Characterization of Low Twist Yarn: Effect of Twist on Physical and Mechanical Properties

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ABSTRACT

The amount of twist plays vital role for finished consumers' good which determines appearance, durability and serviceability of fabric. In this research, yarns made of four twists (170, 190, 210 and 230 tpm (turns per meter) were investigated in order to determine the effect of twist on physical and mechanical properties of low twist yarn. The yarn properties: tenacity, breaking force, elongation, mass variation, hairiness in the yarn were studied. Three counts (30, 40 and 50 tex) were manufactured with various twist levels. It was observed that the strength of yarn was affected with an increase of the twist and count. The yarn manufactured with 230 tpm and 50 tex count shows better yarn strength as compared with other twist levels and yarn counts. Further, it was found that reduction in twist improves the evenness of yarn.

Key Words: **Ring Spinning, Low Twist Yarn, Yarn Strength and Unevenness.**

1. INTRODUCTION

Twist plays an important and significant role on the yarn quality and its production. It provides cohesion between the fibres and gives strength to the yarn particularly when the yarn is subjected to any external force [1-2]. Therefore, twisting mechanism including twist distribution and propagation has attracted the increasing interest of researchers in textiles and apparel. Twist gives shape of the yarn as the fibre strand leave the front roller nip of a ring frame. Simpson and Fiori reported that yarn twist affects yarn properties and spinning efficiency of normal blended yarn [3-5]. Morton [6] investigated that the spun yarns with higher twist multiplier exhibit greater yarn irregularity (40-70%). Gulati, et. al. [7] also worked out on the relationship between diameter, twist, and count. They found that turns per inch in any cross section are approximately inversely proportional to the number of fibers in that part. A close relationship is also exhibited between fiber fracture and yarn strength, about 60% of the fibers break when the yarn strength is at its highest. Barella [8] discusses the influence of twist on yarn diameter, density, and contracture, and has verified experimentally the theoretical relationship between these parameters. The deformation and residual strain of individual fibres in terms of yarn count and twist factor, fibre tension, lateral compression are dependant upon the nature of fibres in the staple yarn [9]. For getting better yarn strength and torque understanding of twist distribution is very important factor [10]. Previous studies have showed that the spirality dependents on various processing factors, such as fiber

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types, yarn properties, fabric properties, machine parameters and relaxation process [11]. From literature review it is visible that various researchers have focused on the characteristics of high twist yarn. In this research, a range of twist level has been analyzed. Authors compare the effect of various twist levels (170, 190, 210 and 230 turns per meter) by taking different counts (30, 40 and 50 tex) in order to find out the most appropriate twist level for producing a yarn having acceptable properties.

2. MATERIALS AND METHOD

PE/CT (Cotton and Polyester) blend were used in this research. 30/70 PE/CT blending ratio has been used for this research. Three different counts (30, 40 and 50 tex) were manufactured on ring spinning machine using 15000 rpm of spindle speed. Fig. 1 shows the experimental plan for production of low twist yarn with four different twist levels. The raw material properties were tested as mentioned in Table 1 using Fibrograph, Stelometer and Micronaire equipments.

The low twist yarns were spun with range of twist levels - 170, 190, 210 and 230 tpm on ring spinning machine by using 15000 rpm of spindle speed. The yarn properties were analysed by using different electronically controlled testing equipments. Uster Tensorapid 4 and Uster Tester 4 were used by applying the recommended procedure. The samples were conditioned at relative humidity of 65 ± 2% and 20 ± 2°C for atleast 24 hours. Minimum 10 tests for skein strength and 100 tests for single yarn strength of each count were tested according to ASTM standards [12-16].

3. RESULTS AND DISCUSSION

3.1. Analysis of Low Twist Yarn Unevenness

U% (Coefficient of Variation): The graphical representation of typical irregularity percentage is shown in Fig. 2. It is observed that mass variation increases in individual count with an increase of twist level from 170 -

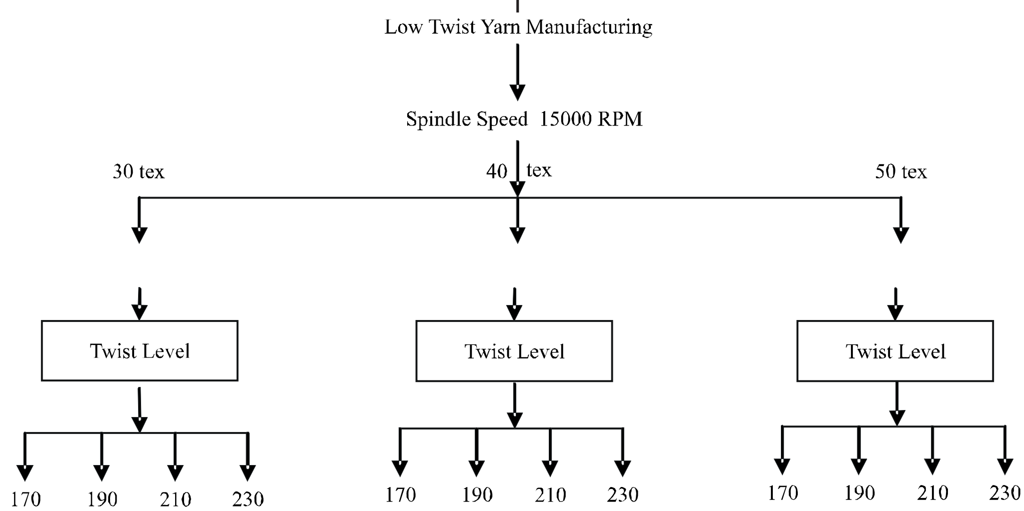

FIG. 1. SCHEMATIC DIAGRAM OF EXPERIMENT PLAN

TABLE 1. PROPERTIES OF COTTON AND POLYESTER FIBRES

No.	Cotton Fibre Properties	Measurement	Polyester Fibre Properties	Measurement
1.	Fibre Strength	32 g/tex	Denier	1.2
2.	Uniformity Index (%)	83%	Tenacity	7.2 gm/den
3.	Mic Value	4.3	Elongation	20%
4.	Length (mm)	28mm	Crimps/cm	6.5
5.	-	-	Fibre Length	38m

190 tpm. However, the change in mass variation varies with respect to different count. For example, mass variation in 170 and 190 tpm increases with an increase of yarn count (yarn density). Whereas, mass variation in 210 tpm decreases with an increase of yarn count and mass variation in 230 tpm remains almost same in all counts. Among the all yarn counts, 50 tex exhibits highest irregularity in yarn with different types of twist level, 230 tpm contains highest irregularity as compared with other twist levels. The reason of this change may be due to uneven fibre distribution along the length of the strand. The strand (yarn) consists highest percentage (70%) of cotton fibre along with polyester fibre (30%). As the yarn count increases from 30-50 tex, the irregularity percentage also increases due to uneven distribution of cotton and polyester fibres along the length of yarn. Further, as the number of turns increases in the yarn diameter more irregularity is seen in the yarn which also may be due to uneven fibre (Cotton and polyester) length and distribution along the length of yarn.

CV% (Coefficient of Variation): CV is defined as the magnitude of sample values and the variation present in the material which may also be used for the comparing the values of degree of variation from one series to another. The graphical representation of all counts and twist for coefficient of variation are shown in the Fig. 3. It is observed that CV increases in individual count with an increase of twist level. However, the change in CV varies with respective to twist levels if change yarn count as well. The CV in 170, 210 and 230 tpm decreases with an increase of yarn count (tex), CV in 190 tpm remains almost same. This CV variation may be due to lower amount of fibres present in yarn cross-section and blend ratio particularly highest ratio of cotton. The staple length of cotton is shorter than polyester however amount of fibre per unit length is greater which leads to U%.

UI (Uniformity Index): Fig. 4 presents the typical graphical representation of UI. It is found that the index decreases with an increase of count, however it decreases with respect to twist per meter. Among all low twist levels, the 170 tpm exhibits highest the UI which may be due to low amount of twist in yarn diameter and thus it gives less mass variation in the yarn. The yarn made with 230 tpm displays lowest value of UI which may be due to coarser yarn cross section and presence of higher number of cotton fibre in yarn diameter.

YH (Yarn Hairiness): The graphical representation of YH for yarn counts and twists used in this research are given in Fig. 5. It is noted that YH increases with the drop of the

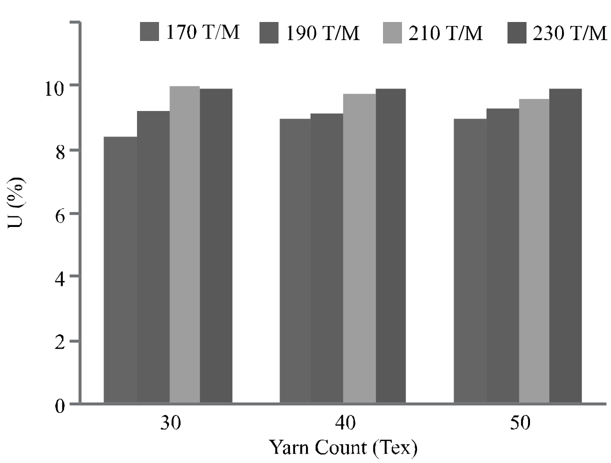

FIG. 2. MASS VARIATION IN LOW TWIST YARN

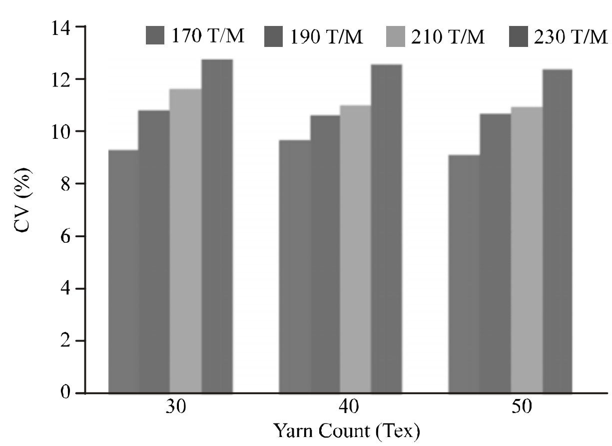

FIG. 3. COEFFICIENT OF VARIATION IN LOW TWIST YARN

yarn twist level. However, there is not significant change with an increase of yarn count. The 170 tpm exhibits higher percentage of hairiness comparing to 190, 210 and 230 tpm. This may be because of fibres are not bound completely as compared with higher twist levels (230) in the yarn cross section, as a result the abrasion created in between fibres and yarn traveller leads to fibres protrude from the yarn diameter and increase the YH. The yarn made with 230 tpm carries lowest amount of hairiness.

3.2 Tensile Properties of Low Twist Yarn

Tensile properties of single yarn made of various counts and twist levels were evaluated. It is observed that yarn tenacity increases with an increase of yarn twist as well as yarn count as shown in Fig. 6. If we compare the tenacity in twist levels, the yarn tenacity in all low twist levels (170-230 tpm) presnets slight increase in yarn count 30 and 50, yarn made of 40 tex displays almost similar tenacity in all twist levels. The elongation and breaking force of single yarn shows similar increasing trend as twist level and yarn count increases as shown in Figs. 7-8. The yarn count 50 and particularly 230 tpm possess highest enlongation and breaking force among their respective counts and levels. The yarn count 50 exhibits favourable tensile behaviour with lowest twist level.

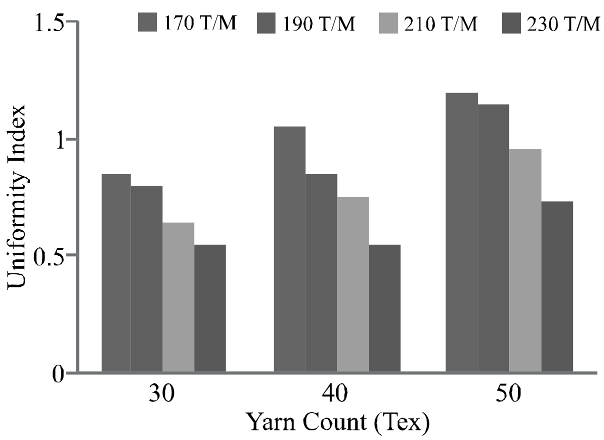

FIG. 4. UNIFORMITY INDEX IN LOW TWIST YARN

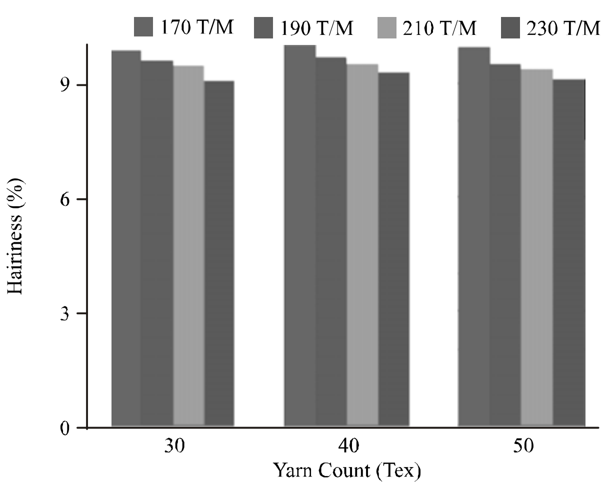

FIG. 5. HAIRINESS IN LOW TWIST YARN

4. CONCLUSIONS

An attempt has been made to manufacture the yarn with lowest possible twist and comparative analysis has been carried out to determine the effect of different low twist levels on a range of yarn count. Low twist yarns were made with 30, 40 and 50 tex count and 170, 190, 210 and 230

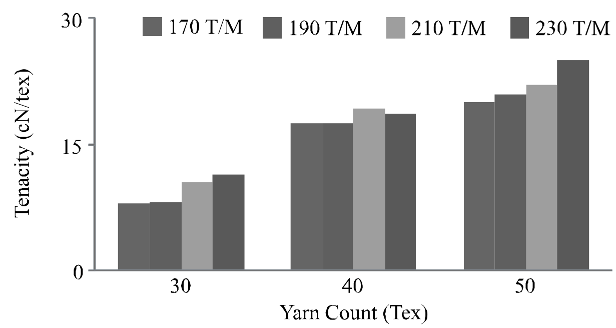

FIG. 6. TENACITY OF LOW TWIST YARN

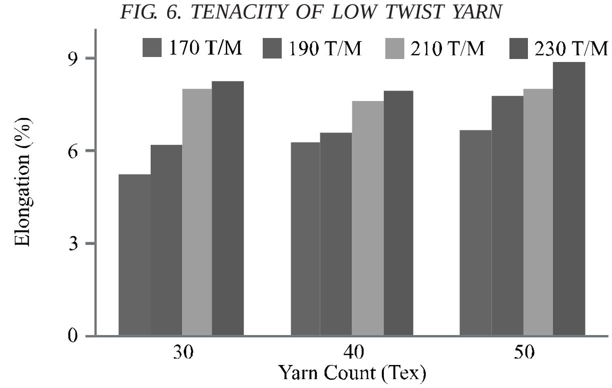

FIG. 7. ELONGATION OF LOW TWIST YARN

tpm. Following key points are concluded during comparative analysis.

(i) The mass variation of low twist yarn of a range of count 30, 40 and 50 tex increases till 190 tpm and it remains almost similar in 230 tpm.

(ii) The coefficient of variation in 30, 40 and 50 tex is constantly increasing with decrease of the twist per meter. This may be due to low amount of fibres present in yarn cross-section.

(iii) The irregularity index of low twist yarn decreases with an increase of count, however it decreases with respect to twist per meter in same count.

(iv) The yarn hairiness of low twist yarn increases with an increase of yarn count. However, it decreases in same count with an increase of twist level.

(v) While evaluating the tensile properties of low twist yarn, it is found that tenacity and breaking force of single low twist yarn increase with respect to an increase of count as well as twist level in same count, however elongation of same yarn increase with similar propagation trend. The yarn count 50 exhibits favourable tensile behaviour with lowest twist level.

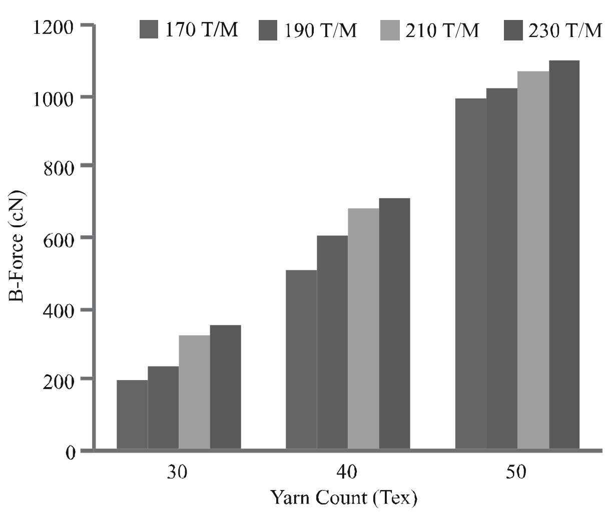

FIG. 8. BREAKING FORCE OF LOW TWIST YARN

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REFERENCES

[1] Rao, R.N., "Estimation of Single Yarn Twist and the Relation between the Estimated and Mechanical Twists", Textile Research Journal, Volume 36, pp. 65, 1966.

[2] Hong, B.T., Bin, G.X. and Xiao, M.T., "A New Analytical Solution of the Twist Wave Propagation Equation with its Application in a Modified Ring Spinning System", Textile Research Journal, Volume 80, pp. 636, 2010.

[3] Simpson, J., and Fiori, L.A., "An Analysis of Carding Efficiency and Processing Performance of Cotton/Polyester Blends", Textile Research Journal, Volume 44, pp. 813-822, 1974.

[4] Simpson, J., and Fiori, L.A., "How Yarn Twist Affects Yarn Uniformity and Imperfections", Textile Research Journal, Volume 45, pp. 136-137, 1975.

[5] Longdi, C., Peihua, F., and Xiuye, Y., "Relationship between Hairiness and the Twisting Principles of Solospun and Ring Spun Yarns", Textile Research Journal, Volume 74, pp. 763, 2004.

[6] Morton, W.E.J., "Twist and Tension as Factors in Yarn Characteristics" Journal of Textile Institute, Volume 21, pp. 205-224, 1930.

[7] Gulati, A.N., and Turner, A.J., "The Foundations of Yarn-Strength and Yarn-Extension, Part-IV: The Influence of Yarn-Twist on the Diameters of Cotton Yarns", Journal of Textile Institute, Volume 21, pp. 561-582, 1930.

[8] Barella, A., "Textiles" Journal of Textile Institute, Volume 21, pp. 205-224, 1930.

[9] Bin, G.X., and Xiao, M.T., "Techniques for Torque Modification of Singles Ring Spun Yarns", Textile Research Journal, Volume 78, pp. 869, 2008.

[10] Lamb, P.R., Wang, L., and Wang, X., "Twist Distribution In Staple Fibre Yarns", Centre for Material and Fibre Innovation, Deakin University, Waurn Ponds, Australia, 2008.

[11] Bingang, X., Xiaoming, T., and Chung-Sang, L., "A Comparative Study of Cotton Knitted Fabrics and Garments Produced by the Modified Low Twist and Conventional Ring Yarns", Institute of Textiles and Clothing, The Hong Kong Polytechnic University, Hung Hom, Hong Kong, May 31, 2010.

[12] ASTM , D2256-02, "Test Method for Tensile Properties of Yarns by the Single-Trend Method", ASTM, Volume 7, No. 1, USA, January, 2005.

[13] ASTM , D5647-01, "Guide for Measuring Hairiness of Yarns by the Photo-Electric Apparatus", ASTM, Volume 7, No. 1, USA, January, 2005.

[14] ASTM, D1445-05, "Test Method for Breaking Strength and Elongation of Cotton Fibers (Flat Bundle Method)", ASTM, Volume 7, No. 1, USA, January, 2005.

[15] ASTM, D1447-00, "Test Method for Length and Length Uniformity of Cotton Fibers by Fibrograph Measurement", ASTM, Volume 7, No. 1, USA, January, 2005.

[16] ASTM, D1448-05, "Test Method for Micronaire Reading of Cotton Fibers", ASTM, Volume 7, No. 1, USA, January, 2005.