STUDIES ON ROTOR-SPUN BLENDED YARNS

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TO MY UNCLE

CERTIFICATE

This is to certify that the thesis entitled "Studies on Rotor Spun Blended Yarns" being submitted by Mr. P. Radhakrishnaiah 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. Radhakrishnaiah worked under our guidance and supervision and has fulfilled the requirement 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

Rotor spinning, which was relatively unknown a decade ago, is today an industrial reality. One factor which is clear from the various papers that have appeared on the subject in recent years is that rotor yarns have a structure which is different from that of ordinary ring spun yarns. In most of the research work done in this connection, emphasis has hitherto been laid on yarn structure with the properties of the yarn explained on the latter basis. Eventhough many research workers have revealed that the rotor by itself is a very efficient blender, a comparative picture of blend intimacy with respect to different process and machine variables such as mixing stage, rotor doublings etc. is not available in the literature. Also very little information is available on the blending behaviour of dimensionally different fibres.

Typical of the character of rotor spun yarns are the belt fibres also known as 'belly binders'. Although it is generally agreed that the fibre length influences belt formation, the exact proportion of long fibres in belts or rather the extent to which long fibres cause belts has not been investigated so far. The influence exerted by other fibre parameters (such as linear density and specific gravity)

also remains to be studied in detail. Coming to the influence of belts on yarn tenacity, the available literature gives only assumptions rather than experimental results. Many research workers have expressed the opinion that belts are partly responsible for the strength deficiency of rotor spun yarns. This opinion, however, remains to be substantiated with experimental evidence. Estimation of percentage of sheath fibres in blended yarns and their contribution to yarn strength at different twist levels has also not been attempted so far. The present work, therefore, can be considered as an attempt to bridge the gaps indicated above.

The thesis has been divided into seven chapters. The first chapter covers the review of literature related to the various aspects of investigation presented in this report.

The influence exerted by the mixing stage, spinning system and rotor doublings on various parameters of blending is reported in chapter two. Beater and roller feed rotor spinning machines and O.M. ring frame were used for the above study. Mixing of fibres (red and blue viscose) was carried out at three different stages namely, before the card, at the draw frame and at the rotor or O.M. ring frame. Three yarn samples corresponding to the three stages of mixing were spun using each of the above three machines. In order to study the influence exerted by rotor doublings, six more yarn samples corresponding to low and high twist were spun on the second generation rotor spinning machine. The standard procedure of embedding small segments of yarn in a polymerizing mixture was used to obtain yarn cross-sections. Values for index of blend irregularity, index of rotational blend irregularity and clustering coefficient were obtained after analysing the cross-sections. The upper and lower limits of index of blend irregularity values were evaluated assuming that the above values follow a χ^2- distribution. All the values of index of blend irregularity which fall within the calculated limits were considered to obey the χ^2-distribution. The correlation between red and blue fibres was also established for each yarn sample. A comparative assessment of different yarn samples with respect to randomness of mixing was made with the help of the values obtained for index of blend irregularity and correlation coefficient. The values obtained for index of rotational blend irregulari were used to compare different samples with respect to rotational distribution of fibres. Deviations from random rotational distribution were also observed from the graphs plotted for rotational distribution.

In chapter three the influence exerted by fibre parameters on migration and blend characteristics of rotor spun yarns is reported. The variable fibre parameters considered for this study were length, denier and fibre type. Fibres which differ in the above parameters were chosen as the components of a binary blend. One component in each blend was dyed to a light shade before blending. The fibres were hand mixed before carding on a Shirley miniature card. The carded material was subjected to drawing and the drawn sliver was used to produce yarn on the beater feed rotor spinning machine. An assessment of blend intimacy of different yarn samples was made adopting the same approach outlined in chapter two. To assess the extent of preferential migration, a parameter known as 'Intensity of Migration' was evaluated for each yarn sample. Intensity of migration values which exceed two standard errors were considered statistically significant. The behaviour of each blend with respect to blending and migration was characterised with the help of experimental results.

Chapter four brings out the influence of fibre length, fibre denier and fibre type on belt formation. The relationship between yarn twist and belt density is also investigated in this chapter. Various combinations of viscose, polyester and acrylic fibres were chosen for the study of frequency and composition of belts. One component in each blend was dyed to a light shade before blending. Fibres were hand mixed before carding and the carded material was subjected to two passages of drawing. The drawn sliver was used to produce yarn on Suessen OE spin tester. To study the relationship between yarn twist and belt density, one of the blends was spun at four different twist multipliers. Belts along the length of specimen were counted using an Olympus binicular microscope. When viewed through this microscope, using a magnification of fifty, a good depth of field was obtained which made counting of belt easy. A total length of 170 cms of yarn was observed for each yarn sample and the ratio of the two types of fibres in belts was established. This ratio when compared with the ratio of fibres in the input sliver gives an idea of the influence exerted by various fibre parameters on belt formation. Belt density or the number of belts per unit length was obtained by dividing the total number of belts observed by the total length of yarn over which belts were counted.

The influence exerted by belts on yarn tenacity is worked out in chapter five. Viscose fibres of different lengths and an Indian variety of short staple cotton were chosen for this study. Viscose fibres (ranging in length from 32mm to 56 mm) were mixed with cotton in the proportion of 12:88 by weight. Suessen OE spin tester was used to produce 18^s count yarn from 100% cotton and cotton/viscose blends. Both cotton and cotton/viscose yarns were spun at three different twist multipliers. For the purpose of comparison, ring spun yarns of the same count and twist factors as mentioned above were also prepared using 100% cotton and one of the cotton/viscose blends. Four different approaches were adopted to ascertain the influence of belts on yarn tenacity.

In the first place all the yarn samples were tested for tenacity. The tenacity values of cotton/viscose yarns were compared with that of 100% cotton yarns.

The yarns produced on the spin tester were subjected to cyclic loading test. Loss of strength due to cycling was computed for both cotton and cotton/viscose yarns.

Core tenacities of cotton and cotton/viscose yarns were compared after testing the peeled yarns on the Instron strength tester.

Finally the extension of belts under axial strain was proved with photographic evidence.

Chapter six deals with the estimation of percentage of sheath fibres and their contribution to the strength of blended yarn at different twist levels. The yarns were tested on Instron strength tester before and after peeling and the contribution of sheath fibres at different twist levels was obtained. The percentage of sheath fibres at different twist levels was estimated by peeling and weighing the yarn samples in a sensitive balance.

Summary and conclusions are presented in the last chapter.

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