Chapter 1
Introduction and Objective

1.1 Introduction

Blending of fibres to obtain a desirable range of properties to suit end-use requirements and economic considerations is a well established practice. The advent of new cellulosic fibres and the availability of fibres with different types and various properties level thereof, have opened up a rich diversity of materials to be blended, in conjunction with other fibres. Especially, tencel is a kind of man-made cellulose fibre, which is made of wood pulp extracted from woods in man-managing forest. As natural fibre, it has good ability of moisture absorbing, air breathing and static contradicting. Besides, it is also strong, easy to dye, well pendent, and comfort to feel. In blends, the natural qualities of tencel complement those of wool, cotton, linen, silk, polyester, elastane and nylon, and enhance their inherent properties. When blended with wool, tencel introduces new softness and drape; whereas on blending with cotton and linen, it increases suppleness and luster. Understanding the translation of individual fibres properties to the blended yarn is necessary for efficient usage of these fibres and for effecting tangible improvement by the modified cellulosic fibre manufacturers. The efficient translation of fibres properties into yarns is the ultimate goal of the textile technologist. Ideally, textile engineers select the fibres types, their blends and yarn parameters with the expectations that an efficient translation of fibres properties will occur in the finished products, which, however is difficult to achieve in practice. The deficiency in full realization of fibre strength in yarn strength is because of the fact that while some fibres break, others slip. The fibre strength realization in a staple yarn is considerably influenced by the level of twist into the yarn. The twist in the staple fibre yarns has the primary function of binding the fibres together by friction to form a strong yarn. While interfibre frictional forces are important at low twist, its obliquity and non simultaneity in the occurrence of break that virtually determine the strength realization at high twists. The optimum twist is determined by the manner in which the opposing forces are balanced and would be dependent upon fibre properties. Twist is expected to have an even greater influence when strength of blended yarns is considered. The non simultaneity in the occurrence of break, which depends upon twist, is the main source responsible for drop in strength and is
attributed to the difference in the extension behaviour of constituent fibres. It will be therefore interesting to study the influence of twist on strength and other properties of the blended yarns. The study would help to find out the optimum twist level for the different properties of blended yarn and would also highlight how the optimum twist modifies with change in the blend ratio and fibre type.

The nature of fibre arrangement in the yarn is another influencing variable that affects the yarn characteristics. Basically, the yarn tensile properties are a function of the fibre properties and yarn structural parameters including interactions of these properties. While the ring spinning process is known to give a yarn in which the fibres are more effectively interlocked, the unconventional spinning technologies namely rotor, air-jet and friction deliver yarn structures with inadequate fibre entanglement. In case of a ring spun yarn, almost all the fibres effectively contribute towards stress development due to the regular orientation of fibres in the yarn. Constant twist over the entire yarn cross section cannot be achieved in a rotor-spun yarn. Instead, the outer yarn layer reveals, to some extent, a different twist structure and these entangled fibres form the sheath of rotor yarn. This type of yarn structure reduces the load bearing capacity of fibres in the cross section. Similarly, air-jet spun yarn has a bundle of parallel fibres in the core of the yarn with outside wrap of fibres. During tensile loading, the strained wrapper fibres exert pressure on the core of the fibres and generate friction among them. The more uniformly the fibres wrap the core and more the number of wrapping fibres, the higher is the tenacity of the yarn. It is therefore easier for the fibres to slip at the parts where there are no wraps. This could be the reason for high tenacity variations in air-jet spun yarns. Because of these geometrical variations in the structure of ring, rotor and air-jet spun yarn, the balances between fibres slippage and fibres breakage during tensile loading are altered to different degrees. Yarn structure development is further complicated when the yarn is spun from blends of fibres with dissimilar properties and type. Since blending is practiced in yarn manufacturing with a view to optimize yarn properties for specific end-use requirements, there is a need to evaluate the physical properties of the blended yarns spun on different spinning systems.

Most of the research done in the past is related to the assessment of influence of fibre and process parameters on the structure and mechanical properties of yarns spun on different spinning system. Experimental investigators are of the opinion that low stress properties and elastic behaviour of yarns are the major factors limiting their
processibility and end-use performance. During weaving, the warp yarns are subjected to complex deformation due to repeated loading and unloading under small stress and abrasion which often causes stress concentration at some places and thus decreases resistance of a material to its failure, even when the imparted stress intensity is well below the ultimate strength of the material. Yarn breakages occur during weaving even though tension during weaving is 5-12% of the average yarn breaking strength, which means breakage on loom does not only depends only on the strength and abrasion resistance but depends also on the cumulative damage on account of tensile fatigue due to cyclic stress. Besides, fabric handle and appearance are also affected by the yarn low-stress properties and their recovery behaviour from strain. So study of yarns for low stress and recovery properties along with abrasion resistance will be of great importance.

Further, predicting the properties of blended or mixed materials has a theoretical and practical significance that is not limited to the textile field. Various researchers have studied the properties of blended yarns and have observed that, in general, the strength of blended yarn is considerably lower than one might expect from the strengths of component fibres. The important factor that affects the properties of blended or a mixture material is the complicated interaction of the components themselves [1, 2]. This interaction is called the hybrid effect. Marom [3] has defined the hybrid effect as the deviation of hybrid structure property from the one estimated by rule of mixture (ROM). A positive value means a positive hybrid effect and it is called a synergetic case where the actual property is greater than the ROM prediction, whereas a negative value reflect a negative hybrid effect and the actual property is below the ROM prediction. In view of this, there is a need to check the efficiency of ROM models in predicting the properties of tencel blended ring, rotor and MJS yarns.
1.2 Objective of the Work

The broad objective of this work is to study the translation of fibres properties into properties of tencel blended yarns spun on ring, rotor and air-jet spinning systems. The specific objectives are:

1. Investigation of the influence of twist and blend ratio on the characteristics of tencel-polyester and tencel-cotton blended ring-spun yarns.
2. Investigation on the physical characteristics of tencel-polyester and tencel-cotton blended ring-, rotor- and MJS yarns.
3. Investigation on the low-stress and recovery characteristics of tencel-polyester and tencel-cotton blended ring-, rotor- and MJS yarns.