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THE EFFECT OF MOISTURE RESTORATION AT GINNING ON HVI AND AFIS FIBER PROPERTIES

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Abstract

The purpose of this study was to determine through a relatively small screening experiment the effect that a new technology, the Lewis Cotton Moisture System, has on the uniform application of moisture in a cotton bale during building, the moisture retention of the bale during long-term storage, and the influence it has on the bale's fiber quality parameters. Bales of normal (≈ 5 percent), six percent, eight percent, and ten percent moisture content were produced in a commercial Southeast gin. The test bales were government classed at the Memphis classing office after ginning and after one year of storage. Also, samples of all bales, captured in airtight glass Mason jars, were tested for moisture content, and after conditioning in a standard atmosphere for Zellweger Uster Advanced Fiber Information System (AFIS) fiber qualities. After the one-year storage period, one bale each of the four test conditions was opened for moisture retention tests, dust level, gram negative and total bacteria, and fungi tests.

Immediately after ginning and being brought to equilibrium in the Memphis classing office laboratory, the data show that bales having the higher levels of moisture restoration had higher fiber strength and color +b values. No statistics were performed because of the small sample size, only data observations of trends are reported for this portion of the screening experiment.

The data also show that the fiber strength observed in the USDA HVI (high volume instrument) data aided the cotton to withstand the rigors of the opening roller of the AFIS instrument resulting in a reduction in short fiber content. Seed coat neps and immature fiber content were less in the bales having higher moisture content.

After one year in storage, tests on one bale from each of the three higher moisture restoration conditions showed a trend towards lower fiber strength and a slight drop in color reflectance, and a small increase in yellowness. The one year stored bales also showed that much of the restored moisture still existed in the higher moisture content bales, and that the higher moisture content bales had significantly less gram negative and total bacteria, and less fungi than the lower moisture content bales.

Further studies are underway to obtain a larger sample size so that applicable statistics can be performed to determine the influence of the Lewis Cotton Moisture System on fiber quality when restoring moisture to cotton at the battery condenser.

Introduction

Cotton is a cellulose fiber that has a moisture regain in a standard atmosphere for textile testing of approximately eight percent. Previous research has shown that the moisture content of a cotton fiber directly affects its strength. The moisture content effect on cotton fiber strength is well documented and has reached a point among every aspect of the cotton industry to be considered common knowledge. However, with moisture restoration to cotton bales comes many additional considerations for the overall effect on cotton fibers. Some of these considerations are color degradation, dust, microbial growth, and the influence that restored moisture in baled cotton has on textile plant performance and product quality. With the development of new moisture application technology questions are being asked by producers, ginners, and textile manufacturers as to what is the optimum level of added moisture to facilitate good quality ginning and yarn and fabric manufacture. All of this, without initiating any fiber damage and/or serious difficulties during bale pressing or textile processing.

The Cotton Moisture System of Lewis Electric is one of several available moisture restoration systems in the cotton-ginning sector prior to baling. The difference claimed by the Lewis system over other moisture adding systems in cotton gins is accuracy in moisture application despite changes in the module moisture or the ginning environment. Some of the differentiating features of the system are: (1) the use of infrared and radio frequency technology to quantify moisture content continuously; (2) the system reads ginning production information every half second and can respond accordingly to ensure uniform moisture application percentage; (3) the additional moisture added to the cotton is computer controlled and divides each pound of water into 91 pulses with a control tolerance of plus or minus one pulse; and (4) the system has an entirely unique five nozzle arrangement for moisture application.

The objective of this screening study was to determine four key points relative to the Cotton Moisture System. The four objectives were: (1) moisture retention of the additional moisture in the bales; (2) distribution of the restored moisture throughout the bale; (3) effect moisture restoration has on the cotton fibers in the bale; and (4) effect of moisture restoration on spinning plant performance and yarn quality (Reported in the Textile Processing Conference).

Experimental

The cotton used in this experiment was grown and ginned near Mason, Tennessee in 2001. The variety was PM1218 BG/RR, which is categorized as early season, storm resistant, mid-tall, semi-smooth leaf, and having a typical gin turnout of 35 percent.

The experimental cotton was ginned from two modules harvested from the same field on the same day. The cotton was ginned in a standard mid-South ginning facility with three Golden Eagle Continental gin stands, Model Super 96. Four target bale moisture restoration conditions were produced. They were normal moisture (5%), eight percent bale moisture, ten percent bale moisture, and a mix of bales having various moisture restoration levels. The ten percent moisture condition studied was for academic purposes, realizing that that level greatly exceeded past research recommendations. Four bales of each of the four conditions were produced.

During the ginning of the four conditions, samples were taken before the gin stand, after the gin stand, after the lint cleaners at the battery condenser, and at the bale press. All samples were placed in glass Mason jars and sealed with airtight lids to prevent loss of fiber moisture. Samples for USDA classing were also taken at the bale press and sent to the Memphis classing facility.

The Mason jar samples were taken to the Institute of Textile Technology where the bale press samples were tested for moisture content using the "bone-dry" method. Once tested for moisture content the remaining portion of the bale press samples was placed in a standard atmosphere for textile testing of 65+/-2% RH and 70+/-2 °F to condition to equilibrium prior to fiber quality analysis. The quality analysis entailed testing for micronaire fineness and for various fiber quality attributes on a Zellweger Uster AFIS (Advanced Fiber Information System) instrument.

Results, Discussion, and Conclusions

Fiber Moisture Testing

Cotton fiber sampled at the bale press during the ginning of the four experimental conditions, and captured in tightly capped Mason jars, was tested for moisture content percent using the "bone-dry" method. The normal bales contained 5.02 percent moisture, the eight percent bales averaged 7.95 percent moisture, and the ten percent bales averaged 9.45 percent moisture. The variable bale lot averaged 5.90 percent moisture. Based on the target values of eight and ten percent, the Lewis Cotton Moisture System accurately metered the proper amount of water to obtain the desired moisture restoration levels.

Three months after the actual ginning, two bales from each of the four trial conditions were sampled at many different points throughout the bale and the samples placed in Mason jars for moisture tests. After three months in a standard cotton warehouse in Tennessee, the bales, which were wrapped in commercially available polyethylene bagging with air holes on 16-inch centers, measured 5.30 percent for the normal bales, 7.34 percent for the eight percent bales, and 9.15 percent for the ten percent moisture restoration bales. After three months in storage there was essentially no change in bale moisture content from the uniform application of moisture using the Lewis system. The other two bales per condition, although not opened, were weighed and the weight compared with that obtained at the gin. Essentially no change in bale weight was observed, e.g., a ten percent bale at the gin weighed 480 pounds. After three months in storage, it weighed 479.9 pounds. A normal bale weighed 512 pounds at the gin and 511.7 pounds after three months in storage.

A bale from each of the four test conditions stored after one year of warehousing at the USDA, ARS, Cotton Quality Research Station, Clemson, South Carolina, was sampled throughout by ARS personnel for moisture content, dust level, gram negative and total bacteria, and fungi. The results of the USDA analyses are given in Table 1.

The data show that after one year in storage the higher levels of moisture still exist in bales where higher levels of moisture restoration were applied at the battery condenser by the Lewis Cotton Moisture System, and that the eight and ten percent bales were significantly lower in gram negative and total bacteria when compared to the normal bake and a six percent bale. Also, the normal and six percent bales were significantly higher in fungi compared to both the eight and ten percent bales, and the ten percent bale was significantly higher in fungi than the eight percent bale. There was no significant difference in dust level between the five, six, eight, or ten percent bales after one year in storage.

One year after ginning the test conditions, one bale of each of three conditions was opened for moisture content and USDA HVI properties determination. The moisture tests, as mentioned, were performed at the Cotton Quality Research Station, USDA ARS, Clemson, South Carolina. The HVI tests were performed at the USDA Classing Office in Memphis, Tennessee. The USDA data for the identical three bales, tested one year apart, are given in Table 2. Because of the small sample size no statistical analysis could be performed on the data to obtain an accurate comparison. Trend observation, however, indicate a possible loss in strength after one year of bale storage. Also, as more moisture is restored at the bale press, and one year in storage, color Rd reflectance decreases and +b yellowness increases slightly. No other HVI data trends were noted.

Fiber Quality Testing

The samples from each bale per condition taken during ginning were HVI classed at the USDA's classing office in Memphis, Tennessee two days later. The average of four bales per test condition are given in Table 3. Because of the small sample size, statistical analysis was not performed on the data, but there is an indication that as moisture is restored to cotton just prior to baling, fiber strength and micronaire increases, and there seems to be a positive play on overall length characteristics. Color tends to slightly move towards increasing yellowness as water is added to cotton just prior to baling. As to whether or not any confidence can be placed on the above observations, more research is underway in the Southeast and far West to provide enough data for statistical analysis.

Samples taken at the gin were also tested for various fiber qualities using an AFIS instrument at the Institute, after the samples achieved equilibrium in a standard testing atmosphere. It must be realized that the data from the AFIS instrument is after the fiber has been passed through a somewhat rigorous opening device to achieve individual fiber separation, similar to passing through a cleaning machine in a textile plant. The results of this work are given in Table 4. The data show a trend toward improved fiber length characteristics, especially the level of short fiber content, as moisture is restored to cotton bales at the gin. This is probably due to the fiber's improved strength helping the fiber withstand the separation action of the opening roller in the AFIS instrument. There is also an indication that seed coat neps per gram decrease and that the immature fiber content percentages are enhanced by the addition of moisture to the cotton.

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Table 1. Results of USDA, ARS, Clemson Cotton Quality Research Station tests of moisture content, dust, bacteria and fungi on four test bales after one year in storage.*

	5% Bale	6% Bale	8% Bale	10% Bale
Moisture Content	5.730 a	6.03 a	6.79 b	7.19 c
Dust	2.816 a	2.728 a	2.751 a	2.703 a
Gram Negative Bacteria	6.071 a	6.125 a	5.575 b	5.556 b
Total Bacteria	6.474 a	6.456 a	6.011 b	6.099 b
Fungi	4.1317 a	3.9335 a	3.2381 b	3.6159 c

* Means with the same letter are not statistically significant.

Table 2. Results of USDA, HVI tests on the identical bales, one year apart in time.

HVI	5% Bale		8% Bale		10% Bale	
Measurement	2001	2002	2001	2002	2001	2002
Micronaire	5.1	5.3	5.2	5.3	5.4	5.3
Strength	29.1	28.2	28.5	28.2	29.1	28.2
Color Grade	31	31	31	31	31	32
Leaf Grade	3	3	3	3	3	3
Color Rd	76.0	76.0	76.0	75.8	77.0	74.8
Color +b	9.1	9.03	9.0	9.23	9.2	9.6
UHML	1.030	1.038	1.020	1.038	1.030	1.035
Uniformity	83	82	81	82	82	81.8

Table 3. USDA HVI data (Memphis AMS), average of four bales per condition.

		Moisture Restoration Bales	
Characteristic	Normal (5%)	8%	10%
Micronaire	5.18	5.25	5.30
Length	1.03	1.03	1.04
Uniformity	82.8	81.5	82.5
Strength	28.55	28.63	29.75
Color Rd	76	76	76
Color +b	8.9	9.1	9.2
Trash	3.00	3.75	3.50
Classer's Grade	31-3	31-3	31-3

Table 4. Results of Zellweger Uster AFIS tests on laboratory conditioned samples of baled cotton taken at the gin while producing the test bales.

		Restored Moisture Bales	
Measurement	**Normal (5%)**	**8%**	**10%**
Micronaire	5.07	5.16	5.14
Moisture Content, %	5.02	7.95	9.45
AFIS			
Mean Length, inches	0.89	0.91	0.91
UQL, inches	1.07	1.08	1.08
Short Fiber, %	9.0	8.6	8.2
Neps per Gram	225	219	223
Seed Coat Neps per Gram	37	34	31
Maturity Ratio	0.89	0.89	0.90
Immature Fiber Content, %	4.3	4.2	3.7
Visible Foreign Matter, %	1.19	1.46	1.29