ABSTRACT

Today moisture comfort is an important aspect for any garment used for sportswear and leisurewear. Every human being sweats during different kinds of activities. An important feature of any fabric is how it transports this water out of the body, so as to make the wearer feel comfortable. Wetting, wicking and moisture vapour transmission properties are critical aspects for the performance of clothes.

Analysis of transverse wicking characteristics of the fabric is also important as longitudinal wicking because the perspiration (sweat) transfer from skin involves its movement through the lateral direction of the fabric i.e., through the thickness of the fabric. When the area spread is high, the evaporation of the fabric is also high. The influence of longitudinal gravity is not considered in horizontal wicking but being multi-directional, it eliminates the directional effect and hence the results will be most dependable for developing fabrics for sportswear.

An average consumer may not understand what transverse wicking is or the characteristics of a good wicking fabric. This research is expected to provide an insight not only to consumers, but also industry, on fabric properties that make up a good transverse wicking garment. The thesis is concerned with the design and development of transverse wicking measurement device using various techniques for analysing the dynamic
liquid transfer behaviour of fabrics in transverse direction. These techniques were employed to do an in-depth study on influence of yarn count, type of yarn, type of doubled yarn combinations, weave structure and fabric cyclic stress on the transverse wicking behaviour of the various fabrics.

Attempts to quantify transverse wicking have led to many test methods, which in turn have led to abundant confusion because of the diversity of the results. The existing methods have its own drawback such as manual method, static measurement, less accuracy and poor data recovery.

In the present work the following techniques are developed to measure the transverse wicking behaviour of the fabrics.

(i) A new technique based on the embedded image analysis using 32 bit Digital Signal Processor through MATLAB software was used to determine the water spreading area with respect to time. The water spreading area recorded with a digital camera and the picture analysing process was automated by use of an image segmentation algorithm: background subtraction. The effect of yarn count, type of yarn and doubling combination on the character of transverse wicking was examined for the fifteen types of cotton plain weave fabrics. The results also confirm that the fabric spreading area is dependent on the count of yarns, type of doubled yarn combinations used and the type of yarns.

(ii) A technique based on image analysis using Photoshop method has been developed to determine the transverse wicking behaviour of different woven and knitted fabrics. The efficacy of the technique was
evaluated by comparing the results with other two developed methods namely manual method and embedded image analysis system method. When compared to image analysis using Photoshop method, the embedded image analysis system method takes less time for testing because of fully automatic calculation through MATLAB coding with digital signal processor. Three test methods were compared for their rate of absorbency and total absorbency statistically. A good correlation was obtained between manual and Photoshop method. Also Photoshop vs EIAS method correlation was found to be better than manual vs EIAS method.

(iii) It is extremely important to evaluate transverse wicking behavior of elastic knitted fabric while the fabric simulated in different body motions. The effects of short interval dynamic extension and recovery on fabric transverse wicking behavior were evaluated as the samples were subjected to different rate of extension (speed), different level of cyclic extension and different liquid flow rate. For this application, a new cyclic stress instrument was designed and developed to apply repeated dynamic extension and recovery on the fabric. The developed instrument is operated through embedded micro controller program. The effect of speed, % of cyclic extension and flow rate with respect to the dynamic transverse wicking behaviour of elastic knitted fabric has been studied using Box-Behnken experiment model. The experiment model identifies the principal experimental variables such as flow rate, % of cyclic extension which has the greatest effect on the transverse wicking behaviour of elastic knitted fabric.
(iv) The dynamic sweat transfer tester for analyzing the sweat transfer behavior of multi design fabrics (single fabric contains different weave structures) has been designed and developed. This instrument has been developed to evaluate the sweat transfer rate in 16 different directions and 48 different regions for a test specimen of 7cm diameter. The concept of the sweat measurement is to measure the sweat transport time required to reach the unit area of the fabric. The instrument works under the principle of electrical conductivity. i.e. wetted cotton fabric acts as an electrical conductor between the power connected 5V copper pins and ground connected copper pins. The unique feature of this instrument is that the sweat transfer rate can be measured in fabrics which have irregular spreading behavior (single fabric which has different weave structures) at one step. Fifteen different fabrics have been analysed for the sweat transfer behavior using the instrument and the results were well correlated $R^2$ is 0.95 with manual test method. The results indicate that the weaves which have more floats show higher sweat transfer behaviour. In knitted fabric, the sweat transfer rate in wale direction is higher than course direction.

From the above four objectives, it is concluded that the transverse wicking behaviour plays a major role in developing active sportswear. It provides additional information to re-engineer the active sportswear for specific sports activity.