2002 BELTWIDE COTTON CONFERENCES, ATLANTA, GA – JANUARY 8-12

ATTRIBUTIVE BLENDING: THE ULTIMATE COMPLEXITY OF MULTI-COMPONENT COTTON BLEND

Yehia El Mogahzy, Asaad Mohamed, Ramsis Farag and Faissal AbdelHady
Department of Textile Engineering
Auburn University
Auburn, AL

Abstract

In this study, the author analyzed the complex nature of multi-component fiber blending through detailed experimental analyses and theoretical treatments of the different modes of fiber blending. This analysis is based on dividing the blending modes into three basic categories:

1. Structural blending
2. Attributive blending
3. Appearance blending

Structural blending implies the extent of geometrical allocation of different fiber segments within the structural boundaries of the fiber strand. It is primarily determined by the dimensional characteristics of fibers such as fiber fineness, fiber length, and fiber crimp. Attributive blending indicates the extent of interaction of different fiber attributes within the characteristic boundaries of the fibrous assembly. This type of blending is primarily influenced by the levels of values of fiber attributes in the blend components and the variability in these attributes. Appearance blending describes the extent of homogenization of color in the fiber assembly. This is primarily influenced by the color differential in the blend components.

The main mechanism determining the blending efficiency of any of the blending modes introduced above is the breakdown of the fiber clusters of the different blend components. This breakdown is a result of the opening process associated with blending. Accordingly, the experimental analysis of multi-component blending performed in this study was performed using an opening and blending unit called the Rotor-Ring. This unit consists of the following components:

- Feed chute plate
- Feed roll
- Opening roll
- Air channel
- Rotor

This system has been used in some limited applications in practice including blending trials, and in conjunction with the QuickSpin® system developed by Hollingsworth. In this study, the system was modified to allow monitoring of the fibers during opening and blending. The modification involved sensors attachments to monitor the speeds of the different units and to monitor the torque resistance in the opening roller. As a result of this modification torque profiles were obtained. These profiles were used to characterize the mechanical nature of fiber blending.

Fiber blends produced on the Rotor-Ring system were analyzed to determine the extents of structural, attributive and appearance blending. Structural blending was examined through comparison of the frequency distributions of fiber length and fiber fineness of the individual components of the blend (prior to blending) and of the resultant fiber blend. These distributions were produced using the Advanced Fiber Information System (AFIS®) produced by Zellweger Uster of Knoxville, TN. This system is capable of optically monitoring single fibers for length and fineness and producing frequency distributions of these parameters.

Attributive blending was examined through comparison of the values of fiber characteristics such as fiber length, fineness, strength, elongation, color reflectance Rd and color yellowness +b of the individual components of the blend (prior to blending) and of the resultant fiber blend at different blend ratios.

Appearance blending was examined using image analysis. The idea is based on developing an image reflecting the shade variation (or grey intensity) of fibers of a certain fiber type through scanning the fiber web produced from the Rotor-Ring system against two backgrounds: black background and white background and developing grey index profiles of the individual components of the blend (prior to blending) and of the resultant fiber blend at different blend ratios.

The results of the experimental analyses introduced above can be summarized as follows:

1. Two-component and multiple-component blending analysis can be performed using an mxk blending matrix in which the m rows describe the values of different fiber attributes and k columns describe the different components in the blend. At each blend ratio, the outcome of the blend can be described by a column vector matrix indicating the resultant values of different fiber attributes in the blend.
2. Blending profiles were developed to fully describe the effects of blending on different fiber characteristics. When two fiber components are used, the blending profile is simply a two-dimensional graph in which the x-axis is the blend ratio or the percent of one fiber component in the blend and the y-axis is the percent attributive representation, or the percent change of the value of a fiber attribute of one fiber component with respect to the value of the other component. In this study, this type of graphs is called "two-component blending profile". A two-component blending profile allows simultaneous evaluations of many fiber attributes not only for the magnitude and direction (increase or decrease) of change but also for the extent of linearity of the change at different blend ratios. For multiple-component blending, radar diagrams can be used to describe recognizable blending patterns.
3. With regard to attributive and structural blending, predictable blending patterns are those patterns which provide intermediate attributive effects at different blend ratios.
4. In this study, deviation from ideal structural blending was observed when fibers of significantly different fineness were blended. In such cases, the characteristics of the blended fibers were biased to the finer fiber component.
5. Bi-modal distributions of fiber characteristics of blended fibers were observed. This trend was attributed to a significant difference of fiber length between the blended components. It is recommended therefore not to blend fibers solely on the basis of fiber length.
6. Blending propensity measured by torque profiling reveal critical information that complement the understanding of the nature of fiber blending.
7. Situations in which blended fibers exhibit characteristics that are fully biased to only one component of the blend can be explained in the context of the blending propensity of fibers.
8. Image analysis provides a new analytical tool of fiber blending. Using this analysis, it is possible to predict the appearance blending at different blend ratios.

In addition to the experimental analyses introduced above, theoretical analyses of mono-blending (blend components of the same type) and multiple-components were performed. These analyses revealed a number of interesting outcomes. These are as follows:

- The variance of fiber fineness has a direct effect on the variance of number of fibers in a micro-section of the fiber strand. As the variance of fiber fineness increases, the variance of number of fibers in a micro-section of the fiber strand increases linearly.
- For a given yarn count (m_s) and gauge length (L_s), the effect of the variance of fiber fineness will depend on the level of fiber fineness (the finer the fiber, the higher the variance in of number of fibers in a micro-section of the fiber strand).
- The variance of the mass of a fiber strand has a direct effect on the variance of number of fibers in a macro-section of the fiber strand. As the mass variance increases, the variance of number of fibers in a macro-section of the fiber strand increases linearly. For a given yarn count (m_s), the effect of the variance of the mass of a fiber strand will depend on the length of the macro-section; the longer the length, the higher the variance in of number of fibers in a macro-section of the fiber strand.
- The effect of the variance of the mass of a fiber strand on the variability of number of fibers in a macro-section of the fiber strand also depends on the yarn count or the yarn mass, m_s; the finer the yarn count, the higher the variability.

The above points represent new directions of the theory of fiber blending that can provide useful guidelines in this critical field.