ABSTRACT

The study comprises the development and evaluation of end use related properties of novel air jet rotor cotton yarns. A combinatorial approach has been followed to develop novel cotton yarns which involve both rotor and air jet spinning techniques. During the course of the work, a need was felt to study the properties against some structural variables. The variables considered were yarn linear density, air pressure and nozzle parameters.

In the initial phase of study, a considerable amount of work was carried out in order to optimize the nozzle parameters for obtaining a substantial improvement in tenacity and hairiness in the yarns produced. A series of experiments was carried out on 20 jet nozzles, and from the properties of yarns obtained from 80 trials, the optimized nozzle was chosen. The optimized nozzle was used for further experiments and the yarn of 20 Ne produced from it was tested for tenacity, elongation, evenness and imperfections, hairiness, flexural rigidity and compression. Besides these properties, the structural aspects of these yarns namely fibre migration, swelling index, packing density and wicking were also studied. For wicking studies, the jet rotor spun cotton yarns of 16 Ne, 20 Ne and 24 Ne were subjected to scouring, bleaching and mercerizing treatments so that the effects of these also could be studied.
The effect of gauge length and strain rate on tenacity, elongation and initial modulus of air jet rotor yarn was investigated in depth and Weibull two parameter model was used to model the mechanical properties.

Literature pertaining to air jet spinning, process parameters that affect the yarn properties and the role of fibre properties has been comprehensively condensed in the various chapters. The major conclusions, which have emerged from the various studies, are presented in the last chapter which also contains a few suggestions for future work.

The results showed that with the nozzle of 45 mm length, 2 mm bore, 2 rows and 4 orifices and 2.5 bar air pressure, substantial improvement in hairiness and tenacity could be achieved. Air jet rotor cotton yarns were found to have good strength and compaction compared to their conventional rotor counterpart.

A slight increase in irregularity was noticed while the yarn hairiness showed an improvement of 22% over the conventional rotor spun yarns. Value of S3, a measure of hairiness which represents the number of hair fibres that are equal to or longer than 3 mm and above, showed 50% improvement in the new jet rotor yarn.

Yarn abrasion, packing and swelling ratio displayed higher values in comparison with the regular rotor spun yarns. The air jet rotor spun yarn had higher fibre migration compared to the regular yarn. A decisive test to find out differences in yarn structure is wickability. Wickability of air jet rotor yarn was found to be lower than that of regular rotor spun yarn. Mercerising
treatment had led to an increase in the wicking behaviour regardless of the type of yarn. The Weibull model was used to predict the tenacity, elongation and initial modulus of yarns at different strain rates. It was found that tenacity fell with increase in gauge length and elongation and the initial modulus followed the same trend. It was found that the initial modulus of yarns was not constant and was influenced by the gauge length.

In view of this, it is suggested that the models which have been developed for predicting the initial modulus of twisted continuous and spun yarns be treated with caution and much more work remains to be done.

The low stress mechanical properties namely flexural rigidity and compression for air jet rotor spun yarns were higher than those of regular rotor spun yarns. In conclusion, it can be stated that the air jet nozzle in rotor spinning has produced a yarn which is quite different from the regular rotor yarn. It is recommended to the spinning mills with a view to improving the quality of the yarns.

The industrial implications of the study have been fully discussed.