

MICRONAIRE ORIFICE CALIBRATION
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Abstract

The USDA, AMS, Cotton Program developed a new procedure to calibrate the micronaire component of the Zellweger Uster 900 automatic High Volume Instrument (HVI) through the use of air orifices to provide a more accurate calibration for the micronaire measurement. A pilot study was conducted on 25 HVI systems at four Cotton Program offices during the 2000 cotton classing season. Checklot results from the Cotton Program's Quality Assurance Section indicate that the HVI systems calibrated with the air orifices had a higher reproducibility for micronaire than those calibrated by the traditional calibration cottons. The study also revealed that the air orifice calibration offers increased efficiency through a faster micronaire calibration and cost savings through reduced calibration cotton consumption. The Cotton Program plans to expand the micronaire orifice calibration to additional classing offices based on the positive results of this study.

Introduction

The Cotton Program provides classification services to the cotton industry on approximately 17 million bales of cotton annually. The measurement of micronaire was introduced into the classification system on June 1, 1966 and was the first instrument measurement to be included in the classification system. Micronaire is a measure of fiber fineness as determined by an airflow instrument. The airflow instrument measures the air permeability of a constant mass of cotton fibers compressed to a fixed volume. The basic components of the airflow instrument include a balance, a compressed air system, and a test chamber. The micronaire measurement was performed through a stand-alone airflow instrument for many years, which was incorporated into the HVI systems when the Cotton Program began HVI testing.

The Cotton Program first began exploring the possibility of using air orifices to calibrate micronaire during the 1997 classing season. While the use of cottons to calibrate micronaire had proven to be very effective through the years, Cotton Program personnel conducted several preliminary tests to investigate the possibility of using air orifices to calibrate micronaire. The results of the preliminary tests identified the potential for achieving greater micronaire calibration accuracy. However, problems were encountered in the test chamber volume setup procedures.

A series of studies were once again conducted by Cotton Program personnel during the winter and spring of 2000 to further investigate the practicality of using air orifices to calibrate micronaire. These preliminary studies resulted in a modification of the micronaire test chamber volume setup procedures and a standardized value establishment process for the air orifices that allowed Cotton Program personnel to overcome the problems that were encountered during the 1997 studies. The results from the 2000 preliminary studies evolved into the decision to conduct a micronaire orifice calibration pilot study at four Cotton Program offices during the 2000 cotton season.

Calibration of the Micronaire Measurement

The accepted method for calibrating the micronaire measurement involves using high and low micronaire calibration cotton standards. Slope and offset constants are calculated based on the differences between the

measured and known values of the calibration cottons. Although this method has worked well for many years, the concept of a mechanical calibration using air orifices in place of cotton offers the potential for greater calibration accuracy. Air orifices can mimic cotton in the chamber for calibration of the air system while providing resistance to airflow that is more consistent than cotton. Airflow resistance in cotton varies depending on factors such as the openness of the fibers being placed into the chamber. Orifices, on the other hand, are precisely manufactured to accurately control the airflow. The disadvantage to the orifice calibration is the lack of sensitivity to chamber volume. Cotton calibration's sensitivity to chamber volume will compensate to some degree for less than ideal chamber volume settings. Therefore, in order to achieve a successful orifice calibration procedure, accurate chamber volume is critical.

Methods for Setting the Chamber Volume for Cotton Calibration

A standardized chamber volume is critical for obtaining the correct cotton density required for accurate pressure drop in the chamber. As previously stated, this becomes even more critical for the orifice calibration method. The accepted method utilized by the Cotton Program for setting the chamber volume is to use a high micronaire standard cotton. This method involves setting the micronaire calibration constants (slope and offset) to their default values followed by performing several micronaire measurements on the high micronaire cotton standard. The chamber depth is adjusted by turning a threaded adjustment shaft until the micronaire measurement agrees with the standard value of the cotton.

Methods for Setting the Chamber Volume for Cotton Calibration

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 a 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 which provides 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 always provide the most accurate chamber volume setting.

Value Setting for Air Orifices and Chamber Size Calibration Cotton Standards

Value setting for the calibration orifices and CSCC standard was achieved by careful calibration of several HVI micronaire systems to "Benchmark Calibration Cotton Standards." The Benchmark Calibration Cotton standards are used as the reference for value establishment on all micronaire calibration cotton standards. Once the benchmark calibration levels of the HVI micronaire systems were verified, values were set on a master set of air orifices and on the CSCC. This process successfully transferred the cotton standard calibration level to the new orifice calibration method.

2000 Crop Study Procedures

Prior to the 2000 classing season, three USDA Classing Offices along with the Quality Assurance Section located in Memphis, Tennessee were designated to participate in the study. The classing offices selected were located in Macon, GA; Memphis, TN; and Abilene, TX. These offices

represented a cross section of the cotton crop and provide classification services on a considerable amount of cotton, ensuring an acceptable number of samples for study. The purpose of this study was to examine the performance of the micronaire measurement of the HVI systems calibrated to the air orifices. The primary goal of this study was to determine if there was any improvement in the reproducibility for micronaire (based on Quality Assurance checklot data) for the HVI systems calibrated to the air orifices compared to those HVI system calibrated to the traditional calibration cottons.

Each classing office selected five HVI systems at random for the study and the Quality Assurance Section dedicated all ten of its HVI systems to the study. The chamber volume was established on all 25 systems through the modified setup procedure using the CSCC standard. Upon completion of the chamber volume setup, the HVI systems were calibrated for micronaire throughout the 2000 crop using the air orifices exclusively. Micronaire calibration cotton standards were utilized for these HVI systems four times per operating shift to verify that the calibration established the correct test level.

The 2000 pilot study focused on the micronaire reproducibility of the HVI systems in the participating classing offices calibrated by air orifices compared to the HVI systems calibrated to the traditional calibration cottons. The samples used for the 2000 study were the checklot samples from each of the participating offices. Checklot samples are samples that have been classed in the respective classing offices and randomly selected by computer for retest at the Quality Assurance Section in Memphis, TN. Approximately one percent of all cotton classed in an office each day is selected as checklot samples and shipped overnight for testing in Quality Assurance. The test results for the checklot samples from Quality Assurance are compared to the test results for the checklot samples from the classing offices. Reproducibility results for each quality factor are provided to the respective classing office on a daily basis to ensure accurate classification data is provided to the cotton industry.

Results and Discussion

A comparison of micronaire reproducibility results was made between HVI systems calibrated with the air orifices and those calibrated with traditional calibration cottons. The average micronaire reproducibility for the HVI systems calibrated to the air orifices was 82% on 5,983 checklot samples with a test tolerance of +/- 0.1 micronaire unit. The average micronaire reproducibility for the HVI systems calibrated to the calibration cottons was 78% on 15,967 checklot samples with a test tolerance of +/- 0.1 micronaire unit. (Table 1)

A comparison of the slope and offset calibration constants for the two micronaire calibration methods was also performed. Variations from calibration to calibration were less for the orifice calibration method versus the cotton calibration method as indicated by the lower standard deviations for the slope and offset calibration constants. (Table 2) This increase in calibration consistency is a good indicator of calibration accuracy.

Conclusion

The micronaire orifice calibration study conducted during the 2000 classing season indicated that the new techniques developed by the Cotton Program for calibrating the micronaire component of the HVI systems provides a method for obtaining greater calibration accuracy for the micronaire measurement. The HVI systems that were exclusively calibrated to the air orifices displayed a higher reproducibility for micronaire based on Quality Assurance checklot samples than the HVI systems that were calibrated to the traditional calibration cottons.

In addition to greater calibration accuracy, the air orifice calibration offers increased efficiency in the HVI operation through a faster micronaire calibration. The orifice calibration also greatly reduces the amount of calibration cotton utilized in the HVI operation, which results in a significant cost savings for the Cotton Program.

The Cotton Program plans to expand the micronaire orifice to additional Classing Offices during the 2001 classing season based on the positive results of this study.

Table 1.

Calibration Method	# Samples	% Reproducibility (+/- 0.1 Unit)
Orifice	5,983	82
Cotton	15,967	78

Table 2.

HVI	Calibration Method	# Calibrations	Slope Standard Deviation	Offset Standard Deviation
1	Orifice	318	0.00422	0.01155
2	Orifice	299	0.00616	0.01441
3	Cotton	287	0.01326	0.05711
4	Cotton	304	0.01352	0.05911