CHAPTER 1

INTRODUCTION

1.1 SCOPE OF MEDICAL TEXTILES

Technical textiles are one of the fastest growing sectors of the global textile industry and Medical textiles stand in the 6th position among Technical textiles. The share of Medical textiles is around 9% among all the Technical Textiles with still enormous potential for growth. Healthcare textiles have a well-established market in the developed countries where the people are health conscious and aware of the risks faced by the patients and healthcare workers due to infectious and blood borne diseases. The demand for healthcare textiles is increasing due to the massive growth in population and the rising standard of living in the developing countries. (Mishra Neeraj and Sheik Javed 2005).

India’s market for medical textiles faces growth by 10 to 12% per annum, making it one of the fastest growing sectors in the country. Due to the rising per capita expenditure on healthcare products, greater exposure to the international arena of healthcare commodities, the importance and awareness of healthcare insurance and medical tourism, the Indian healthcare sector growth is expected to exceed 17 % per annum. (Verma and Anil kumar 2006).

Since the medical textile applications are directly related to the life of humans, they are subjected to stringent testing and hygienic criteria, which has led to an innovative use of variety of fibers and a tremendous
development in this area. A range of natural fibers and man-made fibers, with enhanced comfort and anti-microbial properties, have been introduced in the market. These fibers and their blends are being employed for developing new products in medical textiles (Rajendran and Anand 2002). There is a wide scope for a large scale research and development in this field to make the shift from low value to high value products such as functional bed linens, wound dressings, scaffolds for tissue engineering, sanitary products, medical linens and gowns (Peter Cookson et al 2007).

1.2 NEED OF THE RESEARCH WORK

One among the vast category of Medical textile products is the hospital textiles like bed linens, uniforms, and mattresses which are expected to fulfill hygienic and comfort properties such as air-flow, moisture management, thermal conductivity, wettability, wickability and anti-microbial activity.

The commercially available hospital bed sheets are made of fibers like cotton, polyester and their blends. The moisture absorbency and heat transportation properties of these plain woven fabrics are not sufficient to transmit the body fluids and body heat which creates a damp atmosphere conducive for the growth of micro-organisms like bacteria, fungi and virus. Thus the high-frictional and less-absorbent plain woven cotton bed sheets are the main cause for the frictional festers and pressure ulcer in patients (Van Langenhove 1999).

Similarly the mattresses provided in hospitals are made of hard polyurethane foam, covered by waterproof coated fabric, over which a simple single-layered cotton bedspread is used, which makes the patient highly uncomfortable due to the generated heat and strain on the contact areas.
Excess compression in the contact area damages the blood vessels, leading to bedsores of different degrees with unbearable pain.

1.3 OBJECTIVES OF THE RESEARCH WORK

The present research work aims to overcome the problems faced by the healthcare workers and patients by designing and developing hospital textiles, bed linens and mattresses using different varieties of fibers and their blends.

The objectives of the proposed work include,

- To conduct a survey in various hospitals to understand about the existing bed linens, mattresses and their characteristics.
- To design and develop single-layered and multi-layered bed linen using fibers such as lyocell, bamboo, bamboo charcoal and their blends.
- To design and develop a mattress with pressure relieving characteristics and to study its performance.
- To design and develop wearable electronics for medical textile application and to study its performance and characteristics.

1.4 ABSTRACT OF THE RESEARCH WORK

Single and multilayered bed linens were designed using fibers like lyocell, polyester micro lyocell, micro polyester, bamboo and bamboo charcoal. Lyocell, a regenerated cellulosic fiber is selected as the major component for producing hospital textiles, because of its good ventilation, moisture absorption, smooth surface, low wet cling tendency by maintaining
dry and cool microclimate on the skin. Woven fabrics with different weave structures were constructed with the following fiber combinations:

- Lyocell and its blends with polyester
- Micro lyocell and its blends with micro polyester
- Lyocell with bamboo and cotton
- Lyocell with bamboo charcoal

A mattress was designed to reduce point pressure exerted on contact areas of the body and was also fitted with an air circulation device to reduce heat generated by the body. Electronic devices which could be integrated in medical jackets and bed linens were also designed to assist the patients confined to wheel chair.

1.5 CONTENTS OF THE THESIS

The second chapter of the thesis is the Literature Review, in which the characteristics and advantages of the selected fibers, physiology of human body, role of the skin in the microclimate control, quality requirements of bed linen and mattresses have been discussed. Added to this, various research works carried out relevant to the present work such as study on comfort characteristics of different fibers, their blends, yarns, single layered and multilayered fabrics are also included.

The third chapter of the thesis is materials and methods in which overall work plan of the research work, details of fiber selection, method of producing blended yarns and union fabrics have been listed. The methodology involved in the production of multilayered fabrics, application of special finishes and the testing methods used to evaluate the performance of the fabrics and mattresses have been documented.
In the fourth chapter of the thesis, influence of lyocell/polyester blends and micro lyocell/ micro polyester blends on the development of hospital textile products has been analyzed. In the first part of this chapter, lyocell fiber is blended with polyester fiber in different blend ratios to enhance the water management properties of the resultant fabrics. Similarly, in the second part of this chapter, micro lyocell and micro polyester fibers are blended in two different ratios to produce blended yarns. From each of the blended yarn, three different fabrics were produced with plain, 2/2 twill and 1/3 twill weaves and the fabrics were investigated for their comfort properties.

In the fifth chapter of the thesis, influence of the union fabrics, made of lyocell, bamboo, bamboo cotton and bamboo charcoal yarns, on the development of hospital textile products has been analyzed. Since bamboo fiber is natural, green and eco friendly with excellent anti-bacterial and bacteriostatic functions, it is selected to combine with lyocell to produce union fabrics with improved comfort properties. The prime objective discussed in the second part of this chapter is to combine the positive attributes of the three skin-friendly fibers like lyocell, cotton and bamboo and to analyze the suitability of these union fabrics for hospital textiles.

In the third part of this chapter, the influence of bamboo charcoal / lyocell union fabrics on the development of medical textile products has been analyzed. Bamboo charcoal fiber is found to have some unique properties like high porosity, good ventilation, thermal regulation, odor control, antibacterial and anti-fungal properties, absorption and emission of Far Infrared Energy and better wash durability. This part of the work aims to combine the unique properties of bamboo charcoal fiber with lyocell fiber to produce fabrics with enhanced comfort and hygienic properties which could be used for bedding, clothing, surgical gowns and hospital cloths.
Union fabrics were produced by incorporating lyocell in different proportions with bamboo, bamboo cotton and bamboo charcoal yarns and three weave structures were produced from each proportion and the fabrics were investigated for their comfort properties.

The sixth chapter of the thesis analyses the thermo physiological comfort of the existing hospital bed linen and lyocell fiber based single layered fabrics that have been developed based on the physiology of human body.

The seventh chapter of the thesis deals with the development and analysis of multilayered fabrics, which have the ability to complement and maximize the essential comfort properties of a bed linen. Since the presence of more number of layers can reduce pressure, temperature, shear and friction developed on the body and also enhance the moisture and moisture vapour transport properties, multi layered fabrics were produced by considering the moisture management property as the key factor and analyzed for their comfort properties.

In the eighth chapter of the thesis, a pressure relieving mattress was developed and evaluated for its performance. When the pressure on any part of the body increases beyond 33mm mercury level, blood circulation is arrested which leads to bed sore development. In an effort to produce a pressure relieving mattress, a bed was developed using super soft polyurethane foam, with horizontal and vertical drill holes connected to an air circulation device to give enough air circulation and pressure distribution to more area. The performance of the support surface along with single and multilayered bed linen developed was analyzed.

In the ninth chapter of the thesis, a wireless communication device integrated with woven antenna which could be incorporated into the bed
sheets or the medical jacket of the patients, who are confined to wheel chair or bed, is developed and scrutinized for its performance.

To conclude, the excerpt from the findings of the experimental work has been consolidated and convincingly, the combination of different fibers improves the comfort and thermo physiological characteristics of the hospital textiles and the developed mattress with air circulation device and multilayered bed linen, fulfills the functional properties of medical textile product.