Fiber fineness as a Correction Factor

in the Determination of the

Spinlab HVI tapered beard Linear Density

by

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Introduction

The determination of a fibrogram is obtained on the Spinlab HVI 900 system by scanning the tapered specimen beard with a narrow rectangular beam of light and observing the attenuation of the light through the attenuation of the light beam is converted into an amount reading representative of the fiber numbers in the tapered beard according to lengths. Because of the relationship between light attenuation and mass of the specimen, the same optical components used in fibrogram characterization are also used to determine a length reference position for clamping the tapered beard for tenacity measurement. The light attenuation at this point along the beard is used to denote a "tex" level or specimen linear density for normalization of breaking load.

But as is well established (1) light attenuation is alone not sufficient for determining the mass intercepted by the beam if light scattering is an influential factor. For fibrous materials like cotton, light scattering by the fibers must be accounted for in proportion to the contributing fiber numbers and these numbers must be combined with the measured level of attenuation to correctly represent the mass intercepting the light beam. The method used by Zellweger Uster is one of applying a micronaire value to 2the amount reading provided by their HVI optical system. More specifically, an amount reading is set and a correction made using a micronaire linear function of

$$A*[\text{Micronaire value}]+B$$

Where A and B are constants for the instrumentation. The mass or linear density of a transverse section of the specimen beard is then represented by the product of terms.

$$\text{Amount Reading} * (A*\text{Mic} + B)$$

In practice, "Amount Reading" by optical attenuation is normally selected at a fixed level and, hence, is a constant. There fore if the mass of a narrow transverse section of the tapered fiber beard can be determined at the position of a fixed "Amount Reading" or light attenuation, then the ratio of the mass of the narrow section of beard to the micronaire correction should be constant or, equally, the cut mass of a rectangular section the beard plotted against the micronaire value (MIC) should be linear. The linear correlation fit between the cut mass and micronaire value represents the validity of a micronaire correction, provided the cutting of a section of fiber mass from the beard can be accomplished with sufficient precision.

Experimental

Cut-And Weigh Apparatus

The intent is the comparison of the indirect measurement of mass as used in the Model 900 Spinlab HVI system by applying a cut-and-weigh technique to determine a true basis of mass, compatible with the determination of the influence of specimen preparation on the indirect HVI mass measurements and with the end purpose of improving the mass or tex measurement of HVI tensile test specimen. the accomplishment of this lies in the design and construction of an apparatus for obtaining an acceptably accurate cut-and-weigh measure of the mass at the correctly identified position along the beard.

The technique most common to the literature is one in which the specimen preparation step removes all fibers not involved in the breading load by introducing a back-combing procedure. the procedure is based on an initial clamping of the tapered beard at a point designated by the HVI instrumentation and representative of the position of an indirect measurement of tex by the HVI system used in the normalization of breaking load to give tenacity. Following an initial clamping of the beard, the fibers are released form the specimen holder and all loose fibers removed by air suction from that side of the clamp facing the specimen holder. A designated band of the remaining fiber beard is cut from the array of fibers and weighed. The value obtained is assumed representative of the mass of fiber contributing to the breading load.

The physical structure of the current apparatus is as follows. there are two sets of jaws, situated in close proximity to each other. The back jaw is attached at its ends to pneumatically controlled cylinders that raise and lower a clamping surface. The some is true for the forward clamping jaw. Both are operated independently. Each lowers to clamp a 1/8-inch band segment of fiber array on a plastic strip, subject to the technique chosen. In the original method, the fiber beard extends across the line of path of both raised clamps and just above the plastic base plate. Pretensioning is provided by air suction. A moveable stage upon which rests the loaded Spinlab specimen holder is adjusted in a manner that adjusts the line of clamping by the rear clamping surface, but at the liner edge. The specimen holder then is released of its tapered fiber beard and a vacuum system removes any unclamped fibers and pretensions the remaining fibers. The front jaw - the one nearest the specimen holder - then lowers to clamp the fibers that remain and which would participate in the tensile loading of a break. The rear jaw is raised from its lowered position and the fibers are cut at the edges of both sides of the front clamp using a circular fabric cutter. The clamped strip of fibers can then be removed from the apparatus using tweezers and weighed . This procedure then provides the information to determine the basis tex of the array of fibers in a format similar to that used in the common back combing procedures.

On the other hand, the KD Method proceeds in a like manner except that only the front clamping jaw is activated. The micrometer adjusted stage moves backward or forward to a point where the HVI indirect determination of the tensile test length is in line with the center line of the front clamp. The front jaw is lowered and the clamped bade of fiber is cut against the plastic base strip on both sides of the clamp. Vacuum suction both pretensions the tapered fiber beard before cutting and removes, the clamping bar raised,. And the remaining band of fiber weighed. This weight is similarly converted to a tex value to be compared with the predictive values of the indirect methods of the HVI systems. The validity of this technique is based on the assumption that clamped fiber ends are evenly distributed across the width of the clamping jaw.

Test Samples

The twenty cottons selected for study were provided by Cotton Incorporated. They include several problem cottons that show tensile discrepancies between Spinlab and Motion Control HVI systems. These are identified in Table 1 only by sample number. Additional information includes micronaire, cut-and-weigh amounts taken from strips of tapered beard, arealometer determined fiber fineness, and Suter-Webb array number averaged fineness data.

Results and Discussion

When the amount reading - as provided by the Spinlab HVI optical unit - is combined with a micronaire value for the cotton, a specimen beard linear density or the tapered beard at the position of the measurement is represented by [Amount Reading *(A*Mic+B)]. In terms of the experimental cut-and-weigh mass, one can write.

$$\text{Cut Mass } \alpha \text{ [Amount Reading (A*Mic+B)]}$$

Normalizing the cut-and-weigh mass by the terms on the right side should therefore give a constant value. The results of this is demonstrated in Figure 1, where the normalized values of cut mass using the KD Method are plotted against sample number. It is obvious that constancy is not achieved. The standard error across the means (five replications) of the twenty cottons is approximately 4.5%.

Part of the variation is due to the attempt to rely on micronaire as an appropriate correction for fiber number contributing to scatter of light out of the optical path. This is illustrated by plotting cut mass against micronaire for fixed light attenuation (Figure.2). The distribution of data should be along a straight line having positive slope. There is positive slope, but the scatter of data is considerable and the correlation between the two variables is disappointingly low. The correlation coefficient between the two parameters is calculated to be 0.61. Obviously micronaire is not the most suitable corrector to the attenuation of light passing through a beard of parallel fibers. Either it or additional factors need to be introduced to increase the correlation.

The next step was to introduce additional measures of fiber fineness. Since micronaire is perimeter sensitive, it was presumed that Arealomenter average fineness, as calculated from double compression results, might be a truer indicator of fiber linear density. Arealometer fineness data were collected on all twenty cottons and this information graphed against cut mass. The results of this (Fig 3) were no better than that of cut mass plotted against micronaire. The coefficient of correlation, in fact, was only 0.43.

As an additional step, average fiber fineness was obtained from a Suter-Webb sorter preparation, with the fiber fineness of each length group obtained by fiber count and weigh procedures. These group finenesses were then number averaged giving values as presented in Table 1. The cut masses were then plotted against these fineness values to give the distribution shown in Figure 4. The correlation coefficient as calculated by linear regression analysis procedures was 0.91. this is significantly better than that given between cut mass and micronaire (Fig. 2) or between cut mass and fiber fineness as calculated from arealomenter data (Fig. 3).

Acknowledgments

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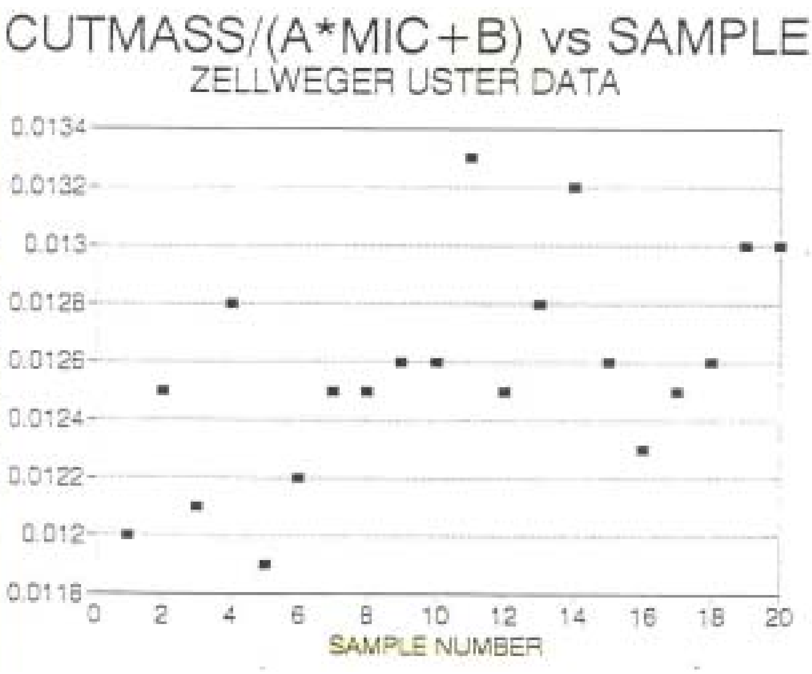
References

1. Duckett, K.E., R.S. Krowicki and D.P.Thibodeaux. 1991. Some Optical Response Characteristics of the Spinlab HVI system to Cotton Fiber Fineness. Proceedings of the Third Cotton Quality Measurements Conference. 851-852

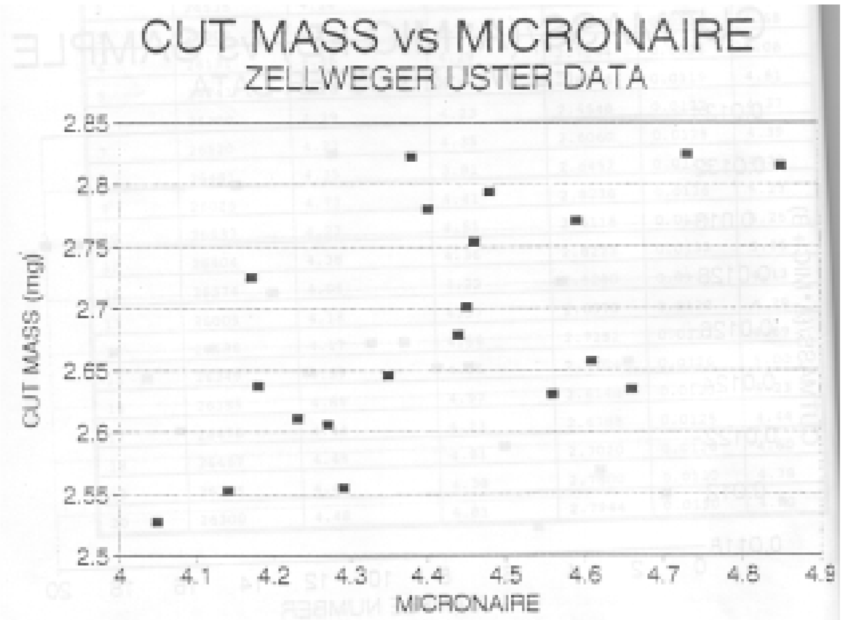
< Table 1 > Physical Properties and Optical Mass Indicators of

Twenty Research Cottons

Number	Cotton ID #	Micronaire	Area-lometer Fineness	Cut Mass	Mass/Phi	Suter-Webb Fine-ness
-------	--------	----------	µg/in	mg	mg	µg/in
1	26412	4.56	4.16	2.6304	0.0120	4.51
2	26535	4.14	4.29	2.5528	0.0125	4.22
3	26303	4.61	4.79	2.6572	0.0121	4.68
4	26131	4.46	4.29	2.7544	0.0128	5.06
5	26241	4.66	4.27	2.6344	0.0119	4.61
6	26390	4.29	4.23	2.5548	0.0122	4.37
7	26520	4.27	4.35	2.6060	0.0125	4.39
8	26481	4.35	3.81	2.6452	0.0125	4.22
9	26026	4.73	4.41	2.8236	0.0126	5.27
10	26637	4.23	4.51	2.6116	0.0126	4.25
11	26404	4.38	4.36	2.8223	0.0133	5.05
12	26374	4.05	4.22	2.5280	0.0125	4.13
13	26005	4.18	4.37	2.6370	0.0128	4.29
14	26488	4.17	4.56	2.7252	0.0132	4.69
15	26349	4.59	4.36	2.7704	0.0126	5.00
16	26355	4.85	4.97	2.8148	0.0123	5.23
17	26476	4.44	4.23	2.6788	0.0125	4.44
18	26487	4.45	4.81	2.7020	0.0126	4.60
19	26395	4.4	4.38	2.7800	0.0130	4.78
20	26300	4.48	4.81	2.7944	0.0130	4.80



< Figure 1 >



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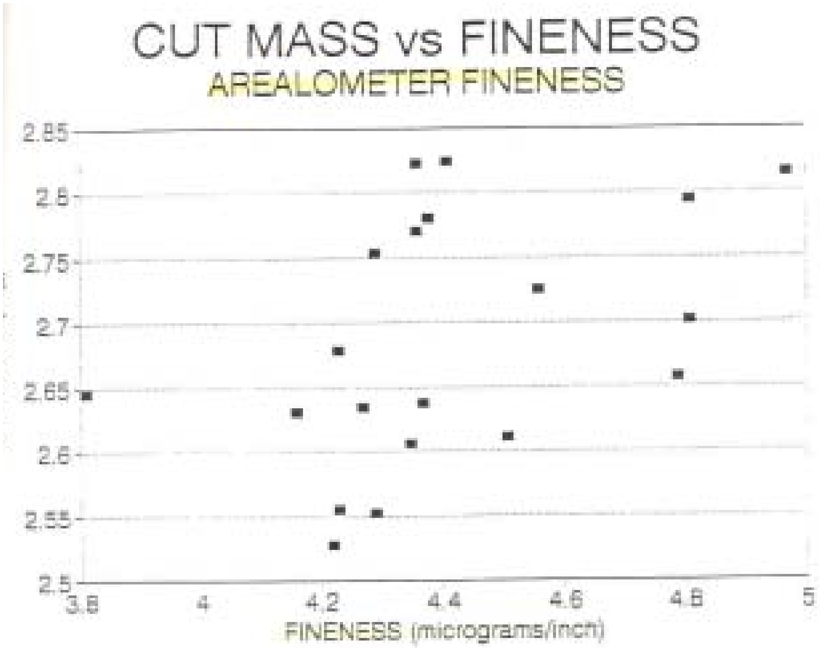

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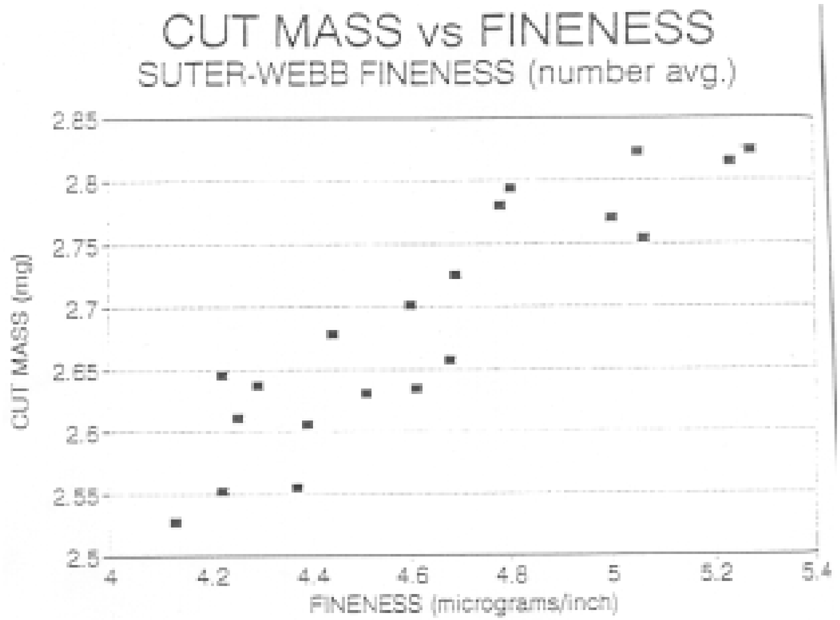
CUT MASS vs FINENESS
SUTER-WEBB FINENESS (number avg.)
2.85
2.8
2.75
2.7
2.65
2.6
2.55
2.5
CUT MASS (mg)
4
4.2
4.4
4.6
4.8
5
5.2
5.4
FINENESS (micrograms/inch)

< Figure 4>