treatment	AFIS UQL, in.	AFIS SFC, %	AFIS Neps, No./g	AFIS Visible Foreign Matter, %	Shirley Visible Non-lint, %
1	1.40	6.0 ab	111 c	2.4 b	7.5 b
2	1.39	5.7 b	142 c	1.7 b	3.7 c
3	1.39	6.7 ab	271 b	6.3 a	14.3 a
4	1.38	7.6 a	332 a	2.6 b	3.9 c

Table 2. Average card sliver properties.

Treatment	AFIS UQL, in.	AFIS SFC, %	AFIS Neps, No./g	AFIS Visible Foreign Matter, %	Shirley Visible Card Waste, %
1	1.38	7.2	114	0.22	30.0 b
2	1.38	6.9	94	0.12	22.6 c
3	1.38	7.9	110	0.21	35.9 a
4	1.37	8.5	159	0.16	30.0 b

Table 3. Average spinning waste.

Treatment	Opening & Cleaning Waste, %	Total Card Waste, %
1	6.2 b	2.9 b
2	3.0 c	2.6 c
3	11.0 a	3.4 a
4	3.5 c	2.6 c

Table 4. Average yarn spinning data.

Treatment	Calculated Ends Down, #/1000 hrs.	Single Strand Strength, g/tex	Single Strand Strength CV, %
1	162 ab	16.7 b	10.4
2	125 b	17.1 ab	8.3
3	239 a	17.4 a	8.6
4	208 ab	17.2 ab	8.2

Table 5. Average yarn Uster measurements.

Treatment	Neps, #/1000 yds	Thick Places, #/1000 yds	Thin Places, #/1000 yds	Uster CV, %	Classimat Minor Faults, Number
1	10.7 b	46.3 b	6.0	13.7 b	58 ab
2	12.0 b	42.7 b	6.3	13.7 b	46 b
3	23.7 a	78.0 a	9.0	14.4 a	88 a
4	17.3 ab	58.7 b	10.0	14.1 ab	82 a