Computational and Experimental Investigation of Moisture Transport of Spacer Fabrics

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ABSTRACT

This paper investigates the moisture transfer behavior of spacer fabrics. Spacer structures are knitted fabric constructions comprising two separate fabrics which are joined together by spacer threads. In order to investigate the dynamic moisture transfer of spacer fabrics, an experimental apparatus was developed which made the simulation of human body sweating possible.

In the experimental section, the influence of some parameters such as the kind of spacer threads and also heat setting under drawing on moisture transport properties is investigated. Heat setting under drawing affects air permeability, thickness and porosity of spacer fabrics. The Results showed that water vapor produced by sweating can be easily and quickly transferred from the skin to the outer surface to keep the skin dry. In the computational section, a mathematical model was developed to describe moisture transport behavior of spacer fabric. The model was in high good agreement with the observations in the experiments.

INTRODUCTION

The creation of clothing which surrounds the body with a microenvironment and function under physiological conditions has made it possible for us to live in conditions as extreme as the hot desert or the cold polar area. Textiles have been developed to improve their physiological functions for thousands years. The ability of clothing to transport heat and moisture vapor, produced by human body, with high water vapor permeability is one of the most important factors allowing the human body to provide cooling due to evaporation [1]. Transfer moisture vapor of clothing has a critical role in wear comfort, especially in conditions that involve sweating. The moisture transfer properties of clothing materials contribute to determining the thermal and sensorial comfort of garments made from them [2]. In fact, an important purpose for clothing designers is keeping the skin dry after physical activity by rapid transport of liquid perspiration away from the skin, because of the role of humidity next to the skin in determining comfort levels [3].

The wear comfort of clothing is affected by physical processes include heat transfer by conduction, convection and radiation. Meanwhile, moisture transfer by diffusion, sorption, wicking and evaporation, and mechanical interactions in the form of pressure, friction, and dynamic irregular contact. The main interests of research in the field are the dynamic heat and moisture transport behavior of clothing and their influence on clothing comfort in the last decade [4].

There are three possible ways the moisture may migrate along the direction of the concentration gradient, when a water vapor concentration gradient is applied across a fabric: travelling of the water moisture through the fiber interiors, along the surfaces of the fibers, or through the air spaces between the fibers and the yarns.

As long as the water remains in the vapor state, bulk transport of liquid by capillary action can be neglected, and these routes may be described by the following three mechanisms: a) molecular diffusion through the polymeric phase, b) surface diffusion of absorbed molecules along the fibers and c) molecular diffusion through the air spaces of the fabric [5].
Perspiration moisture collects in and passes through clothing as worn. Both the collection and passage of