COTTON FIBER BLENDING: FROM TRADITIONAL TO SPECIALTY MIXING APPROACHES

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Abstract

This paper deals with a specific issue of cotton blending that deserves a great deal of attention; that is the blending of cotton varieties of a wide range of quality and market price. To the extreme of this is the blending of Extra-Long Staple fibers (ELS) with medium-staple (Upland type) cottons. Although publically this is not a common practice, it is known that in the global market this practice can be found in many areas of the world for the sake of meeting cost constraints and maximizing profit. The paper clearly indicates that blending these varieties is possible from a technological viewpoint as well as from a fiber quality viewpoint. However, the paper has two unresolved issues that make for a good continuation of this study: (1) blending trials were made using laboratory equipment (modified rotor-ring), which may not fully reflect actual blending in typical spinning mills, and (2) the paper does not deal with the yarns produced from the blends, which can make a substantial difference in the conclusion of this analysis. We intend to continue with this analysis to meet these two requirements.

Introduction

This paper represents a continuation of a long study that began in the year 2000 by the first two authors in which an integrated approach was established to evaluate the theory and the practice of multi-component fiber blending (El Mogahzy, TRJ, 2004, and El Mogahzy, et al, TRJ, 2004, 2005). The result of the study was an analytical approach aiming at more general evaluation of fiber blending as it relates to its critical practical objectives. In this regard, the outcome of fiber blending was classified into four basic modes:

1. Structural blending-This implies the extent of geometrical allocation of different fiber segments within the structural boundaries of the fiber strand.
2. Attributive blending-This indicates the extent of interaction of different fiber attributes within the characteristic boundaries of the fibrous assembly.
3. Appearance blending-This describes the extent of homogenization of color or component apparent intensity in the fiber assembly.
4. Interactive blending-This implies the interaction between different fiber components during the blending process.

The importance of the above classification stems from the fact that each represents a different technological focus in the process of making textile products. Structural blending represents the foundation of any blending process since fibers of different types should be blended together according to some structural or geometrical criteria. In other words, understanding structural blending is a basic technological requirement. This is the reason for the great deal of attention given to this mode of blending in previous blending studies.

Attributive blending has always been considered as a by-product of structural blending. In other words, if different fiber types are blended on the basis of the structural or geometrical criteria, attributive blending is assumed to be simultaneously achieved. One exception to this assumption that was realized by some investigators is the case of blending fibers of different strength properties (Hearle, et al, 1969, and Zurek, 1975). In today's technology, there is an increasing trend toward technical textiles in which fibers are blended not only with substantially different fibers but also with different non-fibrous materials. This makes attributive blending a key issue that should be addressed with great deal of attention. Appearance blending represents a uniquely different and challenging problem. It can be independent of structural blending in many situations. In other words, meeting the structural criteria may not necessarily yield the anticipated appearance of a blended fiber strand (El Mogahzy, 2004).

Interactive blending is primarily a technological issue. Different fibers will have different processing behavior depending on a number of factors including surface morphology and fiber resilience. When two or more fiber types exhibiting substantially different surface or resiliency characteristics are blended together, potential processing problems can occur. In addition to the impact of these problems on processing efficiency, they are likely to influence the other modes of blending.

As indicated in the abstract, the emphasis of this paper is on the blending of Extra-Long Staple fibers (ELS) with medium-staple (Upland type) cottons. The three modes of blending discussed above will be reflected in torquing and cohesion analysis (interactive mode), fineness and length distributions (structural modes) and color homogeneity using Rd and +b (appearance mode).

Why Cotton/Cotton Blend?

Blending of different cotton varieties is one of the oldest practices in the textile industry. The primary reason for this practice is that no single variety of cotton can satisfy all yarn quality requirements unless spinning mills are dealing with a very narrow range of yarn count and for a single application or end product. Most mills have to deal with a diverse product range (e.g. fine and coarse yarns, and knit and woven yarns) and perhaps different spinning systems (e.g. ring spinning, open-end spinning, and air jet spinning). Thus, it is common to mix and blend different cotton varieties. What is not common is to blend ELS cotton with a medium to short-staple cotton. This practice has increasingly been implemented strictly for economical reasons in the face of a very competitive and volatile market. The real problem associated with this practice is the loss of identity of high quality cotton, particularly of the ELS type. However, it remains to be seen to what extent this practice will impact the market trends.

Experiments & Results

The two categories of cotton used in this study are the extra long staple (ELS) Pima cotton and the long staple Upland cotton. Two different Pima cottons (P1 and P2) were blended with two different upland cottons (U1 and U2). Upland cotton was selected to be as close as possible to the selected Pima varieties. Fiber properties of the raw cotton measured at HVI and AFIS are given in Table 1. One can notice that P2 is superior to P1 and U2 is superior to U1. The cotton fibers were blended on the modified Rotor-ring machine (Figure 1) that we used in our earlier works (Elmogahzy, 2004; Elmogahzy *et al.,* 2004; 2005; Farag *et al.,* 2007). Rotor-ring machine settings were: 4 rpm feed roller speed, 3000 rpm opening roller speed and 10000 rpm rotor speed. Three grams of fibers was fed to the Rotor-ring to produce a sliver of 8 ktex (110 grains/yard). The produced sliver is taken and run multiple times through the Rotor-ring machine for more opening and mixing. Blends were prepared by adding Upland cotton to the Pima cottons by increasing percentages. The blending strategy is given in Figure 2. Slivers produced on the Rotor-ring machine after the third run were tested for sliver cohesion on the Instron machine. The blends as in the produced sliver after the third Rotor-ring run were also tested on the AFIS machine for fiber properties and tested on the HVI for only color parameters.

Table 1. Fiber properties of the raw cottons

Fiber Category	Fiber Code	HVI Results						
		Mic	Mat	Len Inch	Unf %	Str g/tex	Rd	+b
SUPIMA	P1	3.6	0.91	1.46	85	43.2	74.3	13.2
	P2	4.0	0.95	1.54	86.2	42.3	76.5	12.4
UPLAND	U1	4.1	0.9	1.17	81.3	33.5	82.3	11.1
	U2	4.4	0.94	1.22	85.9	36.1	82	10.4

Fiber Category	Fiber Code	AFIS Results						
		UQL(w) [in]	SFC(w) %<0.5	SFC(n) %<0.5	Nep Cnt/g	SCN Cnt/g	Fine mTex	Mat Ratio
SUPIMA	P1	1.53	6.1	21.5	205	2	152	0.93
	P2	1.51	3.9	15.8	165	3	167	0.98
UPLAND	U1	1.25	9.7	26.3	223	25	175	0.93
	U2	1.3	6.5	21.7	205	42	181	0.95

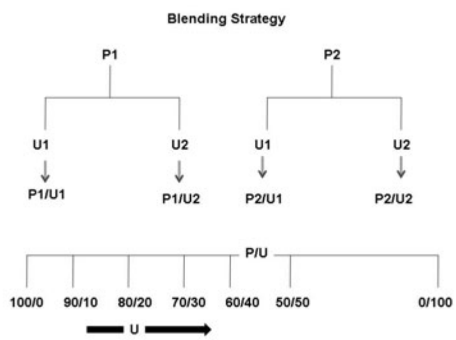

Fig. (1): Blending strategy

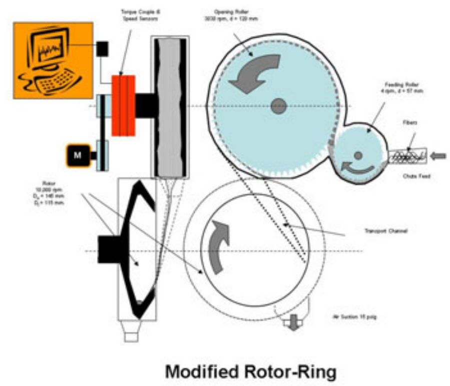

Fig. (2) Modified Rotor-ring Machine

Blend performance

The assessment of the blend performance during processing was based on the opening torque, sliver cohesion, and the tendency of the blend to developing more short fibers and neps. The results of opening torque are given in Figures 3 and 4. The opening torque during the second run is higher than that of the first run. During the third run, the opening torque stabilizes or even decreases. This trend is consistent with our old finding for cotton fibers that the opening torque increases after first runs then stabilizes and start decreasing the more runs we do. For the comparison between different blends, we consider the opening torque during the third run. Figure 4 shows that higher opening torque is associated with longer and finer fibers. Sliver cohesion was found to follow the same trend, as shown in Figures 5 and 6.

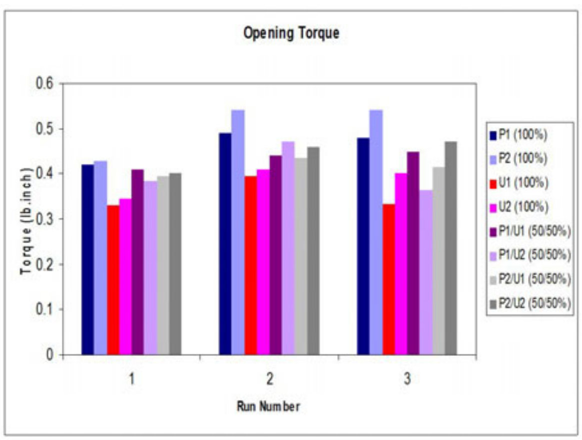

Fig. (3): Opening torque measured at the modified Rotor-ring at consecutive runs

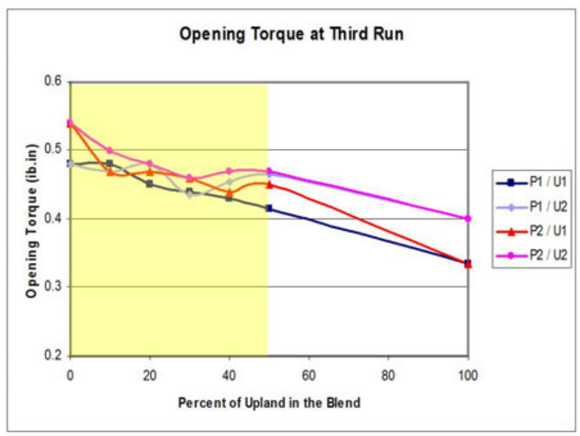

Fig. (4): Opening torque measured at third run at different percents of Upland cotton

Sliver cohesion test as an indication of the blend performance was also analyzed .Sliver cohesion (the force developed during the separation of fiber bundles) was measured on the INSTRON according to the ASTM D2612 at 2 inches gauge length. Figure 5 shows the build up and the decline of cohesion force with the continuous separation of fibers of the P1/U1 blend. The graphs for the other three blends (not shown in this paper) are consistent with Figure 5 in shape and conclusions. The maximum cohesion force decreases with the increase of the percent of Upland cotton in the blend. Figure 6 shows the maximum developed cohesion force at different blends.

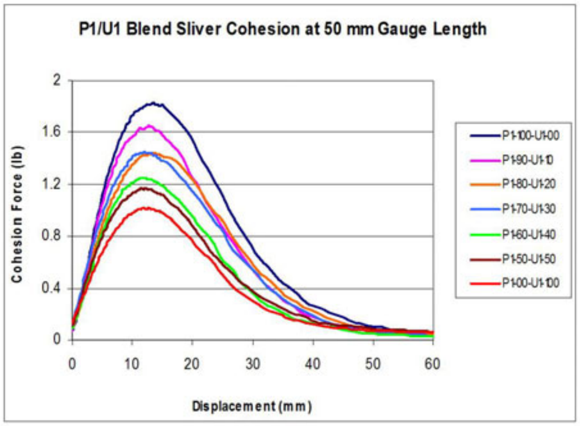

Fig. (5): Sliver cohesion curves for blend P1/U1, an example of all blends

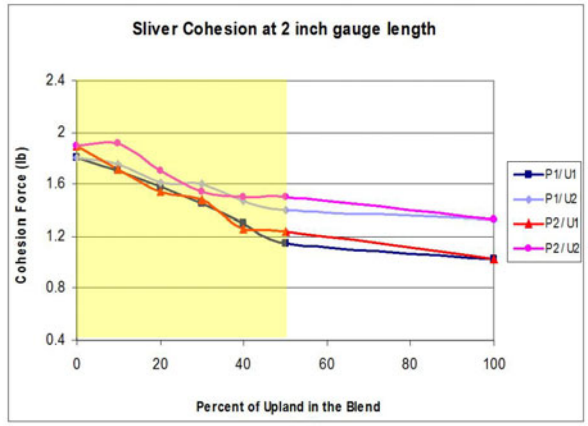

Fig. (6): Sliver cohesion curves at different percents of Upland cotton

Irrespect of cotton fiber category or variety, short fiber content and neps increase with the increase in fiber length and the decrease in fiber fineness and maturity, as shown in Figures 7 and 8.

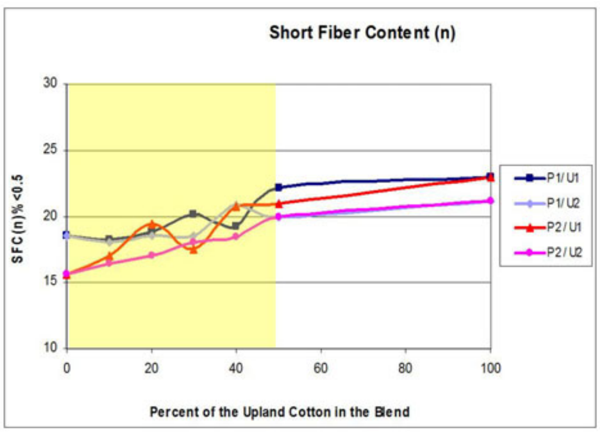

Fig. (7): Short fiber content in the sliver at different percents of Upland cotton

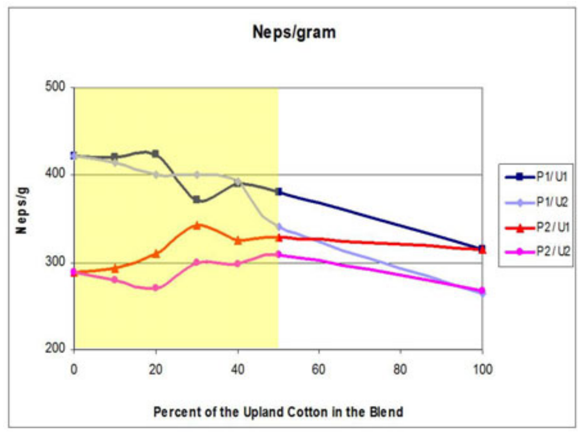

Fig. (8): Neps per gram in the sliver at different percents of Upland cotton

Blend Attributes

Fiber attributes in the blends were measured on the HVI and the AFIS machines. Color is the only property measured on the HVI. We had concerns about the resultant color of the blend as the differences in color values between Pima and Upland Cottons are very high. As seen from Figures 9 and 10, the resultant color value of a blend lies in between the values of the individual components in a fairly linear fashion.

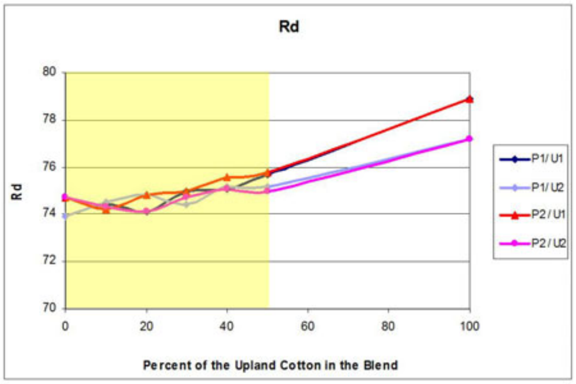

Fig. (9): Color reflectance in the sliver at different percents of Upland cotton

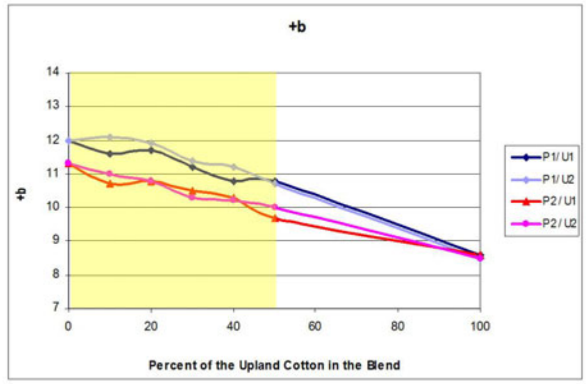

Fig. (10): Plus b in the sliver at different percents of Upland cotton

The resultant fiber length (the average by number) and the resultant fiber fineness (in millitex) also showed a linear change with the percent of Upland cotton in the blend.

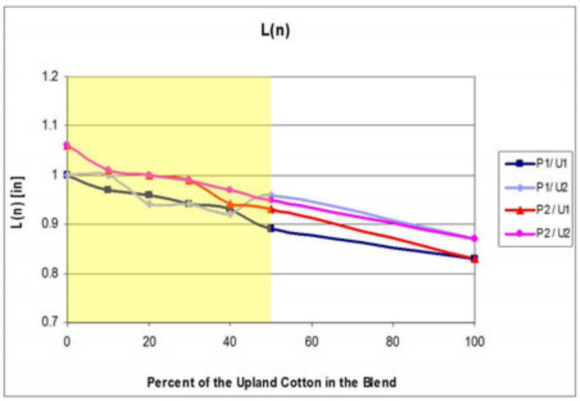

Fig. (11): Fiber mean length by number in the sliver at percents of Upland cotton

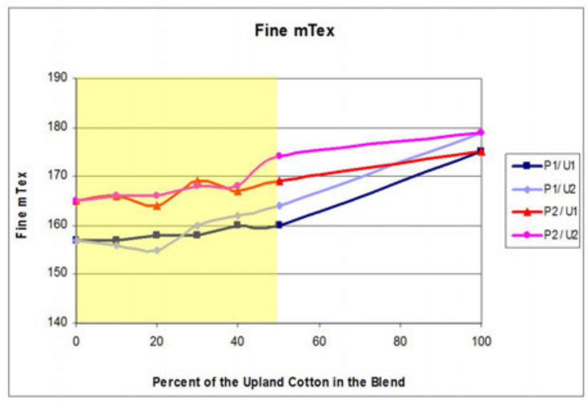

Fig. (12): Fiber fineness in the sliver at different percents of Upland cotton

Figures blew show the fiber length distributions of the individual components as well as the blends.

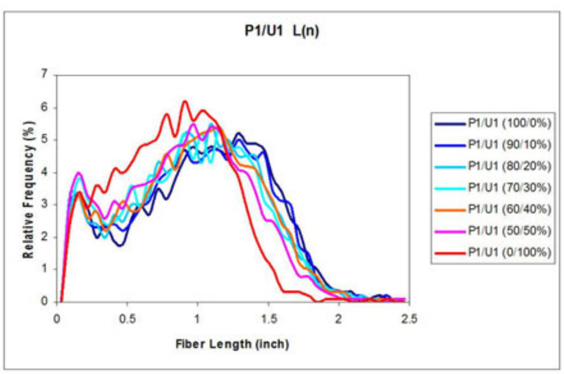

Fig. (13): Fiber Length Distributions of the P1/U1 Blend

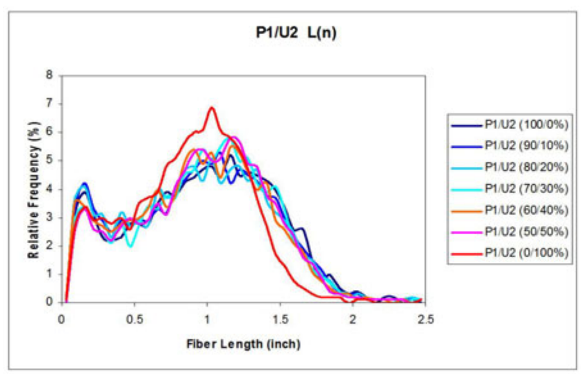

Fig. (14): Fiber Length Distributions of the P1/U2 Blend

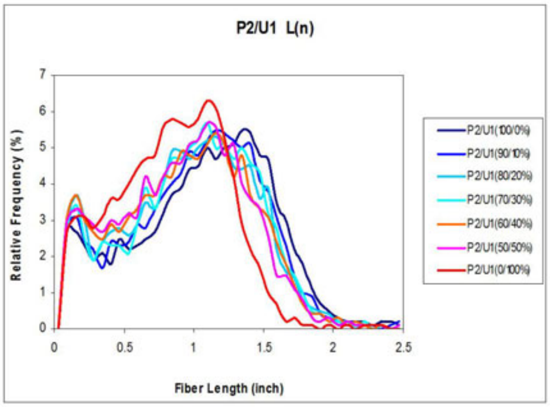

Fig. (15): Fiber Length Distributions of the P2/U1 Blend

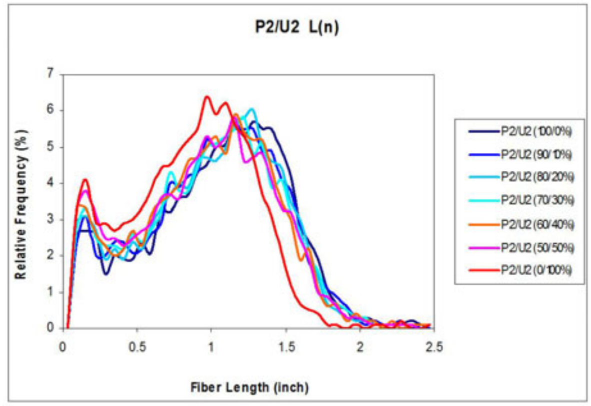

Fig. (16): Fiber Length Distributions of the P2/U2 Blend

Conclusion

This paper covered a work in progress regarding ELS cotton/long-staple upland cotton fiber blending. In general, long-staple upland cotton provides some advantages with respect to processing. These include fiber propensity to open and sliver cohesion. The long-staple upland cotton fiber also provides higher reflectance and lower +b. However, deterioration in mean fiber length is likely to influence yarn strength and yarn evenness; a point that was not addressed in this paper.

The paper has two unresolved issues that make for a good continuation of this study: (1) blending trials were made using laboratory equipment (modified rotor-ring), which may not fully reflect actual blending in typical spinning mills, and (2) the paper does not deal with the yarns produced from the blends, which can make a substantial difference in the conclusion of this analysis. We intend to continue with this analysis to meet these two requirements.

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