A Reference Test for HVI Strength Measurements. Part 2: Experience with International Cottons

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ABSTRACT

Using the Reference Test Method discussed in Part 1, cotton from a number of locations throughout the world were tested to establish or verify reference values. Test results for selected cottons were compared to conventional laboratory methods to demonstrate the relationship between methods. The results demonstrate that the Reference Test Method for HVI strength measurements can be a useful tool in arbitration disputes and in providing independent verification of calibration cotton values.

Introduction

Using the procedure outlined in Part 1, a number of different cottons from various sources are being studied to determine the tenacity of HVI beards. The variation in test results due to instrument adjustments is minimized through careful configuration. In the standard test procedure, the cottons are thoroughly conditioned at 21^{o}C temperature and 65% relative humidity as commonly used in laboratories that test cotton fibers. Under these controlled conditions, the key factor in obtaining precise estimates of tenacity is the development of relationships between optical amounts and weights of the cotton beards. As indicated in Part 1, the relationship appears to be approximately linear over a narrow range of beard weights. However, this approximately linear relationship is different for different ranges of beards weights which results in quadratic relationships (Figure 1) over the wide ranges necessary for estimation by this method. These differences in optical response for different beard thicknesses are probably due to ineffective brushing of thick beards or to saturation of the optical detector as the beards become thinner so that very few fibers are in the measurement zone at some positions. It is not critical to the test results that the relationship between optical response and beard weight be linear. It is critical to test results, that the relationship be *known* because gravimetric and optical measurements from one portion of the beard are used to estimate the gravimetric weight of another portion of the beard. This allows the interpretation of the breaking force measurements corresponding to that portion of the beard.

Material and Methods

To understand the HVI optical sensor reaction while measuring cotton beards, it is necessary to take into account the interactions which occur between the light and the fiber beards in the sensor. Figure 2 suggests that light scattering, absorption, and/or diffraction seems to be induced by the number, the transversal and longitudinal shapes of the fibers, and/or their external surfaces. All these suggest that there will be interactions to some extent of the maturity/fineness complex, the wax content, and cotton colour with weight estimations using the optical sensor.

Four experiments were conducted to address this hypothesis:

- using different cottons covering a wide range of micronaire, we show information concerning the maturity / fineness complex,

- comparison of test results before and after a scouring treatment demonstrate the effect of wax in the measurements,

- comparison of test results before and after a swelling treatment (both after scouring) demonstrate the effect of external surfaces of fibers on the optical estimates of weights, and

- dyeing cotton to different colours within the USDA colour chart shows the effect of cotton colour on the optical measurements, thus introducing errors in the weight estimations.

Two other components may affect strength results:

- Since cotton fibers are hygroscopic, their moisture content tends to always be in equilibrium with the ambient conditions of the laboratories. An experiment was conducted in different ambient conditions to investigate the range of variations in the results, and

- the standard breaking speed of the fibers is approximately 13.3 cm/mn for HVI. By modifying HVI equipment, the breaking speed was increased up to 220 cm/mn to monitor the effects of moisture content vs breaking speed on the strength results.

Results and Discussion

Figure 3 indicates that there is a strong micronaire effect on the weight estimations by optical sensing device (based on 30 measurements, from very light to heavy beards, per cotton). As the micronaire of the cotton goes up, the estimated optical amount goes down for a given weight (Figure 4 by using 1 mg).

Figure 5 shows the relation weight vs. optical response for raw, scoured and swollen fibers (based on 30 measurements, from very light to heavy beards, per cotton). It is clear that both chemical treatments affect the readings. This indicates that the wax content and the external fiber surface structure give more or less interaction between light and the fibers.

Figure 6 gives the USDA colour chart co-ordinates for one cotton which was dyed using combinations of black and yellow dyes. Figure 7 indicates that there are different weight estimations depending on the colour of the fibers. It is not a single effect of reflectance (Rd%) or yellowness (+b) alone, but a combination of these 2 criteria that affects the weight estimates.

Figure 8 indicates that strength readings are affected significantly by the moisture content of the fibers, itself affected by the relative humidity in the laboratory: 52, 54, 63 % RH (based on 30 measurements, from very light to heavy beards, per cotton). This chart also indicates that the strength readings tend to stabilize to a given level as the weight of the beard to be broken is increased.

Figure 9 illustrates the differences (expressed in %) between strengths measured at 45% RH and 65% RH for different break rates: 13.3, 30 and 220 cm/mn. When the break rate is increased, the difference between strength readings made at different relative humidities is decreased.

Conclusions

Strength is determined by calculating the ratio force/weight. In HVI equipment, the weight of broken fibers is estimated by using the response from an optical sensor.

We have demonstrated that many fiber properties or characteristics affect weight estimations using the optical sensor: micronaire, wax content, colour, fiber surface irregularities. These factors are significant in addition to interactions of light and fibers, which induce diffraction, absorption, and scattering that affect the estimates of the weights of the broken fibers.

Variations in laboratory relative humidity affect strength results. One way to significantly decrease this effect may be to increase the fiber breakage rate.

Figure 1. Weight vs. Optical amount.

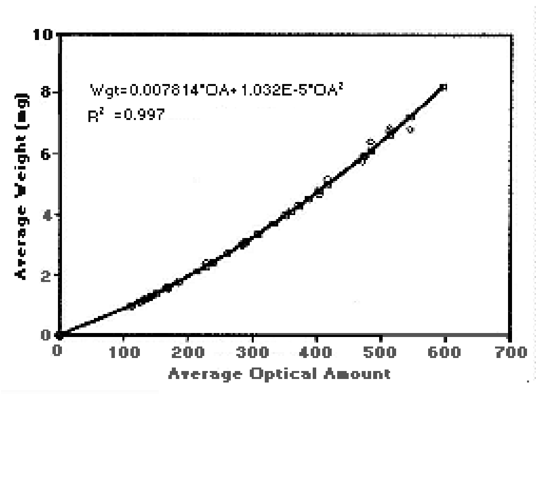

Figure 2. Light in the HVI system.

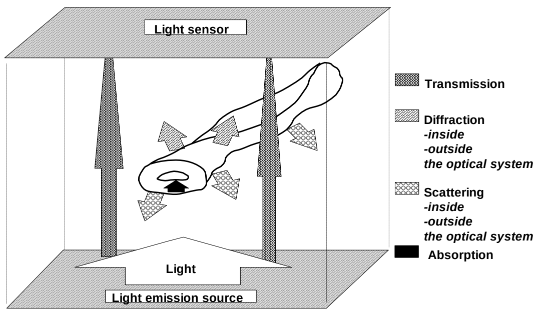

Figure 3. Weight vs. Optical amount for seven different cottons.

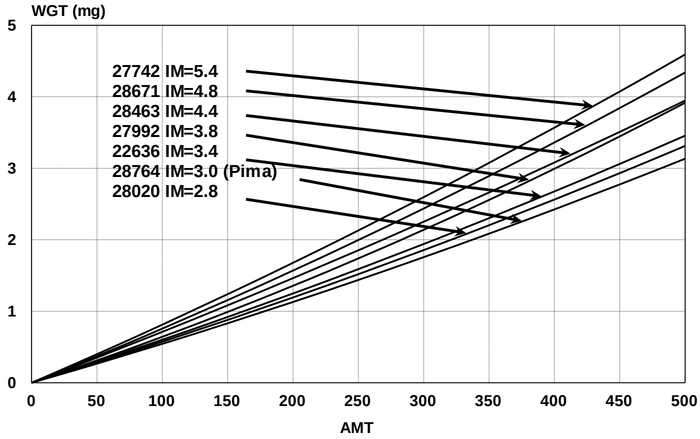

Figure 4. Relation weight vs. IM for given AMT(4a), and for given weight(4b).

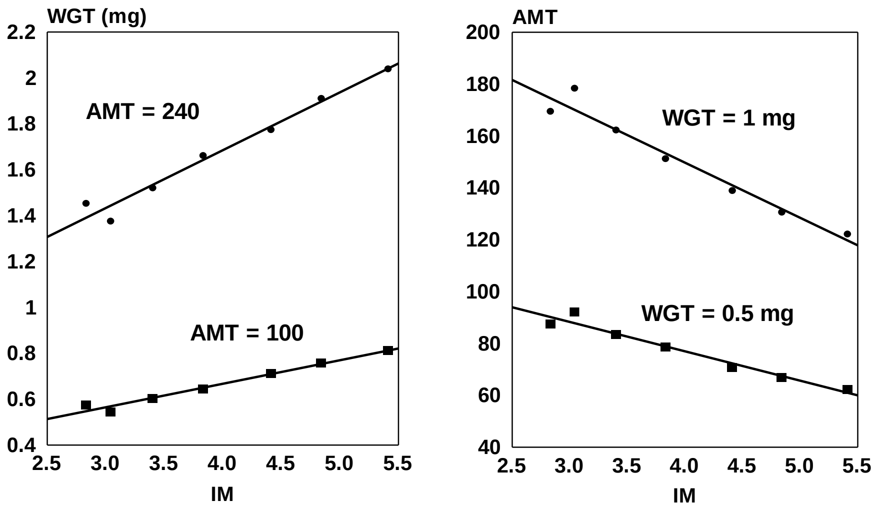

Figure 4a

Figure 4b

Figure 5. Relation WGT vs. AMT for raw, swollen and scoured samples.

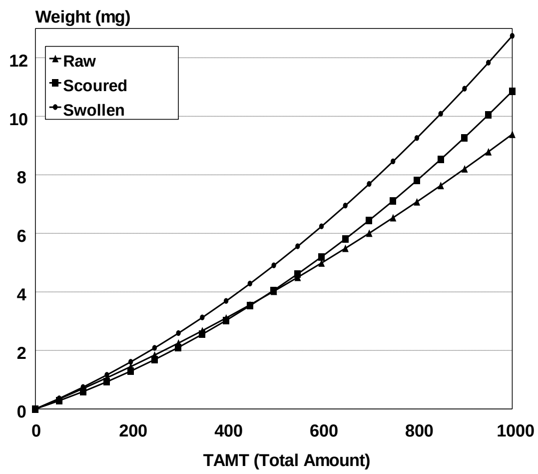

Figure 7. Relation WGT vs. AMT for dyed samples.

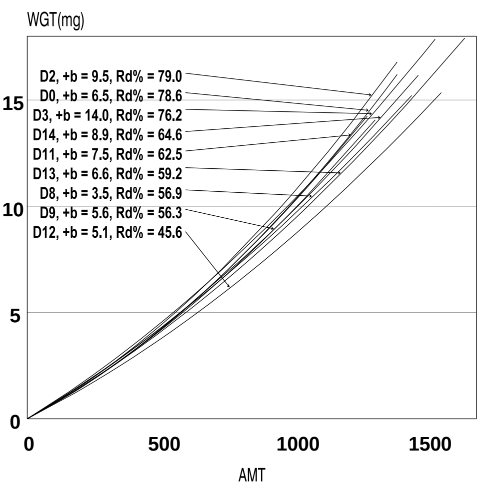

Figure 6. Colour of dyed samples.

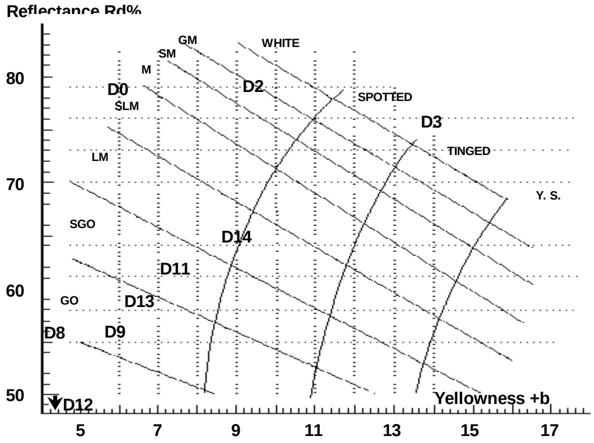

Figure 8. How RH% affects tenacity.

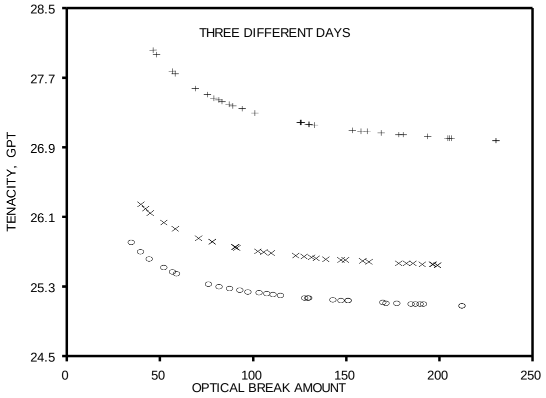

Figure 9. How RH% and breakage rate affect tenacity.