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ORIGINAL ARTICLE

Microcellulose particles for surface modification to enhance moisture management properties of polyester, and polyester/cotton blend fabrics

Magdi El Messiry [a,*], Affaf El Ouffy [b], Marwa Issa [c]

[a] *Textile Engineering Textile Dept Faculty of Engineering Alexandria university, Egypt*
[b] *Textile Engineering Textile Dept Faculty of Engineering Alexandria university, Egypt*
[c] *Faculty of Engineering Alexandria university, Egypt*

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KEYWORDS

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Wettability

Abstract In this work we studied the effect of surface treated fabric by applying Microcrystalline Cellulose (MCC) Particles using two different procedures. The first method was to dissolve MCC particles and form a MCC solution which further was blended with a textile binder to obtain the fabric coating. The second treatment was direct blending MCC particles with same textile binder in order to get the fabric finishing to be sprayed on the fabric surface. The percentage of MCC particles was chosen 6%, as this ratio can be considered the most appropriate one. The effect of these treatments on fabrics moisture wettability with varying percentage of coating was studied. It was concluded that the second method by spraying MCC Particles directly on the fabric surface gives superior improved fabric's wettability and moisture management than solving the MCC and coating the fabric surface. The morphological study using SEM confirmed the presence of MCC particles on the fabric surface; therefore, intensification fiber surface energy leads to increase the wicking properties and increase the rate of water absorption.

1. Introduction

In recent years, there have been considerable research and developments in moisture management fabrics in such a way that the body perspiration is transported away from the skin to the outer surface of fabric where it can evaporate quickly in order to accomplishing the consumer satisfaction of comfort. To achieve such moisture management, the structural design and quality of fibers are modified so that the textile products can have good performance in absorbing, transporting, and dissipating moisture. These properties can be affected by the structure and type of fiber, yarn and fabric along with finishes or coating applied; methods for enhancing the moisture management [1–7].

Polyester fiber is one of widely consumed of all fibers (about 70%), and when one perspires, the Polyester tends to keep the perspiration trapped against the body. Due to the hydrophobic nature, Polyester is also more electrostatic compared to the natural fibers. Therefore, numerous researchers are in progress on the hydrolysis and aminolysis of Polyester

* Corresponding author.

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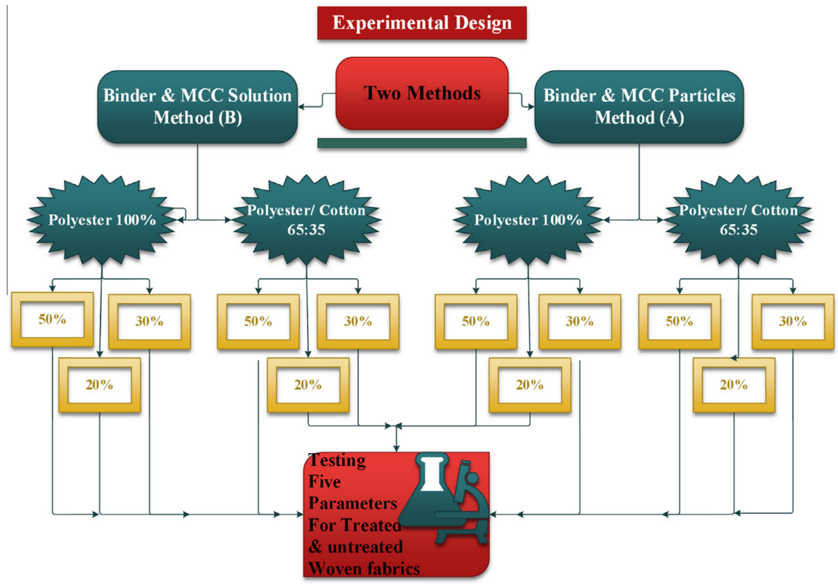

Figure 1 Experimental Design Layout.

fibers to overcome this disadvantage [8–12], in contrary to cotton which is hydrophilic fiber and composed mainly of cellulose. Cotton fabric is able to absorb high levels of moisture, 8.5% moisture regain. Unfortunately, the wicking property between inner and outer surfaces of the fabrics made of cotton fibers is very poor; this makes cotton unsuitable for use against the skin during energetic activity. However, fabrics made of modified Polyester can give better moisture management, especially with using fine filament yarn [13–18]. Moisture management of fabrics not only depends on the materials, but also on their assembly in the fabric. In case of knitted fabrics, warp knitting tends to be a more effective knitting pattern for moisture management than circular knitting [19]. Multi-layers fabric of hydrophilic and hydrophobic material was developed in order to improve its moisture management [20,21]. Various techniques have been emphasized to develop better moisture management such as combining Polyester with different natural fiber types, microfiber, Bi-component fiber, especially different cross-section, plasma treatment and applying surface finish [22–40]. A material such as cellulose that is produced by both plants and bacteria on a totally sustainable basis assumes great significance for future materials development [41,42]. Mechanical treatment and acid hydrolysis are the main and common approaches for isolating cellulose particles [42–46]. Numerous approaches in this direction used different cellulose materials: cationic cellulose, cationic Nanocrystalline cellulose and cotton powder in a way that the hydrophilicity of Polyester fabric was significantly improved [47–50]. Many researchers investigate the mechanism of water vapor transferred through fibrous materials. Das [7,27] indicates that there are several ways: (i) Diffusion of the water vapor through the fibrous layers, (ii) Absorption, transmission and desorption of water vapor by the fibers and (iii) Transmission of water vapor by forced convection. Diffusion of water vapor molecules through air spaces in fabrics is a major contributor to moisture vapor transport. The other transfer processes mentioned above involve smaller amounts of moisture vapor. These processes are more complex than the diffusion processes and can significantly contribute to clothing comfort. With the idea of improving the moisture management, different nano/microparticles were tried by several researchers. Yin Fa et al. [50] applied nano-wool particles to enhance the moisture management capability and hydrophility of Polyester fabrics. Ying Ting et al. [51] treated samples of wool by cotton particles for better moisture management function of the fabrics such as wetting time at bottom, top maximum absorption rate, bottom maximum absorption rate, bottom maximum wetted radius and bottom spreading speed. All these property changes suggest that the hydrophobicity of wool fibers increased after the treatment by cotton fibrils.

In this study, two techniques were suggested in order to study the effect of applying microcrystalline cellulose particles as coating materials on Polyester fabric and its blend with cotton. The wettability of the fabric was measured through the wicking height and the contact angle of the treated samples.

2. Materials and methods

2.1. Materials

Three woven fabrics were selected for this study: Polyester (plain weave, 142 g/m^2, 26 picks/cm, 31 ends/cm), Cotton (plain weave, 195 g/m^2, 21 picks/cm, 25 end/cm) and Polyester/Cotton (65/35) blend (twill weave 2/1, 186 g/m^2, 28 picks/cm, 24 ends/cm).

Microcrystalline cellulose particles (MCC) 20 μm were prepared by sulfuric acid hydrolysis process, produced by Sigma–Aldrich. For Method (A), two commercial textile additives, self-cross linking acrylic binder and Polyacrylate thickener, have been used for cellulosic coating for woven fabrics.

In order to prepare the aqueous mixtures of MCC Particles, Method B, with different mass ratios of Urea, Thiourea and NaOH, the following chemicals were used for the preparation of the cellulose finish Sodium Hydroxide (NaOH), Urea and Thiourea and textile binder.