STUDIES ON STRUCTURAL BLEMISHES IN AIR-JET TEXTURED YARNS WITH PARTICULAR REFERENCE TO NEPS IN THESE YARNS

by

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to the

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Dedicated to

My Parents

CERTIFICATE

This is to certify that the thesis entitled "**STUDIES ON STRUCTURAL BLEMISHES IN AIR-JET TEXTURED YARNS WITH PARTICULAR REFERENCE TO NEPS IN THESE YARNS**" being submitted by Mr. Jaydip Kumar Sensarma, 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 record of *bona fide* research work carried out by him. Mr. Jaydip Kumar Sensarma has worked under my guidance and supervision and fulfilled the requirements for the submission of the thesis.

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

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ABSTRACT

Structural inhomogeneities, one of the main drawbacks associated with air-jet textured yarns, arise from improper and insufficient interaction between fluid forces and the filaments inside as well as outside the texturing jet. The manifestations are in the form of non-homogeneous loop distribution, occurrences of neps and thick places, higher yarn linear density CV%, higher yarn strength CV% and higher instability in the resulting air-jet textured yarn. It is important to check occurrence of these inhomogeneities so that air-jet textured yarns are acceptable in most of the applications they are used.

In order to examine extent of correlation among different inhomogeneity parameters listed above, values of correlation coefficients between them have been obtained through experiments. From the analysis of the experimental results, it has been observed that the inhomogeneity parameter, neps per unit length, has very high correlation with other inhomogeneity parameters, it is easy to assess and has high degree of sensitivity to changes in the process parameters. Hence, neps per unit length has been suggested as index of structural inhomogeneity of air-jet textured yarns to represent different forms of inhomogeneities. Extensive studies on effects of different jet parameters, process parameters and raw material characteristics on formation of neps have been carried out. Attempt has been made to understand the nature of neps in air-jet textured yarns and reason for their formation during the air-jet texturing process.

As a first step, effect of baffle geometry and baffle setting on nep formation has been investigated. Du Pont type XV nozzle with three baffles, viz., cylindrical baffle with small diameter, cylindrical baffle with large diameter and plate baffle with a flat surface have been used to study the effect of baffle geometry and to study the effect of baffle setting, both the Du Pont type XV jet and the HemaJet T100 core have been used. It has been found that use of flat surface baffle (zero curvature) reduces formation of neps significantly in relation to the neps formed while using cylindrical baffles. Use of lower baffle setting also reduces formation of neps during the air-jet texturing process.

Effect of important process parameters, viz., air pressure, overfeed, texturing speed and mechanical stretch on nep formation has been studied using a Central Composite Design. Polyester yarn has been textured at different factor level combinations called design points and nep frequency of these yarns have been measured. Statistical analysis of the results indicates that while increase in air pressure, overfeed and texturing speed cause increase in nep frequency, mechanical stretch has little or no effect on nep frequency in the resulting yarn. A second order response surface equation has been derived which gives empirical relationship between neps per 1000 m and different parameters. A combination of the levels of different factors has also been worked out through 'canonical analysis' which can be used as optimum setting to obtain minimum nep count in textured yarns.

Influence of raw material characteristics, viz., filament initial modulus, filament fineness, interfilament friction and filament cross-sectional shape on nep formation has been studied. To study effect of filament initial modulus, yarns have been drawn at three different draw ratios and at three different temperatures using three POY yarns with same number of filaments of different linear densities per filament. It has been observed that both an increase in initial modulus and an increase in filament fineness cause increase in nep frequency. Nep frequency also increases with an increase in interfilament friction. Use of trilobal filaments reduces nep frequency in the textured yarn.

While the above studies reveal effects of different parameters on nep levels in an air-jet textured yarn in general, a closer look at the neps under microscope reveals different structural patterns. Structure of these neps has been studied extensively using projection microscope and videophotographs. The study has revealed that, broadly, there are two types of neps formed during texturing. In one type of neps (type 1) the filaments divide into two groups where filaments of one group forms individual filament loops while filaments of the other group do not form any loop and either entwine the former group of filaments or form a big loop. The second type of neps (type 2) are formed due to heavy concentration of individual filament loops along a small length of the yarn. It has also been observed that these two types of neps behave differently under tensile load and demonstrate different load opening forces.

With the help of some additional experiments, a hypothesis on mechanism of nep formation has been proposed. The mechanism suggests insufficient opening of filament bundle to be responsible for nep formation in air-jet texturing. While partial non-opening gives rise to formation of type 1 neps, complete non-opening of the filament bundle leads to formation of type 2 neps in the succeeding section of the non-opened section.

Finally, effect of different parameters on formation of these two types of neps has been studied extensively. It has been observed that while changes in some parameters favour formation of one type of neps, changes in other parameters favour formation of the other type of neps. However, both the types of neps increase or decrease together in absolute number whenever there is any increase or decrease in total nep count. An attempt has been made to explain these trends in the light of the proposed mechanism. The proposed mechanism is able to explain the observed results adequately.

This study has helped in identifying the factors responsible for occurrence of neps and in providing an insight into the mechanism of nep formation.

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