CRIMSON PUBLISHERS
Wings to the Research

Trends in Textile Engineering & Fashion Technology

ISSN 2578-0271

Review Article

An Overview on Objective Evaluation of Wicking Property of the Textile Material Used in Sports

Priyalatha S* and Raja D

Department of Fashion Technology, Sona College of Technology, India

***Corresponding author:** Priyalatha S, Department of Fashion Technology, Sona College of Technology, Salem, Tamil Nadu, India

submission: April 06, 2018; **Published:** May 14, 2018

Abstract

Moisture management property is a significant feature of any clothing and especially meant for active sportswear, which determines the comfort level of that fabric. Every human being sweats during different kinds of activities. The major requirement of this moisture management performance is to absorb the sweat quickly from the skin and transport it to the outer surface of the garment to evaporate it quickly in order to keep the body dry and cool. This paper reviews various works done in development of system and instruments used in the evaluation of the moisture transport property of the textile material objectively.

Introduction

Comfort with clothing for sports persons is very essential and considered as primary need than aesthetic properties as it is worn by players the whole day as next to skin. The Moisture absorption and transport properties of fabrics have been widely acknowledged as the key contributors creating discomfort during wear. It also causes increased fatigue level experience which in turn lowers the competence of the player [1]. The major and sole reason for discomfort and increased level of fatigue is due to un-evaporated and drenched moisture stays behind on skin which has to be transported by the textile material which is next to skin. If it is the case, in the warm environment or during exercise or active sports activity, moisture on the skin is comparatively excess and highly correlated to moisture and thermal discomfort. The discomfort caused by improper moisture transport will lead to increased friction with skin, dampness, stickiness, itching, extra added weight, improper stretch ability of the fabric etc [2-5]. which affects the vigorous movements of the sports person while playing. The high comfort clothing is much required and should be provided to our players to make them highly competitive and to excel on their sports.

When considering the comfort, the feel of dryness even in excess sweat is most required which can be achieved by good absorption, easy and quick drying [6]. Clothing which are worn next to skin should be capable of transferring moisture from the skin to the outer surface quickly and evaporating quickly to keep the body dry and cool. It is clear that absorption of water and its transport to different parts of textiles followed by its evaporation is the major requirement [7]. Transport of water to different parts of fabric can be done by Wetting and wicking. The sportswear can be engineered by incorporating many factors such as fiber type, yarn parameters, fabric parameters, finishing types, etc. to achieve maximum comfort at low cost pertaining to specific end use. Many trials with different combination can be carried out from the manufacturing face, but the system to evaluate the moisture transport properties as in the real case is required to finalize the suitability before final production [8].

Mechanisms of water transport in fabrics

Wetting and wicking are important phenomena in the processing applications of fibrous materials. Various aspects of liquid- fibre interactions such as wetting, transport and retention have received much attention both in terms of fundamental research and for product and process development [9].

'Wetting' of a fabric surface is the condition resulting from its contact with a specified liquid under certain conditions. Wetting is the displacement of a fiber-air interface with a fiber-liquid interface. Wetting is a dynamic process [10]. Spontaneous wetting is the migration of a liquid over a solid surface toward thermodynamic equilibrium.

'Wicking' is the spontaneous flow of a liquid in a porous substrate, driven by capillary forces. Because capillary forces are caused by wetting, wicking is a result of spontaneous wetting in a capillary system [11]. On basis of the relative amount of liquid involved and the mode of the liquid-fabric contact, the wicking processes can be divided into two groups: wicking from an infinite liquid reservoir (immersion, transplanar wicking, and longitudinal wicking), and wicking from a finite (limited) liquid reservoir (a single drop wicking into a fabric) [12].

'Drying' has been defined as the removal of volatile substances by heated air from a moist object. During drying of moist objects simultaneous heat and moisture transfer occurs both inside the solid and in the boundary of the drying agent. . Fabric's quick drying properties can be determined according to AATCC Test Method 199-201 [13].

The absorption and spreading of water is affected by their fiber properties, yarn properties, fabric structure and any mechanical or chemical treatments applied on the fabric. Its transport within a fiber depends on a series of factors such as its crystalline structure, crystallite size, orientation and distribution, and by the presence and size of amorphous regions interfacial tensions (temperature, pressure, impurities, polarity...), the other properties of liquid (viscosity, liquid evaporation...) and fibre properties (surface articulation, fibre fineness...)

Subjective evaluation of wicking property of fabrics

The wetness sensation, a subset of thermo-physiological comfort, is related to the amount of accumulated sweat in clothing. Skin moisture is known to correlate with thermal discomfort and unpleasantness, and high vapour concentrations in the clothing-skin microclimate or the presence of moisture on skin or in clothing may lead to sensations of clamminess and stickiness during wear [14]. Researchers have tried various ways of investigating subjects' perception and physiological changes when wearing different clothing or manipulating different fabrics. But the accuracy of the result relies on the honesty of the subjects. A large sample size is required to obtain satisfactory precision and this is likely to be both resource- and time-consuming. The sensitivity of sensory receptors also varies considerably between assessors, enlarging the range and variation of the result [15].

Objective evaluation of wicking property of fabrics

Objective evaluation has been developed to overcome the assessment system which is carried out subjectively also expensive, time-consuming and prone to error due to individual differences. The objective evaluation of liquid absorption [16] and transport properties of the fabrics can be assessed by various principles. They are volumetric method, Observation method Optical method, Spectroscopic method, Electrical method; Pressure based method, Magnetic resonance method and Temperature detection method.

Volumetric method: The main principle of this volumetric method deals with the measure of difference in absorbency of the liquid by the fabric over a period of time. It is simple to conduct. The duration of the test may be rather long and so water evaporation from the fabric is a problem [17]. The Siphon test method, Vertical-wicking experiment, Tensiometer apparatus, Gravimetric Absorption Testing System and dynamic water absorption measurement falls under this classification.

Observation method: A drop of liquid was delivered from a fixed height onto the test fabric. The wicking of the fabric is measured by tracing its outer boundary by direct observations. No specific equipment is required and it offers the opportunity to make measurements for a minimal financial outlay and takes little time [18], but this is at the cost of accuracy; the determination of the end-point by observation is prone to subjective variations. The optical test methods are Areal wicking 'spot' test, Longitudinal wicking 'strip' test (AATCC 197), Horizontal-wicking test, Radial wicking (ring test), Sink test.

Optical method: The experimental setup and procedure of the Contact angle measurement, automatic longitudinal wicking test method, Horizontal-wicking test, Dynamic water absorption tester for terry fabrics, embedded-image processing method are the following the potical evaluation method [19]. Numerous wicking tests have been developed based on image-analysis technique which can record the time-dependent wicking curve with the help of charge-coupled device (CCD) camera.

Spectroscopic method: The determination of mass of water absorbed by fabrics is measure of the differences in depth of colour between the dry and wet states of the fabrics using a spectrophotometer. Transfer-wicking test by X-ray microtomography, transfer-wicking set-up, Transplanar water transport are the examples of spectroscopic method [20].

Electrical method: Electrical techniques are suitable for the investigation of a range of fabric properties providing data that are not so easily accessed by other means. It can be used to measure the horizontal and vertical wicking rate of fabrics by electrical resistance [21]. Horizontal-wicking testing by electrical resistance, Moisture Management Tester (MMT), Longitudinal wicking 'strip' test by capacitance, Vertical-wicking testing by electrical resistivity, Sweat transfer tester are working under the electrical principle [22].

Pressure based method: The fabrics which do not saturate immediately (fabrics with relatively poor absorbency and/or thick fabrics), whereas hydrophilic fabric and multiple layers of fabric can be tested by pressure based method [23]. A pressure sensor was attached to detect the reduction in pressure of the water column due to water absorption in fabric and the small change-of-pressure signal was magnified by amplifier measured based on time. A special feature of this method is that multilayer fabrics can be tested but it is difficult to ensure repeatability [24].

Magnetic resonance method: Nuclear magnetic resonance (NMR) is a physical characterization technique which enables observation of the absorption spectrum of an electromagnetic field by nuclei [25-27]. The absorbed electromagnetic field gives a specific signature for each particular atom; therefore, the atom can be characterized and the electromagnetic intensity represents amount of material presented. NMR has also been used for imaging fluid distribution and movement in textiles.

How to cite this article: Priyalatha S, Raja D. An Overview on Objective Evaluation of Wicking Property of the Textile Material Used in Sports. Trends Textile Eng Fashion Technol. 2(4). TTEFT.000541.2018. DOI: 10.31031/TTEFT.2018.02.000541

Temperature detection method: This technique makes use of the latent heat of evaporation of water from a damp fabric. The temperature of a wet fabric decreases when evaporation takes place. During the evaporation period, the water within the fabric absorbs energy from the surroundings, thus causing a drop in temperature and enabling the presence of water to be detected. Areal wicking 'spot' test by temperature detection, In-plane wicking test by temperature detection are working under this principle [28].

Conclusion

Clothing comfort is a fundamental need for consumers, not only to satisfy the basic need to survive but also to improve quality of life, and is becoming more and more important. The customers place heavy emphasis on clothing comfort and functionality and many high-technology apparel products have emerged. The water absorption and transport properties of fabrics are dominant factors affecting clothing comfort, arousing the interest of many researchers and developers of sportswear, uniforms, intimate apparel, incontinence products or clothing worn to protect against extreme environmental conditions such as fire-fighters' protective clothing and skiwear. However, in reviewing evaluation methods for the measurement of liquid water transport properties, a series of considerations and pitfalls emerge with many of the more-widely used approaches and measurement techniques which now require attention.

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