Polyester textured yarn fabricated spun-like filament by rotor twister

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A novel rotor twister has been used to fabricate a spun-like filament yarn using a draw-textured yarn (DTY) as core yarn and a partially oriented yarn (POY) as wrapping yarn. During twisting, the core yarn passes through a pair of grinding wheels to cause hairiness. The effects of rotor speed, twist multiplier, number of grinding wheels and counts of DTY on tenacity, elongation and hairiness have been studied. It is observed that the decrease in the number of grinding wheels increases the hairiness but decreases the tenacity and elongation. The twist multiplier affects neither the tenacity nor the elongation but the increase in twist multiplier increases the hairiness. The increase in rotor speed increases the tenacity and elongation but decreases the hairiness. With a twist multiplier of 1.4, rotor speed of 8000 rpm and grinding wheels of (60# + 120#), the filament yarn excellently imitates spun yarn.

Keywords: Polyester yarn, Rotor twister, Spun-like filament yarn, Yarn hairiness

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1 Introduction

Synthetic continuous filament yarns are normally textured before being used in processes such as weaving or knitting. Conventional texturing aims to impart texture to the regularly packed, flat filament yarn to increase the comfort and aesthetic appeal of the finished product. Three methods are currently adopted in the production of folded yarns conventional ring twisting, two-for-one twisting and stage twisting. Several studies on the development of twisting machines have already been reported. Although the ring twister and the two-for-one twister have been available for many years, their productivity is still limited owing to their construction and the twisting tension that can be applied. The physical properties of the plied yarns produced by two-for-one twister are generally poorer than those of the yarns obtained using the ring twister.

False-twist textured yarns lack inter-filament cohesion and consequently a number of difficulties exist during unwinding and fabric forming processes. One modern technique for imparting such cohesion is air interlacing of false-twist textured yarns. Air interlacing depends on a nozzle to create a very turbulent high speed air flow.

Constructing a new rotor spinning device to enable high speed twisting and reducing twisting tension are two basic considerations in developing this novel rotor twister. Many critical obstacles in using this novel technique have been overcome.

Although textured yarn can be crimped and bulky, it is quite dull and not very flexible. The textured yarn is available in fewer varieties and is less flexible than staple spun yarn. The present work is aimed at producing spun-like continuous filament yarn that differs from normal textured yarn. The novel rotor twister has been used to fabricate the spun-like yarn using draw-textured yarn (DTY) as core yarn and partially oriented yarn (POY) as wrap yarn. During twisting, the core yarn passes through a pair of grinding wheels to induce hairiness on the surface of the yarn.

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2 Materials and Methods

2.1 Materials

The draw-textured yarns of 33.33 tex / 96f, 66.67 tex / 160f and 100 tex / 256f polyester filament yarns were obtained commercially and used as the core yarns. The polyester (12.8 tex / 36f) partially oriented yarn was used as wrap yarn.

2.2 Mechanism of Rotor Twister

The rotor twister used is shown in Fig. 1. The tangent belt on the motor first drives the rotor spinning device of the twist wrap machine. The front side of the core yarn and the take-up roller drag the wrap yarn and the other end of the untied core yarn is held by the mechanism of tension control roller. When the wrap yarn is untied, the core yarn simultaneously passes through the middle of the rotor twister. The wrap yarn continues to wrap with the rotation of rotor twister and finally the core yarn twisting is completed. Besides, adjusting the speeds of rotor twister and take-up roller could change the amount of twist. When the rotor rotates at a constant speed steadily, a slower speed of take-up roller could lead to a greater amount of twist.

The centrifugal force produced by the fast rotation throws out the wrap yarn on the package to wrap the central filament. The rotor sleeve nut, bearing sleeve and high speed bearings are such that the wrap yarn is fixed on the packages and the weight between the wrap yarn and the motor is balanced to achieve high speed. An infrared device (Microtach 8400) was used to measure the rotory and take-up speeds of the machine. Additionally, the tensioning device (SHARP Limit 2000 gf) on the machine was set to control and adjust the tension of the system.

2.3 Test Method

Owing to the difference in boiled water shrinkage of both draw textured and partial oriented yarns, the hairiness appearance of ground filaments can be set more intensely. The hairiness is caused by the friction of carborundum wheel combinations (GC 60#/ 120#/ or GC 60#/ 180#) with size of 100 mm in diameter and 50 mm in thickness. The number of emery wheels implies the surface roughness, for instance GC 60# has a rougher granular structure and GC 180#, a smoother granular structure. The DTY was passed through the grinding wheels and rubbed by them. It was then passed through the rotor twister and wrapped by the POY to form the spun-like filament yarn. During the experiment, the specification of DTY and the combination of grinding wheels were changed. The rotor twister method was used with different rotor speeds (4000, 6000, 8000, 10000 and 12000 rpm) and various twister multipliers (1.0, 1.2, 1.4, 1.6 and 1.8) respectively to spin three specifications of spun-like filament yarns (45, 80 and 115 tex). The strength of these spun-like filament yarns was tested using a tenacity instrument. The hairiness meter was used to measure hairiness numbers.

2.4 Measurement of Yarn Characteristics

The tensile properties of spun-like filaments produced by rotor twister were further measured by a tensile test instrument (TEXTECHNO) according to ASTM D 2256 standard. The hairiness (> 3 mm) of the hybrid yarn was measured by a Zweigle G565 hairiness tester. The appearance of yarn was observed both by an optical microscope (Olympus CH-2) and a scanning electronic microscope (JEOL JSM-5200).

3 Results and Discussion

3.1 Influence of Rotor Speed and Twist Multiplier on Strength

Fig. 2 reveals that the tenacity of each spun-like filament yarn increases with the rotor speed but does not exceed after the optimum rotors speed (8000 rpm). However, the tenacity of the spun-like filament yarn increases slightly. The tenacity of spun-like filament yarns of all the three specifications also increases with the yarn count, as the count increases the multi-filament ends.

Fig. 3 indicates that the tenacity of each spun-like filament yarn increases with the twist multiplier, but does not exceed after the optimum twist multiplier (1.4). However, the tenacity of the spun-like filament yarn increases slowly. The tenacity of all the three
specifications of the spun-like filament yarn also improves with the (60# + 180#) combination of grinding wheels. Grinding wheels with higher numbers have finer friction particles and therefore cause lighter damage and yield higher tenacity.

The tenacity of spun-like filament yarn is higher than that of normal textured yarn because the spun-like filament yarn is reinforced by the wrapped POY.

3.2 Influence of Rotor Speed and Twist Multiplier on the Elongation

Fig. 4 shows that the elongation of each spun-like filament yarn increases with the rotor speed. The POY provides more elongation than DTY, yielding a higher rotor speed and more POY wrapped on the DTY. However, the elongation also increases with the yarn count, because a higher yarn count indicates the presence of more filaments in a single yarn.

Fig. 5 indicates that the elongation increases gradually with the twist multiplier at a constant rotor speed and yarn count. However, the elongation values of these spun-like filament yarns are close to each other. A higher grinding wheel number (180#) indicates a smaller grinding particle. Therefore, the effect of friction decreases as grinding wheels number increases, i.e. filament ends rubbing decreases the hairiness. The spun-like filament yarn contains more filament ends in a yarn. Thus, the elongation with grinding wheel number (180#) exceeds that with grinding wheel number (120#).

The elongation of spun-like filament yarn is higher than that of normal textured yarn because the spun-like filament yarn is reinforced by the wrapped POY.
3.3 Influence of Rotor Speed and Grinding Wheels Number on Hairiness

Fig. 6 reveals that the spun-like filament yarn with higher count shows a higher hairiness than the yarn with lower count, because a yarn with higher count contains more multifilament ends. Grinding wheels also affect the hairiness for all the counts. A higher grinding wheel number (180#) implies smaller grinding particles, so the friction effect declines as the grinding wheel number increases (120#). Thus, the hairiness rubbed by the grinding wheels with the higher number (180#) is less than that rubbed by the grinding wheels with lower number (120#).

Fig. 7 reveals that a spun-like filament yarn with higher count yields higher hairiness than a yarn with a lower count at each rotor speed, because a yarn with higher count has more multifilament ends than a yarn with lower count. The hairiness, however, decreases as rotor speed increases. The hairs are wrapped by the POY, corresponding to lower hairiness, because the POY is wrapped more closely around the DTY at higher rotor speeds.

3.4 Appearance of Spun-like Filament Yarn and Fabric

Fig 8 clearly shows the surface appearance of the yarn and the fabric weaved by the spun-like filament yarn. The single spun-like filament obviously possesses a hairy structure successfully owing its wrapped yarn. However, the woven fabric possesses less hairiness on the yarn surface. It can be attributed to the effect of reed strike at the yarn surface. For the purpose to enhance the hairy structure of fabric, the boiled water setting process can be used.

4 Conclusions

The hairiness is an important characteristic for the filaments to simulate the hand feeling of ordinary
staple yarn. A novel rotor twister can produce the spun-like filament yarn successfully by using common polymer fibre with a high wrapping speed. This spun-like filament yarn can be used to make a woven or knitted fabric wiper or mop for cleaning, to make clothing, or to serve other industrial purposes. The spun-like filament yarn fabricated by the rotor twister method can be used industrially because of its greater strength and elongation than regular spun-like yarn. With the twist multiplier of 1.4, rotor speed of 8000 rpm and grinding wheels of (60# + 120#), the spun-like filament yarn shows better imitated hairiness compared to other processing conditions. With the twist multiplier of 1.8, rotor speed of 12000 rpm, count of 115 tex, and grinding wheels of (60# + 180#), the spun-like filament yarn has better mechanical properties with the strength of 27.10 cN/tex and elongation of 15.89%.

References