Influence of Frictional Characteristics of Core and Sheath on Structure, Twist, and Tensile Properties of DREF-3 Friction Spun Yarns

by

MAHENDRA GOWDA R.V.

Textile Technology Department

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Spun yarn

Dedicated to

My Parents

CERTIFICATE

This is to certify that the thesis entitled **"Influence of Frictional Characteristics of Core and Sheath on Structure, Twist, and Tensile Properties of DREF-3 Friction Spun Yarns"** being submitted by **Mr. Mahendra Gowda R.V.** to the Indian Institute of Technology, Delhi, for the award of the degree of **Doctor of Philosophy** in the department of Textile Technology, is a bonafide research work carried out by him. Mr. Gowda has worked under our joint guidance and supervision and fulfilled the requirements for submission of the thesis.

The results contained in this thesis have not been submitted, in part or full, to any other University or Institute for the award of any degree or diploma.

Prof. K.R. Salhotra
Department of Textile Technology
Indian Institute of Technology, Delhi
New Delhi-110016

Prof. S.M. Ishtiaque
Department of Textile Technology
Indian Institute of Technology, Delhi
New Delhi-110016

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(MAHENDRA GOWDA R.V.)

ABSTRACT

The influence of frictional characteristics of core and sheath on structure, twist, and tensile properties of DREF-3 friction spun yarns has been investigated with the objective of improving the yarn strength and enhancing the sheath slipping resistance.

In case of filament-core DREF-3 friction spun yarns, the friction between the core and the sheath, and the inter-fibre friction with in the sheath has been changed by either modifying the filament-core surface character through twisting, and air-jet texturing processes or by changing the sheath-fibres' friction through the application of different level of finish over the fibres. In case of staple-core DREF-3 friction spun yarns, the friction between the core and the sheath, and the inter-fibre friction with in them has been changed by the application of different level and type of finish on both core and sheath fibres.

The change that has taken place in the frictional characteristics of core and sheath components has been measured by using a new approach developed on the basis of measurement of friction between fibre fringes. The frictional characteristics, namely, fibre-to-filament friction and fibre-to-fibre friction are, therefore, measured to investigate their influence on yarn structure, twist, and tensile properties.

As regards the influence of frictional character of the filament-core on yarn tensile properties, it has been observed that the yarn spun from Z-twist filament-core exhibits superior tensile properties as compared to the yarn spun from Flat filament-core. The air-jet textured filament-core (AJT_{30}) spun yarn, on the other hand, exhibits lower tenacity in comparison to Flat filament-core spun yarn. Nevertheless, the higher fibre-to-filament friction in this yarn has resulted in significantly higher sheath contribution to the resultant yarn strength. The yarn also exhibits excellent sheath

slipping resistance. A method has been devised to measure the sheath slipping resistance in the yarn.

In respect of the influence of frictional characteristics of filament-core and staple-sheath on yarn structure, twist, and tensile properties, it has been found that the twist and wrapping of sheath fibres is more or less the same in case of Flat, and Z-twist filament-core spun yarns due to similar fibre-to-filament friction in both the cases. The air-jet textured filament-core (AJT_{30}) spun yarn exhibits significantly higher sheath-fibre wrapping due to greater fibre-to-filament friction. This is responsible for greater sheath contribution and excellent sheath slipping resistance in the yarn. The increase in fibre-to-filament and fibre-to-fibre friction due to increase in the level of add-on finish on sheath fibres has resulted in significant increase in twist and wrapping of sheath fibres over the core, leading to greater cohesion between the core and the sheath. This in turn has resulted in a significant increase in yarn tenacity and sheath slipping resistance. The tenacity has increased by about 7.0%, 7.4%, and 10.4% in case of Flat filament-core, Z-twist filament-core, and AJT_{30} filament-core spun yarns respectively. Besides this, the sheath fibres are found to be arranged in layers and exhibit differential twist structure.

With regard to the influence of frictional characteristics of staple-core and staple-sheath on yarn structure, twist, and tensile properties, it has been noticed that the increase in friction between the core and the sheath, as well as the inter-fibre friction within them, significantly increases the twist and wrapping of sheath fibres over the core. It is very interesting to observe that the core in the yarn exhibits twist in both Z and S directions. The false twisting of core and the presence of false twist in the core of the yarn has been analyzed. The total entrapped false twist in the core has also been found to increase with increase in fibre friction. The yarn packing fraction increases by about 6% for an approximate increase of 9-14% in fibre-to-fibre frictional force. The tenacity also increases by 18%. There is a good association between the yarn tenacity and the fibre-to-fibre frictional force (correlation coefficient = 0.93).

Finally, with respect to the influence of frictional characteristics of core and sheath in relation to core-sheath ratio and spinning drums' speed on yarn tenacity, it has been observed that the core-sheath ratio of 70:30 has resulted in maximum yarn tenacity. The increase in spinning drums' speed from 3500 rpm to 5000 rpm increases yarn tenacity significantly. The extent of increase is higher at lower level of fibre friction and vice versa. However, the maximum tenacity was achieved at spinning drums' speed of 5000 rpm for higher level of fibre friction.

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