2003 BELTWIDE COTTON CONFERENCES, NASHVILLE, TN – JANUARY 6-10

BALE MOISTURE CONTENT'S INFLUENCE ON FIBER PROPERTIES

Everett E. Backe
Institute of Textile Technology
Charlottesville, VA

Abstract

A screening experiment was conducted to determine the effectiveness of the Lewis Electric Company's Cotton Moisture System for restoring moisture to cotton at the battery condenser during ginning. The study was designed to assess claims that the unit can restore moisture to cotton at any given reasonable target value and to do it evenly and uniformly throughout the bale. Additional tests were performed to determine if any quality deterioration of fiber properties occurred after one year in storage. Target levels of five, eight, and ten percent final bale moisture content were studied. One six percent bale was also used in this investigation for mix variability spinning trials. The results of the moisture content tests showed that the Lewis Electric Company's Cotton Moisture System accurately restores moisture to cotton bales at the target level desired, and it maintains the target level evenly and uniformly during the building of the bale. After three months in warehouse storage, the moisture contents of the test bales were close to the values determined immediately after ginning, overall and throughout the bales. After one year in storage, the higher the level of moisture restoration initially, the higher the value obtained from bone dry testing. USDA tests for bacteria, dust, and fungi showed the higher moisture content bales to be lower in total bacteria, gram negative bacteria, and fungi compared to the lower moisture content bales. The ten percent bales were higher in bacteria and fungi than the eight percent bales. No differences were found with respect to dust from any of the moisture restoration levels studied. High Volume Instrument (HVI) and Advanced Fiber Information Systems (AFIS) fiber test results after one year in storage showed a possible loss in fiber strength at all moisture levels, and the higher the moisture content the lower the color Rd value and the higher the +b value. The color change was slight in all cases. AFIS measurements showed a trend towards improved fiber length and lower short fiber content as the level of restored moisture increased. Increases in moisture also tend to decrease AFIS seed coat neps, and improves immature fiber content values.

Introduction

Recent developments in moisture restoration technology for cotton bales at the battery condenser during ginning has precipitated much discussion as to what level of moisture content in cotton bales should exist for maximum return to the producer, ginner, and eventual textile processor. This, without undue fiber quality deterioration. Claims by Lewis Electric Company of Memphis, Tennessee that its Cotton Moisture System can restore moisture to ginned cotton just prior to the bale press at any given reasonable level, and do it evenly and uniformly throughout the bale, has been the basis of the newly found interest in cotton moisture restoration research at the gin.

In 2001, the Institute of Textile Technology undertook this screening experiment to determine the validity of the Lewis Electric Company's claims, and to find if the added moisture being evenly applied stayed in the bale over long periods of time to eventually aid the textile processor.

The trial began on September 13, 2001, and spanned over a one-year period. This work found its way into the public literature where it received both accolades and criticism from various cotton groups. As a result, trials are now underway in the Southeast and the Far West to repeat the work. Collaborating in the two studies are the National Cotton Council, the USDA ARS mid-South and Far West ginning laboratories, and the Cotton Quality Research Station at Clemson, South Carolina, and the Institute of Textile Technology.

Experimental

The cotton used in this study was commercially grown near Mason, Tennessee. The variety was PM 1218 BG/RR. Two modules, harvested from the same field on the same day, were ginned at the Longtown Gin in Mason. The Lewis Electric Company's Cotton Moisture System was manually set at three different target values, i.e., five, eight, and ten percent. Four bales were produced at each moisture level. One bale of six percent moisture was produced to facilitate a variable moisture content mix for later spinning trials. Samples were taken at the bale press during ginning and placed in airtight Mason canning jars for eventual moisture content and AFIS fiber quality tests at the Institute of Textile Technology. The standard USDA samples were taken and sent to the Memphis Classing Office for HVI class.

After three months in storage bales from each of three moisture levels were opened and sampled for moisture content tests. Again, tightly sealed Mason jars were used to hold the samples until testing at the Institute of Textile Technology.

After one year in storage the remaining unopened bales from each of the three multi-bale moisture levels and the one six percent bale were opened and Mason jar sampled for moisture content, dust, gram negative bacteria, total bacteria, and fungi testing. The HVI testing was performed by the Memphis Classing Office on the exact same three moisture content level bales as immediately after ginning. The USDA Cotton Quality Research Laboratory in Clemson, South Carolina, performed the dust, bacteria, and fungi testing.

Results and Conclusions

Moisture Content Testing

Cotton fiber sampled at the bale press during the ginning of the three multi-bale experimental conditions, i.e., five, eight, and ten percent, and captured in tightly capped Mason jars, was tested for moisture content percent using the bone-dry method. The five percent bales contained 5.02 percent moisture, the eight percent bales average 7.95 percent moisture and the ten percent bales averaged 9.45 percent moisture. Based on the target values of five, eight, and ten percent, the Lewis Electric Company's Cotton Moisture System accurately metered the proper amount of water to obtain the desired moisture restoration levels.

After three months storage, two bales from each of the three multi-bale trial conditions were sampled at many different points throughout the bale and the samples placed in Mason jars for moisture tests. After three months the bales measured 5.30 percent for the five percent bales, 7.34 percent for the eight percent bales, and 9.15 percent for the ten percent moisture restoration bales. There was essentially no change in bale moisture content from the application of moisture using the Lewis Electric Company's system.

A bale from each of the three multi-bale test conditions and the one, six percent bale stored after one year of warehousing 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 Electric Company's Cotton Moisture System, and that the eight and ten percent bales were significantly lower in gram negative and total bacterial when compared to the five percent bales and the six percent bale. Also, the five percent bales and six percent bale 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, one bale of each of the three multi-bale conditions was opened for moisture content and USDA HVI properties determination. The USDA's Memphis Classing Office 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, indicates a possible loss in strength after one year of bale storage. Also, as more moisture is restored at the battery condenser, and one year in storage, color Rd reflectance decreased and +b yellowness increases slightly. No other HVI data trends were noted.

Fiber Quality Testing

The samples from each bale per multi-bale 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 is 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.

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 more 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 immature fiber content percentages are enhanced by the addition of moisture to the cotton.

Acknowledgement

The author wishes to thank the Lewis Electric Company of Memphis, Tennessee, for funding this screening project and purchasing the cotton, the Longtown Farms, Mason, Tennessee, for ginning the four test conditions, and the USDA-ARS Cotton

Quality Research Station, Clemson, South Carolina for providing some of the moisture content measurements and all of the dust, bacteria, and fungi data.

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