

Effect of Some Splicing Variables Upon Strength Characteristics of Polyester/Cotton Blended Yarn

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ABSTRACT

The effect of some mechanical changes, such as splice length control lever (LN lever) setting, twisting pressure of splicing at auto cone on tensile parameters of P/C blended yarn were investigated for different blend ratios and twist factors. The highly significant differences were shown for twist and blend while their interaction remained non-significant.

Key Words: Autoconer; Splicing; Yarn strength; Yarn elongation

INTRODUCTION

Yarns very often require a rewinding operation after spinning. Because of the relatively short lengths of yarn on individual spinning bobbins, it is not practical to use them directly in such operations as warping, twisting, and quill winding. In winding, larger packages are formed by combining the lengths from a number of spinning bobbins into a package, such as a cone or tube that will allow for more continuous operation in subsequent processes. The winding process serves to achieve additional objectives made necessary by the requirements of the subsequent processing stages.

For a long time, winding was considered to be a simple, unimportant and non-productive process because it merely transfers the yarn from one kind of package to another. But now technical importance is given to this process as it provides a fair chance to eliminate faults in yarn in addition to enhance the process efficiency. The most convincing contribution to yarn quality improvement in recent time has been achieved with the autoconer splicing technique. During the processing of yarns, there is the age old problem of joining up two yarn ends, because the yarn flow is interrupted, for example, due to yarn breaks, the removal of yarn defect or due to the end of a yarn package. An ideal yarn piecing would be one, which could pass the following process with out interruption and not lead to any deterioration in the quality of the finished products. In addition, such a piecing technique should be suitable for all fibre materials, regardless of structure and denier of the yarn. Because of the yarn like character of the piecing site, as well as the advantage of not requiring any extraneous jointing material such as adhesive, special importance attaches to the splicing joint compared with other piecing methods.

When yarn breaks, it is joined automatically by the splicer. The splicer overlaps the yarn ends from the package and bobbin sides, twist them together using compressed air, and thus splices them together without a knot. One important parameter which can adversely affect the strength of splices is insufficient compressed air pressure. To eliminate this possibility completely, the autoconer is fitted

with a pressure monitor. If the air pressure in the system falls to below the pre-determined level, the pressure monitor stops the splicing carriages. Splicing cannot continue until the problem has been corrected.

The twisting pressure takes part in giving strength to the splicing zone, while joining the untwisted tapering ends of breaking yarn. Kaushik *et al.* (1988) while studying Quantitative contribution of splice element found that twist contributed most to the strength of spliced yarn and there was a progressive decrease in breaking strength and elongation of spliced yarn. Similarly splicing length plays a greater role in giving strength to the splice. Hence splice length control lever (LN lever) setting is very sensitive as well as important. Cheng and Lam (2000) narrated that splice strength increased for longer fibers and decreased with increasing twist. They further observed that as LN lever number decreased splice strength increased.

MATERIALS AND METHODS

The present research study was initiated in the Department of Fibre Technology, University of Agriculture, Faisalabad, and conducted at the Crescent Textile Mills Ltd. Faisalabad during the year 2002. The details of the material processed and method applied to record the data for various quality characteristics are as follows.

Raw material selection. Lint cotton samples of Uzbek Variety (Skup-x) having 28.6 mm staple length, 29 g/tex strength, 4.3 micronaire value and 49.9% uniformity were taken from the blow room. While the polyester (ICI Terrylen) with 1.2 denier, 7.1 g/tex tenacity and 39 mm length was selected for this study.

Spinning process. Cotton and polyester were processed separately at the blow room and card MK5C of Crosrol. The blending was done at the drawframe of Toyoda DYH 500C by taking the following rotating ratios viz, $B_1=30:70$, $B_2=45:55$, $B_3=52:48$ and $B_4=77:23\%$.

Pure Cotton (B_0) as well as samples of polyester and cotton blends were spun into 30^s yarn at the miniature ring frame (Edera spin tester) with three different twist factors i.e. $T_1=3.40$, $T_2=3.60$ & $T_3=3.80$.

Winding process. The second phase of research was carried out at the autocone winder Murata Mash Coner by

employing three different splice length control lever (L-N lever) settings i.e. $S_1=LN_3$, $S_2=LN_4$, $S_3=LN_5$ and three different twisting pressures i.e. $P_1=5 \text{ kg/cm}^2$, $P_2=5.5 \text{ kg/cm}^2$ and $P_3=6 \text{ kg/cm}^2$ were selected to prepare samples for comparison

Yarn characteristics. The yarn tensile parameters viz yarn strength, yarn elongation and rupture per kilometer were tested using Uster Tensojet. The procedure of testing was adopted as given in ASTM standards (1997)

Statistical analysis. Four factor Completely Randomized Design was applied in the analysis of variance for testing differences among various quality characters studied in this investigation. Duncan's Multiple Range Test was also applied for individual comparison of means among various quality characteristics as suggested by Steel and Torrie (1980). The data thus obtained were subjected to statistical manipulation on computer using M-Stat computer package developed by Freed (1992).

RESULTS AND DISCUSSION

Single yarn strength. The statistical analysis of variance for single yarn strength indicates that the difference in the mean values due to different blend ratios and B x T are highly significant and for twisting pressure and B x P x S are significant while due to different LN lever settings along with all interactions are non significant.

The mean values of single yarn strength for different blending ratios, twist factors, twisting pressure at splicing zone and LN lever settings are given in Table I. It was found that as the share of polyester fibre in the blend increases the single yarn strength value also increases. This evidence is supported by Kaushik *et al.* (1987), who reported that polyester spun yarns and polyester rich blends showed greater strength retention in splicing. As opposed to the present results, Kaushik *et al.* (1988) reported that twist contributed most to the strength of spliced yarn. It was found that with the increase in twisting pressure single yarn strength decreases. Previously, Kaushik *et al.* (1988) while studying splicing process narrated that the intermingling/tucking contributes the most to the strength of spliced yarn (52%). Results indicated that different LN lever settings did not affect single yarn strength.

The maximum value is noted for the combination of $B_4P_2S_3$ (polyester rich blend with moderate twisting pressure and maximum LN lever number) i.e. 611.4 g; while minimum value of single yarn strength is recorded for the combination of $B_0P_2S_2$ (cotton yarn with moderate twisting pressure and LN lever number) i.e. 301.5 g.

It is evident that for cotton yarn moderate twisting pressure and maximum LN lever setting (LN_5) give good results for single yarn strength while for P/C blended yarn low and moderate twisting pressure with maximum LN lever setting (LN_5) there come good single yarn strength value. Therefore for different blend ratios of P/C different combination of twisting pressure and LN lever are required. This evidence is supported by Kaushik *et al.* (1988) who

while discussing splicing process stated that adjustments are needed only for air pressure of the twisting nozzle and splice length, according to the kind of yarn.

Yarn elongation. Difference was found in the mean values for yarn elongation due to different blends twist factors, LN lever settings, B x T and B x T x S interaction are significant while different twisting pressure along with all interactions remain non significant (Table II).

The mean values of yarn elongation due to different blending ratios i.e. B_0 , B_1 , B_2 , B_3 and B_4 are 3.78, 5.00, 6.02, 6.32 and 8.38%, respectively. Increasing the share of polyester in the blend gradually increased the yarn elongation. These results get confirmation from Amjad (1999) who stated that yarn elongation increased with increase in the share of man made fibre in the blend. The individual mean values of yarn elongation due to different twist factors i.e. T_1 , T_2 and T_3 are 6.01, 5.85 and 5.84%, respectively. The results show that with increasing twist, yarn elongation reduces. Similarly Kaushik *et al.* (1988) observed that there was a progressive decrease in breaking strength and elongation of spliced yarn.

The mean values of yarn elongation due to different twisting pressures i.e. P_1 , P_2 and P_3 are 5.98, 5.88 and 5.86%, respectively. These results indicate that with increasing twisting pressure, yarn elongation decreases. In a previous study Kaushik *et al.* (1988) agreed that the breaking strength, breaking elongation and work of rupture of spliced yarn was lower than for normal yarn.

The individual means of yarn elongation for different LN lever settings i.e. S_1 , S_2 and S_3 are 5.86, 5.85 and 6.00%. The best mean value of yarn elongation is observed at S_3 . However, all these values differ non significantly among each other.

The maximum value is recorded for the combination of $B_4T_1S_3$ (polyester rich blend with minimum twist and maximum LN lever number) i.e. 8.65% while minimum value is noted for the combination of $B_0T_2S_1$ (cotton yarn with moderate twist and minimum LN lever number) i.e. 3.36%. Both cotton and P/C blended yarn with minimum twist, better yarn elongation value comes at LN lever setting S_3 (LN_5) while for moderate and high twist S_2 (LN_4) setting is better for obtaining good yarn elongation value. Therefore for different P/C blends different combinations of twist and LN lever are required as Kaushik *et al.* (1988) narrated that adjustments are needed only for air pressure of twisting nozzle and splice length according to the kind of yarn.

Rupture per kilometer (R.K.M.). Difference was found in the mean values of R.K.M. due to different blends twisting pressure and interaction of B x T, B x P, T x P, T x S, P x S, B x T x P and B x P x S are highly significant while due to different twist multipliers, different setting of LN lever along with all interactions are non significant (Table III).

It was found that that with increasing share of polyester fibre in the blend, R.K.M. value of the yarn also increases. Previously, Onder and Baser (1996) stated that longer fibre in the cross section of the yarn increased its

tenacity. The values of R.K.M. for different twist factors differed non significantly from one another. However Wu and Yihlee (1995) narrated that tenacity of the fibre increased with the increased twist up to a certain limit. It was found that R.K.M. value decreases with increasing pressure. While studying the splicing process, Gebald (1984) narrated that on the autoconer there are two features which ensure splice reliability. One important fault which can adversely affect the strength of the splices is insufficient compressed air pressure. Individual mean values for yarn R.K.M. due to different settings of LN lever i.e. S₁, S₂ and S₃ are 20.73, 20.81 and 20.76 g/tex, respectively. The best mean value of yarn R.K.M. is noted at S₂; however, all these values have non significant difference among each other. Showing that variation of LN lever setting does not affect the R.K.M. value of yarn.

The maximum value is recorded for the combination of B₄T₂P₁ (polyester rich blend with moderate twit and minimum pressure) i.e. 29.02 g/tex; while the minimum value is noted for B₀T₁P₂ (cotton yarn with low twist and moderate pressure) i.e. 14.83 g/tex. For the moderate twisted polyester, rich blended yarn minimum twisting pressure at splicing zone yield good R.K.M. value. Also this pressure is suitable for high twisted cotton yarn.

The maximum value of R.K.M. is observed for the combination of B₄P₁S₁ (polyester rich blend with minimum pressure & LN lever number) i.e. 29.71 g/tex; while the minimum value is recorded for the combination of B₀P₂S₂ (cotton yarn with moderate twisting pressure and LN lever number) i.e. 14.98 g/tex. It is clear that better results for R.K.M. value come at the setting S₁(LN₃) of LN lever at low and moderate pressure in case of P/C blended yarn but at low pressure in case of cotton spun yarn.

While studying effect of fibre/yarn variables on mechanical properties of spliced yarn, Kaushik *et al.* (1988) agreed that air overtaxing (twisting) in the splicing chamber generated torque, which rotated the individual fibres of the two yarn ends; thus, causing fibre intermingling and binding in the splice zone. During fibre intermingling tensional rigidity and breaking twist angle of the fibre react to the torque. The lower torsional rigidity and higher breaking twist angles for polyester fibres allow the use of higher pneumatic pressure in the splicer to permit better fibre intermingling.

CONCLUSIONS

1. Percentage of individual fibres in the blend as well as the changes in twist factor affect the spinning performance and all the yarn parameters significantly.
2. Yarn parameters show better results at twisting pressure P₁=5 kg/cm². P₃=6 kg/cm² and at Ln₅ for different blends and twist factors. However, the over all effect of twisting pressure an splice length control lever (Ln lever) on all the yarn parameter is found non significant.

Table I. Comparison of individual treatment means for Single yarn strength

Blend Ratio	Means	Twist factor	Means (g)	Twisting pressure	Means (g)	LN lever settings	Means (g)
B ₀	320.65 e	T ₁	425.10	P ₁	431.62 a	S ₁	425.82
B ₁	369.05 d	T ₂	428.83	P ₂	427.01 ab	S ₂	425.72
B ₂	415.40 c	T ₃	427.56	P ₃	422.86 ab	S ₃	429.96
B ₃	432.29 b						
B ₄	598.42 a						

Any two means not sharing a letter in common differ significantly at 0.05 level of probability

Table II. Comparison of individual treatment means for Yarn elongation

Blend Ratio	Means	Twist factor	Means (g)	Twisting pressure	Means (g)	LN lever settings	Means (g)
B ₀	3.78 e	T ₁	6.01a	P ₁	5.98	S ₁	5.86 b
B ₁	5.00 d	T ₂	5.85b	P ₂	5.88	S ₂	5.85 b
B ₂	6.02 c	T ₃	5.84b	P ₃	5.86	S ₃	6.00 a
B ₃	6.32 b						
B ₄	8.38 a						

Any two means not sharing a letter in common differ significantly at 0.05 level of probability

Table III. Comparison of individual treatment means for Rupture per Kilometer

Blend Ratio	Means	Twist factor	Means (g)	Twisting pressure	Means (g)	LN lever settings	Means (g)
B ₀	15.77 e	T ₁	20.81	P ₁	20.97 a	S ₁	20.73
B ₁	18.74 d	T ₂	20.82	P ₂	20.80 ab	S ₂	20.81
B ₂	20.12 c	T ₃	20.68	P ₃	20.53 b	S ₃	20.76
B ₃	21.22 b						
B ₄	27.78 a						

Any two means not sharing a letter in common differ significantly at 0.05 level of probability

3. As the share of polyester fibers in the blend increases, splice strength increases while with the increasing twist factor and LN lever number splice strength decreases.

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