SIGNIFICANT EVENTS LEADING TO THE DEVELOPMENT AND UTILIZATION OF THE MICRONAIRE TEST

Harvin Smith, Assistant Director

Introduction

The micronaire test for fineness and maturity of cotton fibers is now in such wide use that it is often taken for granted. However, inquiries from various sources regarding the history of the development of this measurement prompted us to conduct a library search and to interview many colleagues and friends who are knowledgeable about this subject.

Those interviewed were:

Carl Cox, *retired Director, Texas Food and Fibers Commission, Dallas, Texas*

S.R. Griffith, *USDA, AMS Cotton Division, Washington, D.C.*

Busch Landstreet, *President, Starlab, Knoxville, Tennessee*

H.H. "Hob" Ramey, *USDA, AMS, Cotton Division, Memphis, Tennessee*

Larry Teague, *retired Vice President, Motion Control, Inc., Dallas; Texas*

Emerson Tucker, *Textile Engineer, Plains Cotton Cooperation, Assn., Lubbock, Texas*

Ed White, *retired Vice President, Spinlab, Inc., Knoxville, Tennessee*

Theoretical Basis

Early work relating to flow rate through porous media dealt with water flowing through sands and shale. D'Arcy [7] in France published the basic law in 1856. This law is summarized by the equation:

$$Q=KA\ \Delta p$$

where Q=flow rate, A=area of specimen, L=length of specimen, and Δp=the pressure difference.

Kozeny [17,18], in 1927, found that the flow rate through granular beds was inversely proportional to the square of the specific particle surface, if the porosity configuration, dimensions and pressure differences were held constant. This is written $1/S^2$, where S equals the ratio of the perimeter to the cross sectional area for textile fibers.

Experimentation with Air Flows

Clayton [61, in 1934, described the modification of an instrument designed for measuring the permeability of fabrics to accept porous plugs of fibers. The sample holder was one inch in diameter and 2 1/2 inches high. Following this, many researchers reported on the use of air flow gauges to estimate the diameter and linear density of textile fibers. The work by Ed Calkins [3], Elting & Barnes [8], Karrer and Bailey [151, Pierce and Lord [20], Fowler and Hertel [111, and later Sullivan and Hertel [24,25,26] showed significant relationships between air flow and diameter of animal and manmade fibers as well as the linear density of cotton fibers. The work by Hertel, et al., led to the development of the Aerolometer. This was an instrument to measure both maturity and linear density of cotton fibers and was manufactured by the Special Instruments Laboratory (Spinlab).

A significant paper was published by George Pfieffenberger [21] in 1946 using a modified fabric air gauge similar to that described by Clayton. He reported a very close relationship between air flow and linear density in terms of fiber weight per inch measured by the comb sorter method. At the time, Pfieffenberger was director of the Chicopee Research Laboratory, which was located at Texas Tech University in partnership with the Department of Textile Engineering.

The Micronaire

In 1947, W.S. Smith [22], West Point Mfg. Co., reported on an air gauge manufactured by the Sheffield Corporation called the "Gaugemaster's Precisionaire". He made slight modifications to this device in order to adapt it for use with textile fibers. The instrument was found to be fast, stable and simple to operate. A special feature was a highly regulated air flow and it required little adjustment or calibration. The following year the Sheffield Company placed this machine on the market, it was quickly adopted by the cotton industry, and the term "micronaire" entered the lexicon of the cotton/textile industry

The Role of the U.S. Department of Agriculture

The cotton division of USDA was quick to accept the new Sheffield micronaire and ordered six for its Washington Laboratory and field laboratories at Clemson, Stoneville, College Station, Las Cruces and Memphis. In 1950, Burley and Rouse [2] announced the development of a curvilinear scale for Upland cotton which gave a very high correlation with values obtained from the weight per inch measurements using the Array comb sorter. In 1952, they also announced the development of another micronaire scale for Pima cotton. The Pima scale was 0.8 units lower than the corresponding value on the Upland scale.

Two pilot studies were made by USDA to determine the feasibility of making micronaire measurements in USDA cotton classing offices. The first was made in Raleigh, N.C. in 1953. This study showed that a production rate of up to 1000 samples per 8-hour shift could be achieved if two operators were used–one to weigh and the other to operate the machine and record the data. The other study was performed at the Corpus Christi, Texas USDA office in 1954. About 13 percent of the local crop was measured that year. The study concluded that it was feasible to provide micronaire, or "mike", tests in USDA offices, particularly if a blended specimen from both sides of the sample was used instead of measuring each side separately.

Standards Established

"ASTM Standards on Textile Materials" in October 1952 and again in November 1953. The method was accepted by the Society in June 1954 and adopted as standard in 1956. This method is published as method D-1448 in the "ASTM" Book of Standards". The method was later adopted as an International (ISO) Standard.

In 1956, USDA also adopted the micronaire test as an official standard measurement for cotton delivered on cotton futures contracts.

The International Calibration Cotton Standards Program was established in 1957. This program is operated by USDA and governed by a committee which includes representatives from the National Cotton Council, the Cotton Producers Steering Committee, American Cotton Shippers Association, American Textile Manufacturers Institute, the International Textile Manufacturers Federation, and the U.S. Department of Agriculture. Test laboratories were designated by these organizations to assist in establishing the values for these standards. Originally, the cotton standards included 10 different cottons covering the range of the micronaire scale. These standards include Upland, Egyptian and Asia types which represent most of the world's cottons.

New Instruments Developed

Between 1952 and 1956, several attempts were made to "improve" the Sheffield micronaire by adding a pneumatic plunger to replace the manual plunger supplied with the instrument. These attempts were generally unsatisfactory and highly dangerous to operate. In 1954, an instrument developer named Glen Witts was approached by Carl Cox to solve the problem. Mr. Witts decided he could build a complete new instrument cheaper than he could modify the Sheffield. He formed a company called "Motion Control, Inc.", and came on the market with his new "Fibronaire" in 1956. Along with the Fibronaire was a superior scale designed especially for weighing the 50 grain (3.2 grams) specimen. This was called the "Fiberweigh". These instruments operated much faster than the manual Sheffield system and were quickly adopted by both USDA and the textile industry.

USDA Made Micronaire a Fixture of Cotton Classification

In 1957, a micronaire unit was installed in the Lubbock, Texas USDA office to measure a statistical sample of the crop in that area for market news purposes. This was done in cooperation with the Plains Cotton Growers Association. The Lubbock office also participated in a study to determine the influence of the measurement on samples classified as "irregular, weak, and wasty (IWW)". Such samples were arbitrarily reduced in staple length. Judging IWW cotton was highly subjective and the opinion of different classers varied widely. It was found that almost all classers agreed that cottons measuring 2.6 and lower should be designated "JWX'V". Disagreement increased as the mike readings increased up to about 3.5, where no cottons were judged to be 'IWW" in character.

The Phoenix USDA office began to publish mike readings in their quality reports in 1958. The west--em, southwestern and mid-south areas all published quality statistics on micronaire in 1961 and all USDA offices were included in 1963.

In 1960 the USDA began to make micronaire testing services available to merchants, mills, and producers on a fee basis. Because of the differences observed between the micronaire measurements and the actual weight-per-inch the terminology was changed in 1961 to "micronaire reading" instead of micrograms-per-inch, the Upland scale was adopted for all cottons and use of the American Egyptian scale was abandoned. [27] It was not until 1964 that an amendment to the Smith-Doxey Act was passed to include the micronaire test as a service to all qualified producers. This service became effective July 1, 1966. That same year the Commodity Credit Corporation designated the mike test as a quality-factor for all cotton entering the loan. Thus, the micronaire had become part of the official classification of U.S. cottons alon8 with grade and staple. At this time, USDA also discontinued use of the IWW" designation, since the micronaire measurement provided a very low in maturity than did the subjective judgments about fiber "character" made by human classers.

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