IMPROVED MICRONAIRE CALIBRATION

Steve L. Grantham, James L. Knowlton and Lee Gibson
USDA, AMS,
Cotton Program
Memphis, TN

Abstract

In its continued mission of providing quality data in a timely fashion, the USDA, AMS, Cotton Program fully implemented a new micronaire calibration during the 2001 season. This newly developed micronaire orifice calibration utilizes stainless steel precision-drilled air orifices for the calibration of the micronaire system. This new method has provided the Cotton Program the ability to provide more precision to the micronaire calibration. Costs associated with the calibration routines have been reduced as a result of the non-deteriorating nature of the orifices and the decreased consumption of calibration cottons.

Introduction

The Cotton Program currently has twelve classing offices across the United States cotton belt. Cumulatively, the classing offices will grade approximately 17 million bales annually and individual classing totals usually vary from 300,000 bales to 3,000,000 bales depending on the office and the cotton production of the crop in the area. The Cotton Program utilizes 240 High Volume Instruments throughout its twelve locations for the determination of 5 official fiber quality measurements that are provided to the cotton industry. These measurements are related to the micronaire, length, length uniformity, strength and color. The Cotton Program also utilizes a corps of classers in each location that determines the official grade for leaf and makes any notations for extraneous matter if enough is detected throughout the sample.

The Cotton Program first began using instrumentation in the classification system in June of 1966. The first instrument measurement was the micronaire. The micronaire measurement is a determination of fiber fineness. A specimen of cotton within a specified weight range is placed inside a chamber with a constant volume. The cotton is subjected to airflow and the micronaire is determined by the amount of air that passes through the fibers. This stand-alone instrument was referred to as the fibronaire and was a part of the High Volume Instrumentation that was first introduced in the Cotton Division in 1980.

During the 1997 crop year, the Cotton Program began investigating a better calibration of the micronaire system. The variability within the cotton fibers was accounted for in calibration initially by performing multiple tests that were averaged. A comparison of the observed average value and the actual standard value was used to calculate the slope and offset values needed for the optimum setup. However, other factors still remained unaccounted for such as operator technique. In the most recent instruments produced by Zellweger Uster, other methods were adopted through software to reduce other inherent factors affecting the calibration process. Limits were established in the HVI software regarding the degree of change that would be allowed in the calibration constants. Thereby, if the observed value compared to the standard value calculated a slope and/or offset constant that was outside of set parameters, the instrument would reject the calibration constants and fail the calibration, thus forcing a recalibration routine. The Cotton Program personnel felt that enhancing setup procedures and utilizing more precise calibration material could improve these methods. It was believed that machined orifices could produce a similar affect as cotton in the micronaire system and would produce a more precise calibration due to the precision drilling of the orifices. Several studies were developed and tested over the span of 3 years to determine the feasibility and future possibilities of orifice calibration and its effect on the accuracy of the micronaire measurement.

During the spring and summer of 2000, great strides were made in the final design of the necessary procedures and materials for a much more extensive study. This study was conducted on a broader scale throughout the 2000 crop season and a total of 20 HVIs were evaluated in 4 different offices. Following the promising results of this study, a full implementation of the micronaire orifice calibration was initiated in the 2001 crop season.

Calibration

The calibration of the micronaire utilizes high and low micronaire cottons in the determination of the proper slope and offset calculations. These calculations are applied in the micronaire measurement as a means of measuring the range of micronaire found in various cottons. Precision air orifices are utilized in much the same way as cotton in the calibration routine. An orifice with a larger diameter hole is utilized for the high micronaire measurement and a small diameter hole is utilized for the low micronaire measurement. The difference in diameter causes the similar pressure drop found in the cottons resulting in the determination of the micronaire measurement. However, since there is variability inherent within cotton fibers and the

holes in the orifices have relatively no variation due to their precise manufacturing, the orifices provide a more precise measurement for the determination of the slope and offset constants calculated in the calibration routine. This is very evident when looking at the actual slope and offset values taken from several instruments in the 2000 study and illustrated in the following Table 1. This data provides evidence that the precision-drilled orifices yield more stability in the calculation of the slope and offset constants.

One challenge associated with the orifice calibration is the lack of sensitivity in the volume of the chamber size. Cotton must still be used for the setup of the chamber size and this has proven to be critical in the proper instrument setup for the micronaire measurement. In order to achieve improved accuracy in setting the chamber volume for the orifice calibration method, a new cotton standard was developed. The new standard is high micronaire carded cotton named "Chamber Size Calibration Cotton (CSCC)." The procedure for using the CSCC involves calibrating the micronaire measurement to the orifices first. The orifice calibration ensures accurate air system calibration. Exactly ten grams of CSCC is then placed into the chamber for measurement. The chamber depth adjustment shaft is then adjusted until the known CSCC value is measured. This chamber volume setting procedure reverses the order of the currently accepted method. By reversing the order, the calibration of the air system is accurately achieved with the orifices that provide a solid basis for accurate setting of the chamber volume using the CSCC. The old cotton chamber volume setting method, which relied upon default calibration slope and offset settings, did not guarantee accurate chamber volume setting. Default slope and offset settings confound air system differences with chamber volume setting.

Value Establishment

It is imperative that the Cotton Program maintains a constant level of testing from year to year. Prior to the implementation of the micronaire orifice calibration, several tests were performed to ensure that no shift in that testing level would occur. The Standardization and Engineering Branch (S and E Branch) selects bales of cotton each year for purposes such as instrument calibration, instrument evaluation and grade standards. In addition the S and E Branch maintains in its inventory a variety of bales referred to as stake bales and benchmark bales. These bales serve as monitors of the testing level from year to year. The standard values for the orifices are referenced to the benchmark cottons.

When establishing values, multiple instruments were calibrated to the micronaire calibration cottons. Samples of the benchmark cottons were gathered and tested on the instrument as well as the precision drilled orifices. These values were recorded and all of this data was corrected to the standard benchmark levels to minimize any level difference caused by calibration influences. All of the precision-drilled orifices thus have their standard values referenced back to the benchmark cottons. In addition, three sets of precision-drilled orifices have been mounted in the brass plugs and have been established as reference orifices for the purpose of monitoring the level.

Conclusions

There were many challenges along the way in the development of this new calibration procedure. Probably the most challenging was the optimization and setup of each of the components in the micronaire system. The previous calibration procedures utilizing cotton did not optimize these setups because the cotton would account for deficiencies in the calibration routines. The sensitivity to the chamber size proved to be one of the most challenging hardware setups. Different types of procedures and materials were investigated in an attempt to find a precise way of establishing the chamber size. Other materials and other procedures for establishing a constant chamber volume from instrument to instrument did not prove to be as sensitive or as successful as cotton. A carded high micronaire cotton proved to be the best material for establishing a constant volume size that could be set and maintained across several instruments.

Several precautionary measures were put into practice during the 2001 classing season in conjunction with the new micronaire calibration procedure. A weekly chamber size verification, weekly brass plug verifications, and daily cotton verifications were implemented. The weekly chamber check was established to monitor any drift in chamber size. The brass plug verification was established as a means of monitoring potential drifts in the micronaire values of the orifices due to potential residue build up on the orifices.

One key advantage of the micronaire orifice calibration routines is the ability to identify hardware deficiencies more effectively. Proper instrument setup is more crucial and essential for the calibration of the micronaire system utilizing the precision-drilled orifices. This new calibration procedure has proven to be more challenging than past methods but has already demonstrated some positive impacts on the Cotton Programs ability to trim costs while maintaining a high level of quality in testing. Improved consistency within the calibration routine has led to improved efficiency in production and operations. There is less variability in the micronaire calibration due to the consistency of the orifices when compared to the cotton.

The USDA, AMS, Cotton Program continues to gain experience with instrumentation, calibration and testing practices. The cotton industry will continue to see improved results and efficiencies as instruments become better through technology and enhanced calibration and setup practices.

Table 1.

STANDARD DEVIATIONS		ORIFICE		COTTON	
OFFICE	**HVI (900-U)**	**SLOPE**	**OFFSET**	**SLOPE**	**OFFSET**
		.00494	.03043	.00831	.03835
ABILENE		.00214	.00737	.00766	.05434
		.00742	.05200	.01335	.10270
MACON		.00983	.01702	.01160	.06155
		.00422	.01155	.01326	.05711
MEMPHIS		.00616	.01441	.01352	.05911