CHAPTER 1

INTRODUCTION

Moisture transfer property is an important aspect of any fabric which decides the comfort level of that fabric. Whatever heat the human body produces must flow through the fabric via the body surface by conduction, convection and radiation. Sports which involve higher level of physical exertion causes the body to sweat and it should be evaporated in making the body cool. So the clothing must ensure higher level of moisture transmission. Fabric must have the property of transferring the sweat out of the body and make the wearer to feel comfortable. So moisture management can be defined as the ability of a fabric to transport moisture away from the skin to the fabric outer surface and to release it into the surrounding air. Hence wetting, wicking and moisture vapour transmission characteristics are the critical aspects of a fabric in deciding the clothing comfort of the wearer.

1.1 NEED FOR MOISTURE TRANSFER

Comfort can be stated as physical, physiological and psychological effect of an equilibrium state between the human being and the environment. The energy expended by a person engaged in normal routine indoor activity is found to be 50 watt/square meter/ hour. The metabolic heat generated is readily dissipated through the clothing as sweat. It is found that at rest, a body will release about 60 ml of water vapour per hour under ambient conditions. Moderate exertion like walking will increase the amount to 450 ml per hour. During sporting activity like tennis or cycling, the metabolic heat increases 6 times and perspiration 14 times (840 ml).
During sweating, the human body humidity is more or less absorbed by the fabric. If the humidity remains in the fabric and is not get transferred to the surface for evaporation, cooling may not occur. The body warms up and even more sweat is produced. During such hard physical activity, the wearer perspires and the fabric will get wet. The sportswear exerts a barrier for efficient transfer of excess heat resulting in a rise in core body temperature greater than 37°C which increases sweating. The fabric worn next to the skin should have two important characteristics. It must evaporate the sweat from the skin surface and to transfer the sweat to the atmosphere to make the wearer feel comfortable. Moisture management also refers to the transfer of moisture vapour and perspiration away from the body. Moisture management is also referred as the ability of fabric to absorb gaseous or liquid humidity from the skin, to transfer it from inside of fabric to outer surface and to release it to the atmosphere. In functional fabrics, to maintain high moisture, cotton fibres are used to maximize the moisture transfer. Piller (1986) has developed double layered knitted fabrics with polypropylene yarn as inner layer and cotton or viscose yarns as outer layer which makes the wearer more comfortable during strenuous activity.

1.2 CLOTHING COMFORT

A clothing should have good mechanical and technological characteristics and should possess easy care properties and good comfort properties. The comfort sensation of clothing can be recognized mainly with respect to its moisture transfer characteristics. According to Rees (1969), the comfort of clothing in a person is due to the temperature regulation of the body system. According to Slater (1985) physiological comfort mainly depends on the ability of human’s body to maintain life and psychological comfort of the mind’s ability with respect to the environment of the body. According to Prabhakar Bhat & Bhonde Hu (2006), the fabric thickness,
mechanical behavior and fit of the garment play a major role in deciding the dimension of comfort.

1.3 AIM OF DEVELOPMENT OF MOISTURE MANAGEMENT FABRIC

The performance of sportswear fabric can be greatly achieved only if it is systematically designed. The moisture vapour permeable and moisture management of fabrics are very important to prevent water condensation in the fabric and to ensure improved thermal, functional and comfort performance. According to the amount of physical effort made by a person and the degree of humidity released, different concepts can be combined to reach an optimized moisture management.

Thermo physiological comfort entails both thermoregulation and moisture management. The heat balance of the system relates to the function of skin, fabric and amount of air entrapped in between skin and fabric. This heat balance varies with the change in wind velocity, external atmospheric temperature or the activity of the individual causing change in heat or moisture production of the body. The individual will feel comfortable till the amount of heat produced is equal to the amount of heat lost.

As far as strenuous sports activities are concerned, the body exerts continuous lower level of sweating. It is not as important to evaporate humidity immediately as it is in the case of strenuous effort, after which cooling is immediately needed.

The aim of development of moisture management fabric is to transport the humidity from the surface of the clothing to the atmosphere for evaporation. This occurs by capillary force known as wicking. The capillary force increases as the gaps between the individual fibres become thinner. That
means that finer the fibres, the smaller the gaps; better will be the transport of humidity. The evaporation of humidity absorbed depends on the type of fibre used.

Usage of hydrophilic fibre results in faster evaporation of the humidity. Clothes which have a humid feel are unpleasant to wear. Hydrophilic fibre such as cotton can absorb a certain volume of water with feeling humid whereas hydrophobic fibre such as polypropylene can transfer the moisture in making the skin dry.

Fabrics made from cellulosic fibers such as cotton are considered comfortable to use under normal conditions. During strenuous activity, cotton fibers absorb high levels of moisture, leading to a feeling of wetness and cling. It possesses very slow wicking rate from inner fabric to outer fabrics which make cotton fibers unsuitable for use as in the case of sportswear.

1.4 PHYSIOLOGICAL REQUIREMENTS OF A SPORTS WEAR

According to Figure 1.1, the professional sports person practically experiences maximum physical performance during his sporting activity which involves shorter time in wearing the clothing with constant climatic condition.
With respect to leisure sport, maximum physical performance is not achieved during the sport activity. Also the sports person wears the fabric for a longer duration of time and there exists variation in the condition of the climate.

According to Figure 1.2, when the weather is colder, the sport fabric must exhibit a higher level of thermal insulation. As the weather changes from cold to hot, the thermal insulation value gets decreases. The thermal insulation behavior of a sports fabric is decided by the type of fibre, yarn and the technique adopted in producing the sports fabric.
To attain variation in thermal insulation, sports fabric must be constructed in a manner which includes many layers rather than single layer which are designed in such a way to adopt and to act according to the condition of the weather.

According to Figure 1.3, the moisture transfer capability of a sports fabric depends on the characteristics of the fibres used in constructing the sports wear.

<table>
<thead>
<tr>
<th>Nature Fibres</th>
<th>Synthetic Fibres</th>
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<tbody>
<tr>
<td>Hydrophilic</td>
<td>Hydrophobic</td>
</tr>
<tr>
<td>Good moisture absorption rate</td>
<td>Lower moisture absorption rate</td>
</tr>
<tr>
<td>Lower moisture transfer rate</td>
<td>Higher moisture transfer rate</td>
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</tbody>
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**Figure 1.3 Characteristics of fibres** (Umbach 1993)

Natural fibres such as cotton are hydrophilic in nature with high absorption characteristics. But the absorbed moisture is able to get released slowly from its surface resulting in low moisture transfer rate. But in case of synthetics such as polypropylene, polyester which are hydrophobic in nature absorbs very little amount of moisture with higher moisture transfer rate.

Sports wear should be designed in such a way that it must have good air, water and heat transmission and water storage properties. But good liquid transmission is difficult to have in a textile material that also has a good water storage property. Good liquid transmission is found in hydrophobic materials such as polypropylene, polyester whereas good storage property is seen in hydrophilic materials as cotton. Instead of using a hydrophilic material
such as cotton in constructing a single layer knitted sportswear, a double-face knitted fabric can be used with two material such as hydrophobic and hydrophilic in which the former has good water transmission property and the latter possesses good water absorption and storage properties.

1.5 MECHANISM OF MOISTURE TRANSFER IN DOUBLE-FACE KNITTED FABRIC

Figure 1.4 shows that the perspiration from the skin is being wicked by the conductive layer. It gets transferred to the absorptive layer and dissipated into the open atmosphere through evaporation.

![Figure 1.4 Mechanism of moisture transfer in double-face knitted fabric](Anbumani & Sathish Babu 2008)

After wicking the perspiration from the skin, the conductive inner layer transfers the liquid perspiration rapidly to the absorbent outer layer as a result of the capillary effect. This capillary effect can be optimized by selecting the hydrophobic material suitable for the conductive layer of the double-face knitted fabric. Also the absorptive layer can be chosen as a hydrophilic material which absorbs the moisture from the conductive layer.
1.6 RESEARCH OBJECTIVES

i) To study the influence of yarn type on moisture transfer characteristics of double-face knitted fabrics.

ii) To study the influence of yarn fineness on moisture transfer characteristics of double-face knitted fabrics.

iii) To study the influence of tuck density on moisture transfer characteristics of double-face knitted fabrics.

iv) To study the moisture management properties of double-face knitted fabrics.

1.7 ORGANIZATIONAL STRUCTURE OF RESEARCH THESIS

The aim of this research work is to study the influence of moisture transfer characteristics of double-face knitted fabrics in order to study the performance of double-face knitted fabrics suitable for active sportswear. The thesis is divided into nine chapters.

Chapter 1 introduces the thesis subject and discusses the need for undertaking the study with research objectives.

Chapter 2 gives an extensive survey on literature related to the research work. This literature review provides the necessary background and guidance to carry out the entire study.

Chapter 3 describes the materials and methods used in producing the double-face knitted fabrics required for the study. The testing methods adopted for the study are discussed in this chapter.
Chapter 4 discusses the influence of yarn type on moisture transfer characteristics of double-face knitted fabrics.

Chapter 5 describes the influence of yarn fineness on moisture transfer characteristics of double-face knitted fabrics.

Chapter 6 describes the influence of tuck density on moisture transfer characteristics of double-face knitted fabrics.

Chapter 7 describes the study of moisture management properties of double-face knitted fabrics.

Finally, summary of the study with various conclusions drawn from this research work are given in the Chapter 8.