FIBRE BREAKAGE IN ROTOR SPINNING DURING OPENING BY THE COMBING ROLLER

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CERTIFICATE

This is to certify that the thesis entitled "Fibre Breakage in Rotor Spinning During Opening by the Combing Roller", being submitted by Mr. R. Chattopadhyay to the Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy in Textile Technology, is a record of bonafide research work carried out by him. Mr. R.Chattopadhyay has worked under our guidance and supervision and has fulfilled the requirements for the submission of this thesis, which to our knowledge has reached the requisite standard.

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

Ever since BD 200 rotor frame appeared on the world textile scene, rotor spinning has been gaining acceptance as an inseparable part of the spinning technology all over the world. The unprecedented success of this system, can be attributed to the continuous process of improvements in the design aspects related to fibre separation, rotor drive, rotor groove geometry and the aeromechanical control on the fibre transport. The combing roller system of fibre separation, employed in practically all the makes of rotor frames, has proved to be very effective in terms of fibre separation even at very high production speeds. However, one of the inherent drawbacks of this system is the damage caused to the fibres during the process of separation. While some fibres undergo only slight mechanical damage to the surface, many others may suffer from severe damage and breakage.

The present work relates to the process of fibre breakage during fibre separation in the rotor spinning and aims to investigate the various aspects of fibre breakage such as the incidence of fibre breakage and the mechanism and the pattern of such breakage. A suitable mathematical model has been proposed to describe the breakage proeess. The associated phenomenon of tenacity loss during the fibre separation has also been dealt with.

For the direct observation of the incidence and nature of fibre breakage the tracer fibre technique, first developed by Morton and Summer, was suitably modified and used for the present studies. The tracer fibres with one end dyed with a direct dye (Fast Light Yellow 5 GL), so as to distinguish between the front and the rear end, were put one by one with the dyed end at the rear, on the web coming out at the second passage of drawing by intermittently stopping the drawframe. The drawn sliver containing the tracers was fed to the rotor machine. The machine was run for a few seconds so that the fibre ring deposited in the rotor groove contained only one tracer. The fibre ring was carefully removed from the rotor groove after stopping the machine and then viewed under ultra violet light using a magnifying glass. The observations show that the breaks occurred mostly in the front 10 mm portion of the fibre. A probable mechanism of such fibre breakages has been put forward. It is suggested that the combing roller pulls the fibres from the fringe by making them hook around the wires or the pins on the surface of the combing roller. If the trailing end of the fibre is free enough from the nip of the feed roller the fibre will come out intact. If, on the other hand, it is strongly held at the nip, the impact force of the wire points causes the fibre to be under tension which, if sufficiently high, can break the fibre at the apex of the hook. Suitable evidence has been put forward to substantiate this hypothesis.

A simple probabilistic model based on the number length relationship of the fibres, before and after breakage, has been suggested for estimating the probabilities of breakage, including the multisegmental breakages. The calculated and observed values of breaks show a reasonably good agreement. The model was also used for calculating the overall proportion of fibres that break. A simple distribution, the exponential distribution, has been shown to fit the length distribution of the broken segments.

Studies have also been carried out on the effect of fibre parallelisation and the direction of feed on fibre breakage. It has been found that the fibre with a leading hook is more prone to break than a fibre with a trailing hook. From the results obtained, it seems that the direction of feed of the majority hooks to the combing roller is a more important factor influencing the fibre breakage than the parallelisation of the fibres in the sliver.

The last part of the work concerns the mechanical damage to the fibres during opening in terms of the loss in the fibre tenacity. The bundle strength of the fibres in the feed sliver and those collected from the rotor groove are compared. It is observed that there is invariably a drop in the tenacity after the fibre opening. It has been shown that the combing roller speed, the direction of sliver feed, the number of drawframe passages and the length and the type of fibres affect the extent of this tenacity loss. A probable mechanism for this loss has been put forward. It has been suggested that the action of the combing roller wire points causes surface damage to the fibres in the form of minute cuts or bruises thereby creating weak spots along the length of the fibre. Photographs of the damaged portions of the fibres and the staining test done with Congo Red show the existence of such cuts or bruises on the fibre. Some yarn samples were also spun under various processing conditions to ascertain the extent to which the reduction in fibre length and the fibre tenacity during fibre separation affects the strength deficiency of rotor yarns vis-a-vis ring yarns.

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