ABSTRACT

Plying is one of the most important and expensive processes in the industry. Following the constant growth in demand of technical textiles, the need for expansion of production capacities for plied yams has drastically increased. A considerable proportion of single yams need to be plied and restructured after primary spinning, in order to meet more demanding requirements. Plying determines the structure of yarn, yarn strength and handle properties of the resultant product. Furthermore, it affects the volume, quality and hairiness of the yarn. Plied yams are more regular, the longitudinal variations in the individual ends are balanced and the spot defects are compensated. They have higher strength, elongation, volume and abrasion resistance and lower hairiness when compared with their singles. Therefore, to improve yarn properties and to produce higher value products, plied yams are formed by plying and twisting of two or more single yams.

It is an established fact that structure plays a major role in the physical, mechanical and performance characteristics of spun yams. Hence, study of structure is essential to engineer yams for structure plays a major role in physical, mechanical and performance characteristics of spun yams. The structure of single yarn further changes on plying due to relocation of distribution of fibre in yarn matrix. Several researchers have investigated the structure of plied yams in terms of few structural parameters which are not sufficient to fully grasp their structure. The first part of present study is, therefore, carried out with an aim to fill the gap. For this ring, compact rotor, vortex and hybrid plied yams at varying levels of twist factors are produced and analyzed in the first part of the study. The experimental results clearly indicate that ply twist factor along with spinning systems plays an important role to influence the structural parameters of plied yams and explanation for this is well documented.

Physical properties of yams e.g. unevenness, hairiness are recognized as important quality parameters as these not only contribute to the aesthetic appearance of the fabrics but also influence the mechanical properties of the yams and fabrics made there from. With this in mind, the second part of the study focuses to comprehend the inner lying facts to engineer plied yams for different end uses.
Understanding physical properties of plied yarns remains a challenging task as these get affected by the spinning system and process parameters. The response of unevenness, hairiness of yarns to change in spinning system and ply twist factor has been explained.

Beside physical properties, mechanical properties of yarns are of no less importance as these decide their applications specifically in industrial uses. These properties also depend on spinning system and process parameters. The reported information for plied yarns on these aspects is very limited. With this in mind, an attempt has been made to study the mechanical properties of the plied yarns in relation to different spinning systems and process parameters in the third part of the study. To get better insight, tenacity, breaking extension, initial modulus, work of rupture, specific work of rupture, flexural rigidity, specific flexural rigidity and abrasion resistance of single and plied yarns were measured and compared. Further technical studies have shown that it is possible to realize the folded yarns of different yarns spun on various spinning systems. Yarns spun on different spinning system may be characterized by different quality attributes. To balance all the structures, it is interesting to realize a hybrid plied yarn consisted of one ring, compact, rotor and vortex yarn. This allows in theory to obtain a blending of different mechanical properties. So, in this study an attempt has also been taken to assess the quality of hybrid plied yarns.

Amongst mechanical properties, tensile strength and breaking extension are the two most important properties which are sensitive to the change in testing parameters. The response under nonstandard conditions may further be different. The last part of the study, therefore, aims at investigating tensile behavior of plied yarns through analysis of yarn failure zone when tested under nonstandard conditions. Finally, the major conclusions arrived out of the above experimental work are presented.