INFLUENCE OF SOME PARAMETERS ON INTERNAL STRUCTURE OF OPEN-END AND CORE-SHEATH FRICTION SPUN YARNS

by

PRASHANT

DEPARTMENT OF TEXTILE TECHNOLOGY

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1. Spun yarn 2. Friction Spun yarn

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CERTIFICATE

This is to certify that the thesis entitled "**Influence of Some Parameters on Internal Structure of Open-End and Core-Sheath Friction Spun Yarns**" being submitted by **Mr. Prashant** 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. Prashant has worked under our 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.

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ABSTRACT

The influence of opening roller speed, difference in drum speed, suction air pressure and sheath sliver feeding position on structural characteristics and properties of friction spun yarns have been investigated in details using Box and Behnken design of experiments. The study was carried out on both open-end and core-sheath types of friction spun yarns.

The air flow at different positions inside the transparent duct of DREF-III friction spinning machine was measured with the help of three-tube yaw probe, multi-tube manometer and traversing mechanism. For this purpose a transparent duct with exactly of same dimensions to that of original duct was fabricated from acrylic sheet. The results show that air flow inside the duct is not uniform both near inlet and outlet of the duct. The instability of air flow is more near the side walls, particularly in the inlet zone. In fact, near the side walls in the inlet zone the air flow is in upward direction. The increase in opening roller speed increases the rate of air flow. However increase in suction air pressure reduces the magnitude of instability in air flow near the side walls.

The internal structure of open-end and core-sheath friction spun yarns were studied with the help of tracer fibre technique. Twist structure of friction spun yarns were studied in leading and trailing half of fibres for different sliver feeding positions. The results show that fibres from 1st feeding position (near to delivery end) have higher helix diameter, helix angle and lower helix twist than fibres from 5th feeding position (away from delivery end). The results also show that there is considerable difference in the level of helix twist, helix diameter and helix angle in trailing and leading half of fibres. Sheath

fibres of core-sheath friction yarns have significantly lower twist than open-end friction yarns under identical spinning conditions. In core-sheath yarns, core fibres have lower level of twist in both 'S' and 'Z' directions, but the intensity of twist is significantly higher near the trailing end in Z direction. The increase in suction air pressure increases twist in sheath fibres for both types of friction spun yarns. The total entrapped false twist in the core also has been found to increase with increase in suction air pressure.

The migration parameters of friction spun yarns were studied in details with 2-dimensional and 3-dimensional images. The results show that 3-dimensional studies gives higher mean fibre position (MFP), root mean square deviation (RMSD) and mean migration intensity (MMI) than 2-dimensional study. It is observed that fibres from 1st sliver feeding position have significantly higher MFP, RMSD and MMI than 5th sliver feeding position. The results show that for open-end friction spun yarns the trailing half of fibres have higher MFP, MMI and RMSD than leading half of fibres for 1st feeding position while reverse trend is observed for fibres from 5th feeding position. The migration parameters are mainly influenced by suction air pressure followed by opening roller speed and difference in drum speed for both open-end and core-sheath friction yarns.

As regard to influence of process parameters on fibre configurations in friction spun yarns, it is observed that the sheath fibres have highest percentage of leading hooks followed by trailing hooks, entangled hooks and straight fibres for both types of yarns. The study also shows that fibres from 5th sliver feeding position have higher percentage of leading and trailing hooks and lower percentage of entangled fibres than fibres from 1st sliver feeding position for both types of yarns. The spinning-in coefficient of sheath fibres from 1st sliver feeding position is lower than fibres from 5th sliver feeding position. In open-end friction spun yarns the spinning-in-coefficient initially decreases and then increases with the increase in opening roller speed and decreases consistently with increase in suction air pressure. However, the core sheath yarns do not show good correlation with the process variables.

The packing density of both types of yarns is only influenced by suction air pressure and increases with the increase in suction air pressure. The packing density of core-sheath friction spun yarns is higher than open-end friction yarns.

The results show that with the increase in opening roller speed and suction air pressure tenacity, elongation and work of rupture of open-end friction yarns increase but for core-sheath yarns the tenacity, initial modulus and work of rupture only influenced by suction air pressure. With regard to the influence of process parameters on physical properties of friction spun yarns it is observed that increase in opening roller speed and suction air pressure significantly reduces unevenness and imperfections of open-end friction spun yarns but have no significant influence on core-sheath yarns. Hairiness of both types of yarn decreases with the increase in suction air pressure.

Finally, with respect to the influence of transport duct profile on air flow, it has been observed that modified duct profile improves the air flow inside the duct. This improvement in air flow improves the yarn structure and tensile properties for open-end and core-sheath friction spun yarns. However improvement in tensile properties is more significant for open-end friction spun yarns. In core-sheath friction spun yarns the improvement in yarn tenacity is highest for 50:50 core-sheath ratio and for higher linear density.

CONTENT