A COMPARATIVE STUDY ON PARAMETERS USED FOR CHARACTERIZING COTTON SHORT FIBERS

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Abstract

The quantity of short cotton fibers in a cotton sample is an important cotton quality parameter which impacts yarn production performance and yarn quality. Researchers have proposed different parameters for characterizing the amount of short fibers in a cotton sample. A comprehensive study was carried out to compare various short fiber parameters reported in the literature. The comparisons were focused on: the variations of these parameters, their relationships with the traditional Short Fiber Content (SFC), and their capabilities in predicting yarn properties. The advantages of the new short fiber parameter – Lower Half Mean Length – are discussed.

Introduction

The quantity of short cotton fibers in a cotton sample is an important cotton quality parameter. It impacts yarn production efficiency and cost, and product quality (Backe 1986; Thibodeaux et al. 2008). The global cotton industry is increasingly interested in the characteristics of short fibers (Ethridge and Krifa, 2004). Over the past decades, researchers have proposed different parameters for characterizing the amount of short fibers in a cotton sample. Short Fiber Content (SFC) is the most commonly used short fiber parameter. The problems with SFC include high variations and definitions of different length values in different standards (0.5 inch in the United States, and 16 mm in China). There also have been criticisms that using these values to predict spinning process properties lacks sound explanations.

Therefore, researchers have been proposing alternative parameters of SFC. We conducted a thorough literature search on other short fiber parameters. Then, we carried out a comprehensive investigation that compared the various short cotton fiber parameters reported in the literature. These parameters include:

1. Short Fiber Content ($SFC_{½"}$), which is defined as the percentage of fibers (by weight or by number) shorter than ½ inch. (ASTM D1440-07).
2. Short Fiber Content (SFC_{16mm}), which is defined as the percentage of fibers (by weight or by number) shorter than 16 mm. (Chinese Standards GB/T 6098.1-2006).
3. Lower Half Mean Length (LHML), which is defined as the mean length (by number) of the short half of the fibers by weight. This parameter was proposed by Cui et al (2009).
4. Relative Short Fiber Content (Rel. SFC), which is defined as the percentage of fibers (by weight or by number) shorter than 1/2 of the Upper Half Mean Length (UHML). This parameter was proposed by S. A. Heap (2004).
5. Floating Fiber Proportion (FFP), which is defined as FFP = (S2.5/Ln – 0.975) × 100, where S2.5 is the 2.5% span length, and Ln is the mean length by number. This parameter was proposed by K. L. Hertel and C. J. Craven (1960).

6. Floating Fiber Index (FFI), which is defined as FFI = (UQL/MLw – 1) × 100, where UQL is the Upper Quartile Length, and MLw is the mean length by weight. This parameter was proposed by T.J.F. Fransen (1984).

Materials and method

The comparisons of the short fiber parameters were focused on

1. The variations of these parameters;
2. Their relationships with the traditional Short Fiber Content; and
3. Their capabilities in predicting yarn properties.

A good short fiber parameter should meet all of the following criteria:

1. Lower variation;
2. High correlation with SFC;
3. Predict yarn properties well; and
4. Easy to understand and therefore easier to be accepted by the industry.

We used AFIS to test 28 bales of different cottons. These cottons' properties cover wide ranges. We took 10 samples from each bale and 5 replicates for each sample. Each rep had 5,000 individual fibers tested on AFIS. $SFC_{1/2"}$ values were directly obtained from AFIS. SFC_{16mm}, LHML, Rel. SFC, FFP, and FFI were calculated from fiber length distributions from AFIS. Cotton fibers of those samples were made into open-end and ring yarns.

Results

The results show that $SFC_{1/2"}$ has the highest variation, and LHML has the lowest variation. LHML's CV% is only about 1/3 of SFC's CV% (Table 1).

Table 1. Average CVs (%) of the Short Fiber Parameters

$SFC_{W1/2"}$	SFC_{W16mm}	Rel SFCw	FFI	FFP	LHML
5.50	4.51	3.80	2.99	2.52	1.80

The correlations among $SFC_{1/2"}$, SFC_{16mm}, and LHML are very high. The correlation coefficient between LHML and $SFC_{1/2"}$ by weight is 0.986. The correlation coefficient between SFC_{16mm} by weight and $SFC_{1/2"}$ by weight is 0.991. FFI, FFP, and Rel SFC's correlation coefficients with $SFC_{1/2"}$ are lower (<0.8).

Linear regression models were developed to predict yarn properties using different short fiber parameters. Other length parameters were also included in the models. Results indicate that LHML and SFC perform similarly in predicting yarn properties.

LHML is a complement of UHML, which is available for every U.S. cotton bale classed by USDA. UHML has been widely used and people are familiar with it. For that reason, LHML, as the complement of UHML, is easier to be understood and accepted by the industry. The correlation coefficient (R^2) of LHML and UHML is 0.67.

Conclusions

Based on this comprehensive investigation, LHML has the lowest variation, is highly correlation with SFC, predicts yarn properties similarly as SFC does. LHML is easy to understand as a complement to UHML, which is used for cotton length globally. Therefore, LHML is a good alternative parameter of SFC to characterize cotton short fibers.

Disclaimer

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