CHAPTER - 1

INTRODUCTION

Amongst the important developments which have occurred in the last 30 years in the textile industry, one must certainly include the invention and subsequent commercial use of man made cellulosic fibres. Lyocell, viscose and modal are all cellulosic fibres with identical empirical formula i.e., they are different molecular weight polymers of cellulose formed by the condensation of β-D-glucosidic links. However, they are made by different processes which give rise to fibres with not only different molecular masses but different super molecular structures e.g. molecular orientation, degree of crystallinity, crystalline and amorphous dimensions and the shape and size of voids. Such differences are known to give rise to fibres with different properties, e.g. mechanical strength, water retention and propensity to fibrillation.

The advantages of man made fibres lie in the fact that compared to natural fibres they show less variability of fibre properties. Also, the diameter, shape, elastic modulus, tensile strength and failure strain of regenerated cellulose can be tuned during fibre production by varying process parameters. In general, the average tensile strength of regenerated cellulose fibres is comparable to natural ligno cellulosic fibres, whereas their elastic modulus is usually below that of natural fibres. However, failure strain of regenerated cellulose fibres is upto 10 times higher than in natural fibres which makes them particularly useful for applications where higher fracture toughness is required. Similar to some other polymer fibres, the stress strain curve of a regenerated cellulose fibre consists of two phases. The first phase shows linear elasticity upto the
yield point. Then the slope of the stress – strain curve decreases, followed by a second nearly linear phase until fracture.

Gindl and Keckes (2006) have found that strain hardening process was found to be more pronounced for lyocell in that higher crystallinity and higher orientation of cellulose chains were noticed. Elastic modulus of viscose showed a marginal increase.

Colom and Carrillo (2002) have studied the responses of modal, lyocell and viscose staple fibres to caustic soda treatment of various concentrations ranging from 0 to 24%. The parameters, crystallinity accessibility, and unit cell structure changes occurring in the three fibres were studied. While for viscose fibres the proportion of crystalline regions increased at low alkali concentrations, for lyocell fibres a decrease in crystallinity was observed. A transformation from celluloseII to amorphous cellulose was observed. While for lyocell, transformation was partial, the modal and, in particular, the viscose fibres showed a complete transformation and the swelling agent caused the fibre to dissolve at high concentration.

Bamboo fibre is regenerated cellulosic fibre produced from bamboo. The type of bamboo used for apparel is Moso Bamboo (Phyllostachys Pubescens). Starchy pulp is produced from Bamboo stems and leaves through a process of alkaline hydrolysis and multiphase bleaching. Further chemical processes produce bamboo fibre. They possess numerous unique properties like inherent anti-bacterial property a unique anti-bacteria and bacteriostasis bio-agent named “Bamboo Kun” is combined with bamboo cellulose molecules tightly and remains all along during the process of being produced into bamboo fibre good level of
ultra violet protection (UPF) and antistatic property. Bamboo fibre fabrics made up of 100% bamboo fibre are characterized by its good hygroscopicity, excellent permeability, soft feel and easy dyeing. Also, bamboo cultivation does not require fertilizers, pesticides and chemical herbicides. They are regarded as a renewable and biodegradable fibre because of their remarkable attributes. Its cultivation requires very little water, they are naturally regenerative and is one of the fastest growing plants. It has less impact on environmental issues as compared with conventional cotton and other petroleum derived synthetic fibres. Conventional cotton involves a requirement of large quantities of water and pesticides. So, bamboo fibres can be considered as a potential substitute to conventional synthetic and cotton fibres. Bamboo fibres are 100% biodegradable. The work discussed in the following is primarily concerned with an investigation into the fundamentals of the man made fibres to see if any niche products can be produced.

1.1 MOTIVATION

The study of man made cellulosic yarns such as viscose, tencel, cotton and bamboo is of interest in several respects. First, yarns are used for structural applications of practical interest such as sewing threads, fabrics meant for apparel and technical textiles. In applications, one may make use of these yarns in designing fabrics to achieve a particular goal. There are diversified uses of textile materials in technical textiles. Several articles about bamboo, modal and tencel yarns have been published. However, to date very little mechanical property data for conventional and compact yarns at different gauge length have appeared in the literature. Also, the experimental results from several sources appear to be inconsistent. In order to fully understand conventional, compact,
bamboo, viscose, tencel and cotton yarns, characterization of the mechanical properties of these fibres is required.

Compact yarns were studied for various properties vis-à-vis conventional yarns and woven and knitted fabrics made from them were studied for their comfort and handle properties. What has not been done is the effect of gauge length on the yarn characteristics after subjecting them to finishing treatments such as scouring, mercerizing and bleaching treatments and to model them by Weibull distribution. Also the response of these yarns to resin finishing with different concentrations has not been investigated so far and this aspect has been included in the present study. The effect of resin finishing on the properties of cotton, viscose, bamboo and tencel fabrics with different concentrations of resin and temperature has not been investigated to optimize the conditions for obtaining products with desirable characteristics. This thesis addresses these aspects in depth and provides data. The dyeing behaviour of cotton, tencel, viscose and bamboo dyed with reactive dyes of different concentrations has not been studied in depth and this thesis addresses this aspect.

Compact yarns are used for the manufacture of apparel fabrics. Its use in other areas needs to be known and for this, the effect of finishing treatments on their characteristics has to be studied. Many studies have been conducted on the properties of yarns produced from conventional and compact spinning systems. With recent advancement of related technologies, a widening range of products demands a better appreciation of mechanical behaviour of yarns. Early studies on this area focused primarily on fibre migration, effect of twist and wickability of these yarns. Data on the effect of gauge length on the characteristics of these yarns subjected to scouring, mercerizing and bleaching are scant. This
work is primarily concerned with investigation for having a better understanding of the potential of compact and man made cellulose yarns.

1.2 AIM AND OBJECTIVES OF THE PRESENT INVESTIGATION

The introduction of compact yarns has led to a wide range of products in the textile industry. So that they can be used in other areas such as garment industry and medical textiles, a knowledge on their mechanical properties tested in a radically different way is required. In spite of the developments, it is clearly felt in the man made fibre industry, that much more needs to be done in order to develop niche products. Future developments require a careful study of the existing technology so that those factors that are critical to quality are identified and new range of product can be developed. Thus resin finishing treatment was applied on the conventional and compact yarns produced from cotton with a view to studying their properties. Also, resin finish was given to fabrics produced from cotton, viscose, tencel and bamboo yarns with varying concentrations of resin and temperatures. The crease recovery characteristics of the fabrics were studied to have a fresh look at their end uses in apparel sector.

Also, the dyeing behaviour of cotton, viscose, tencel and bamboo fabrics was investigated to have a better understanding of their structure and dyeability.

The objective of this research is that with the knowledge gained, it will be possible to reach a better understanding of the range of innovative products that can developed with compact and advanced man made fibre yarns. The rest of the thesis will be presented as follows.
Chapter 2 will include a detailed literature survey on the subject.

Chapter 3 will look in detail about the test procedures and equipment used in evaluating yarn and fabric characteristics.

Chapter 4 will look at the effect of gauge length on the yarn characteristics of conventional and compact cotton yarns subjected to treatments such as scouring, mercerizing, bleaching with hydrogen peroxide and sodium hypochlorite. Weibull statistics was applied in modeling the tensile properties.

Chapter 5 will look at the response of resin treatment namely DMDHEU (dimethylol dihydroxy ethylene urea) to compact and conventional yarns. One of the motivations for carrying out this study was that no significant work on the properties of cross linked bleached cotton yarns has been reported.

Chapter 6 will discuss the experimental findings of the characteristics of cotton, viscose, tencel, bamboo, polyester and bamboo blended yarns.

Chapter 7 will look at the crease recovery and other properties of cotton, tencel, viscose and bamboo fabrics.

Chapter 8 will look at the dye uptake of cotton, tencel, viscose and bamboo fabrics dyed using reactive dyes.

Chapter 9 will summarise and discuss the findings of the investigations.