CALIBRATION OF UPGRADED FINENESS AND MATURITY TESTERS. PART II. EXPANSION OF RESULTS

T.M. Von Hoven, J. Montalvo, S. Reed and D. Francois
USDA, ARS
Southern Regional Research Center
New Orleans, LA
Sherman Faught
Cotton Incorporated
Cary, NC

Abstract

Calibration of SRRC upgraded FMTs (Fineness and Maturity Testers) using the constant offset technique has proved successful as demonstrated previously (Von Hoven et. al, 2001). However, one of the FMTs shipped to SRRC for upgrading and calibrating was loosened during shipment. Due to a series of problems, the FMT was not air-tight and thus not generating reliable data. Once the system was leak free, it was upgraded and calibrated as the unit that preceded it. A comparison of micronaire, fineness and maturity between the two upgraded and calibrated FMTs demonstrated that the two FMTs were generating statistically similar data.

Introduction

Previous research has shown that to generate reliable and accurate data from the Shirley Developments Limited Micromat, FMT (Fineness and Maturity Tester), an upgraded, leak free instrument is required. Air is drawn through the cotton specimen producing negative pressure drops, PL and PH at the initial and final stage of compression. Thus, if the system leaks, micronaire, maturity and fineness values are incorrect because PL and PH measurements are incorrect. During shipment of an FMT to SRRC for upgrading, several problems arose which required solutions to render the system leak free. For example, the gap between the sample chamber top and chamber lid was no longer parallel and, in fact, was too large, > 0.6 mm. Once the system was upgraded and leak free, it could then be calibrated in the constant offset technique as was presented previously (Von Hoven, et. al, 2001). This paper describes some of the solutions and compares data from the retooled system to that of a previously calibrated FMT.

Experimental

Upgrading of an FMT has been described in detail (Von Hoven, et. al, 2001). Some new problems for the instrument under consideration are as follows. Initially, shim stock metal was used to shim the rotator bar holders to reduce the gap. A parallel gap of about 0.4 to 0.45 mm gap is common to the other upgraded FMTs and is very important in making the system leak free. The next problem was with the Teflon wall of the chamber cylinder. It had dropped down in its metal liner so that it was no longer flush with the top surface, and was no longer vertical in the metal liner. Because of this, a new Teflon cylinder was press fit into the metal holder using 6000 psi. This offered a very permanent solution to this problem. To keep the sample piston vertical, a shim was placed at the bottom brace to reduce the off angle at which the piston resided. To make the lid handles more secure, a stabilizer bar and additional screws were included. Next, the lid latch bar catch was moving from left to right. Washers were added on either side to stabilize it. Because of this lateral movement, the latch bar catch had worn and was no longer parallel to the bar. To alleviate this problem, a shim was used to make the latch bar catch parallel to the latch bar. All of this was accomplished while maintaining the chamber volume.

Materials and Methods

The micronaire, fineness, and maturity values by independent reference methods for twelve calibration cottons, were averaged across the methods to produce their declared or target values (Von Hoven, et. al, 2001). These reference methods included image analysis of fibers following the Boylston technique (Boylston et. al, 1991) to polymerize the samples. The images were analyzed using the Fiber Image Analysis system (Xu-B; and Ting-Y-L, 1996). Near Infrared Spectral Analysis Software, NSAS, by NIRSystems, Inc. was used to generate the spectra and data. The NIR was calibrated with other data for micronaire, fineness and maturity to generate those values for the bulk sample of the twelve cottons. Fiber fineness and maturity ratio were measured using 2000 fibers according to British Standard Methods (British Standard BS 3085:1981 and BS EN ISO 1973:1996). The declared values were used as input data in a computer program to back calculate Lord's FMT models to produce declared PL and PH values for the twelve cottons.

Once leak free, the FMT was calibrated using the constant offset technique with the same twelve cottons used to calibrate the other instruments (Von Hoven et. al, 2001). In brief, the constant offset technique involves increasing the PL and PH piston stroke lengths slightly and the resultant pressure drops through the cotton, until the difference between the experimental and target instrument readings is independent of micronaire. This technique results in a constant difference or offset of about -8 mm of water for the pressure drop through the calibration cottons. Setting the zero adjustment on the digital pressure indicator to a + 8 mm of water will automatically subtract the offset from the actual pressure drops from the cotton, which are no longer seen on the pressure indicator. These corrected readings referred to herein simply as observed readings and are stored on hard disk and used to compute micronaire, maturity and fineness.

The twelve cotton samples were prepared for FMT calibration by the constant offset technique and then analyzed as unknowns. Four-gram fiber samples were carded using Louete cotton hand cards with 100 picks per inch. The carded sample was then rolled into a sliver with a diameter of approximately 2 inches. The sliver was inserted into the FMT chamber using a pronged mechanical device. Operators handled the cotton only to weigh the sample and place it on the cards, after that the operator did not touch the sample.

To check the stability of the system, a series of 95 measurements across 11 measurement sets were repeated with physical standards that simulated a high, mid, and low micronaire content (Montalvo and Faught, 1999). The coefficients of variation were determined and shown in Table 1.

Results and Discussion

Maturity and fineness for the twelve calibration cottons were measured directly using BSM. They were calculated using parameters measured by image analysis and fiber to bulk sample corrections predicted using NIR. The declared values of PL and PH were then generated from the mean of BSM, NIR and image analysis techniques. After calibration of the FMT, the declared micronaire and fiber properties for the twelve cottons were compared to those measured by FMT when the same twelve cottons were analyzed as unknowns.

Previous research demonstrated the practicality and goodness of fit of data of the constant offset calibration technique (Von Hoven, et. al, 2001). Utilizing the constant offset relationship, the mean difference between observed and target values are automatically subtracted for PL and PH and then maturity and fineness are calculated. Relating the PL and PH calculated maturity and fineness values to those of the mean of the BSM, NIR and image analysis good correlations were discovered. Figure 1 indicates the difference between the declared and observed values with the pressure indicator zero adjustment set at 0 mm water, and are independent of micronaire. Figures 2, 3, and 4 show the relationships with the zero adjustment set at + 8 mm water, between the declared and observed values for micronaire, maturity, and fineness. As can be seen from these graphs, the correlation is quite good indicating that using the constant offset technique can correlate the observed FMT values to the declared values.

Comparing two upgraded FMTs (both Micromat models) that had been calibrated identically, the instruments are producing the same results. As in Figures 5, 6, and 7 the correlations of the micronaire, maturity and fineness values are excellent between the two machines.

In the 95 runs of the physical standards, the FMT was leak free and generated precise data. Table 1 shows the CVs of micronaire, maturity and fineness of six of the nine sets of data as well as the pooled CV from all measurement sets. Refining operator technique decreases CVs. Based on this data, the importance of the physical standards in checking the leak status of the FMT as well as the calibration of the FMT is clearly demonstrated.

Conclusions

The constant offset between the declared and observed values seems to be the easiest and most direct way to calibrate the FMT. With a mere automatic subtraction of the offset, there is high correlation between the declared and observed PL, PH, micronaire, maturity and fineness data. In addition, two upgraded, calibrated FMTs produce data that are highly correlated for micronaire, maturity and fineness, indicating that the constant offset technique and the prescribed upgrading and calibrating are valid.

Acknowledgments

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Table 1. Headspace resistance standards CV (%) over several replications.

Measurement Set	Fineness	Maturity	Micronaire
1	0.098	0.12	0.00
2	0.078	0.068	0.00
3	0.092	0.078	0.034
7	0.064	0.038	0.00
8	0.066	0.061	0.00
9	0.054	0.037	0.00
Pooled CV	0.072	0.065	0.017

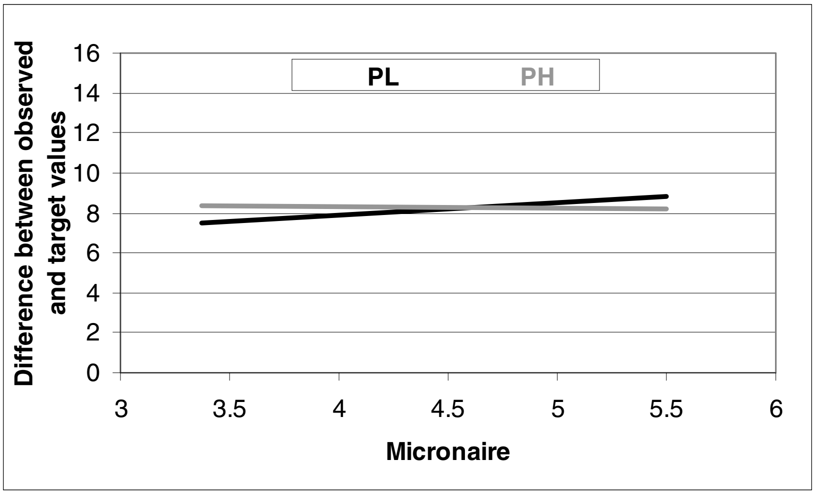

Figure 1. Constant linear offset relationship between observed and target instrument readings.

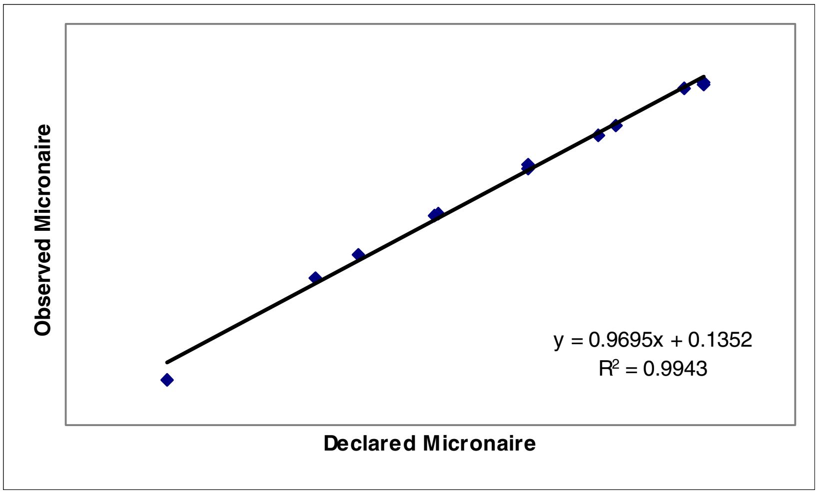

Figure 2. Relationship between observed and declared micronaire after offset correction.

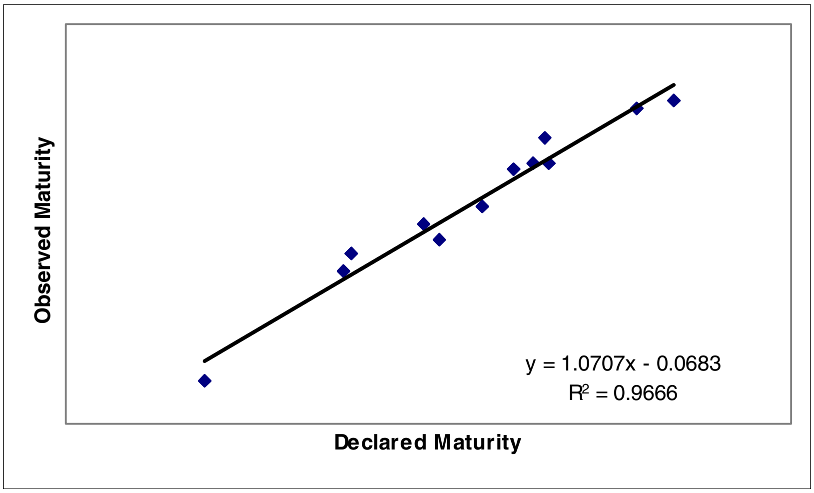

Figure 3. Relationship between observed and declared maturity after offset correction.

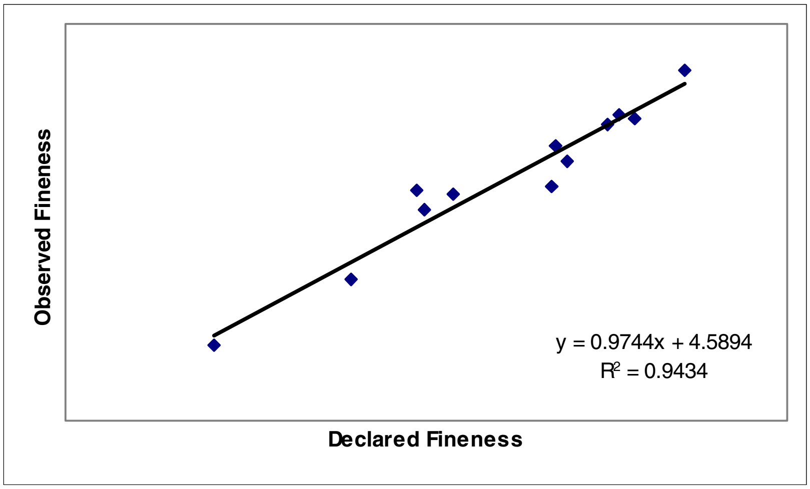

Figure 4. Relationship between observed and declared fineness after offset correction.

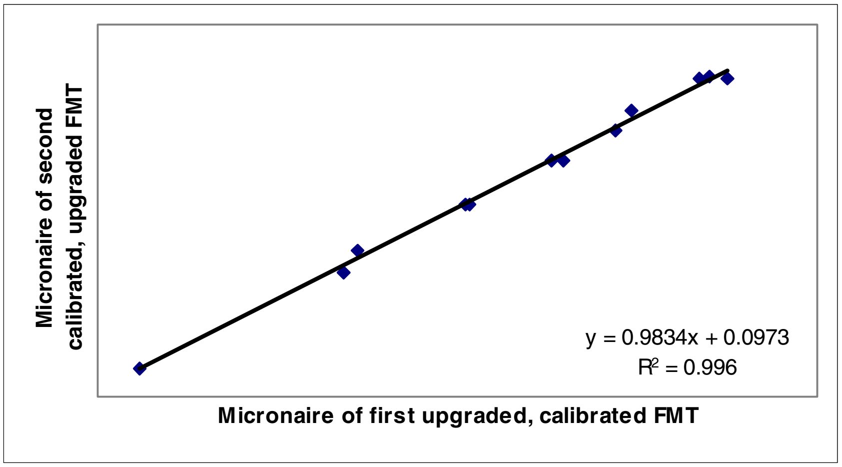

Figure 5. Comparison of micronaire of two upgraded, calibrated FMTs.

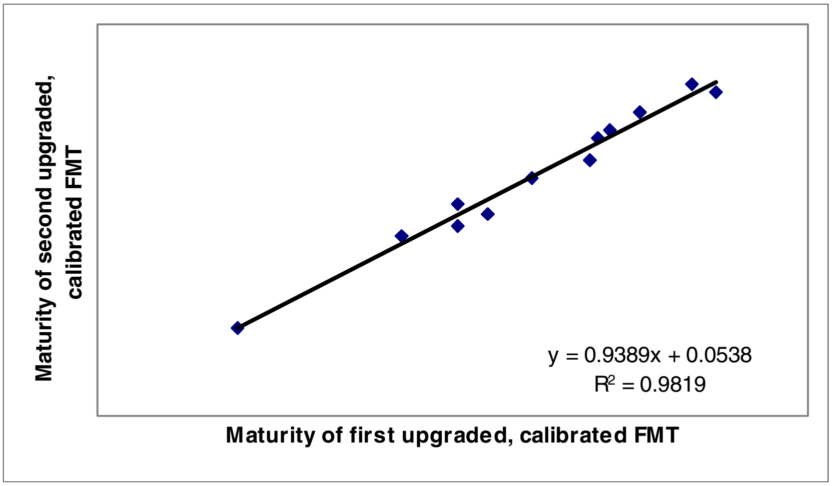

Figure 6. Comparison of maturity of two upgraded, calibrated FMTs.

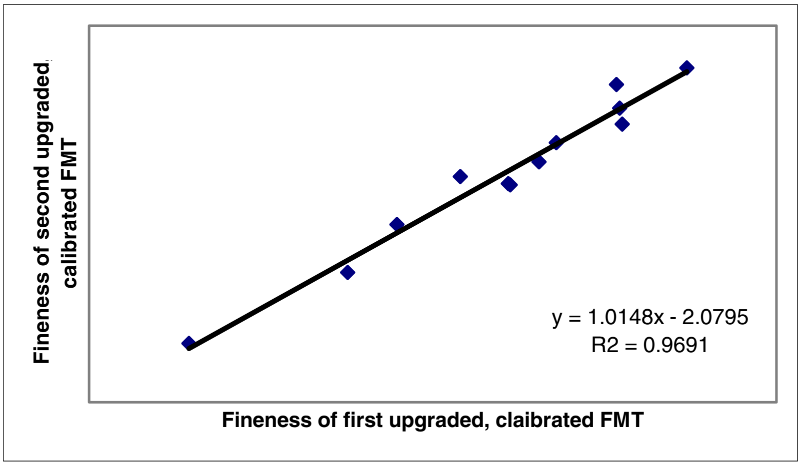

Figure 7. Comparison of fineness of two upgraded, calibrated FMTs.