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ABSTRACT

A fundamental and classical problem in textile material science is the connection between strength of fibres and yarn, and so it is significant both in theory and in practice to establish this relationship. The strength of a yarn depends on strength of the constituent fibres. However, full realization of fibre strength in yarn strength is not realized in commercial practice as some fibres break, while others slip. The nature of fibre arrangement in the yarn is another influencing variable. Thus fibre properties and yarn structural parameters play a significant role in determining the tensile behaviour, namely, strength, modulus, elasticity, yield stress, work of rupture, elongation and low stress properties of the spun yarn. While the ring spinning process is known to give a yarn in which the fibres are believed to be more effectively interlocked, the unconventional spinning technologies namely rotor and air-jet deliver yarn structures with inadequate fibre entanglement. Because of the geometrical variations in the structure of ring, rotor and air-jet spun yarn, the balance between fibre slippage and fibre breakage during tensile loading is altered to different degrees.

Yarn structural development is further complicated when the yarn is spun from blends of fibre with dissimilar properties and type. Blending of different fibres is a very common practice in spinning industries to obtain desirable range of properties to suit end-use requirements and economic considerations. Both the advent of new cellulosic fibres likes tencel and availability of fibres with different types and properties have opened up a rich diversity of materials to be blended. Tencel fibre blends well with both natural and synthetic fibres such as cotton, polyester, lycra or wool adding comfort and performance. So far, there is no extensive survey comparing the characteristics of tencel blended yarns spun on ring, rotor and MJS spinning systems. The present research focuses on investigating the quality aspects of tencel-cotton and tencel-polyester ring-, rotor- and MJS yarns.

In the first part of the study, the role of twist in ring spinning was analysed. For this the properties of tencel-polyester and tencel-cotton blended yarns produced with five different blend ratios and six different twist factors have been studied. An attempt has also been made to optimize the twist factor for different yarn characteristics viz. tenacity, breaking extension, unevenness and imperfection, hairiness and flexural rigidity. The experimental results clearly indicate that optimum
twist factor is different for the different properties analysed and explanation for this is 
well documented.

Because of the geometrical variations in the structure of ring-, rotor- and air- 
jet spun yarns, the substrate characteristics are different for each spinning technology. 
With this in mind, the second part of the study focuses on the comparison of physical 
characteristics of tencel-polyester and tencel-cotton yarns spun on ring, rotor and air- 
jet spinning machines in relation to fibre composition. The behaviour of tencel fibre in 
blends with polyester and cotton fibres and its proportion for the physical 
characteristics of ring, rotor and MJS yarns has also been explained.

Low stress properties and elastic behaviour of yarns are the another major 
factors limiting their processibility and end-use performance. With this in mind, the 
low-stress and recovery properties of ring, rotor and MJS yarns spun from tencel-
polyester and tencel-cotton mix have been studied. To gain a better insight, tencel-
polyester and tencel-cotton yarns have been produced with varying fibre 
compositions. Tensile energy, tensile resilience, packing density, structural integrity, 
abrasion resistance and recovery properties ( Immediate elastic recovery, delayed 
recovery and permanent set) at 2% and 4% extension level were measured and 
compared for three types of yarns produced from both tencel mixes at different blend 
proportion.

In the last part of the study, the efficiency of the linear and quadratic rule of 
mixture (ROM) to predict the mechanical properties of tencel blended ring-, rotor- 
and MJS yarns has been applied with the help of mixture experiment model. A 
mixture experiment used involves the study of performance of various mixture 
formed by mixing two or more components. The linear and quadratic canonical 
polynomials for two components mixture model have been considered. If the 
blending of components is strictly additive then linear canonical polynomials is 
most appropriate representation of the surface, and when there is a curvature in the 
mixture surface then canonical polynomial of degree two is taken as 
representation of the surface. The tensile strength, breaking elongation, flexural 
rigidity and abrasion resistance of tencel-polyester and tencel-cotton blended yarns 
have been compared with the values predicted using linear and quadratic rule of 
mixture (ROM) and applicability of the both ROM models are suggested for 
different properties of tencel mixes ring, rotor and MJS yarns. Finally, the major 
conclusions arrived out of the above experimental work are presented.