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MOISTURE TRANSPORT IN WOVEN FABRICS CONTAINING COTTON FIBERS

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ABSTRACT

Cotton is currently the most commonly used raw material of natural origin in a production of clothing. Due to its very good hygroscopic properties, it is also often used in production of underwear, bandages etc. A liquid moisture transport plays a crucial role in shaping a physiological comfort. As part of this study 2 pairs of woven fabrics containing cotton fibers with twill 3/1 S weaves were tested in the range of their ability to moisture transport in the form of liquid. Moisture transport is the fabric's ability to wick moisture away from the body. The investigation were carried out on the Moisture Management Tester. The investigations allowed to assess the moisture transport of individual fabrics.

KEYWORDS

Woven fabrics, weave, moisture transport, physiological comfort.

INTRODUCTION

Scientists around the world are concerned with the topic of physiological comfort. However the interest in the transport of moisture in liquid form (sweat) is relatively new. Until now, there has not been such an accurate method or equipment to reproduce conditions for the propagation of liquid moisture through textiles. In Poland this topic is still not very common. Moisture transport in the form of liquid plays a very important role in shaping physiological comfort, which is a basic feature in the use of clothing. Ensuring the comfort of using clothing is currently one of the most important criteria in its production. From the point of view of physiological comfort, the ability to manage a moisture through clothing fabrics is very important [1]. The ability to manage moisture through textiles has become very important especially in the last decade. Textiles that are referred to as moisture management are those that easily flow moisture from the body surface and leave the skin dry, and the user of the clothing does not feel uncomfortable [1,2].

Moisture transport can be tested in various ways. Water – vapor permeability is tested using a Permetest device and 'skin model' [3] which are commonly used to determine resistance to water vapor passing through textile materials. These devices allow tests to be carried out according to standardized procedures [4–6]. Many different tests are used to assess fluid transport through textiles. Vertical wicking test method [7] and contact angle method [8] are the most commonly used. However, these 2 methods are very simple and do not provide information on what to do the exact parameters of textiles with regard to transport moisture. Based on these methods, it can only be determined whether the material textile is hygroscopic and how much it can absorb moisture.

The most famous instrument for measuring moisture transport in liquid form is the Moisture Management Tester - M290 by SDL Atlas. The measurement is based on the AATCC test method, which is used to measure, evaluate and classify textiles in terms of their moisture management capacity. This method presents objective measurements. The results obtained using this method are based on water resistance, hydrophobicity and water absorption, which characterize the internal structure of the fabric, including its geometry. The test also checks the fabric's ability to wick moisture away from its surface [9,10].

MATERIALS AND METHODS

Two pairs of woven fabrics (1,2 and 3,4) of twill 3/1 S weave were tested. The basic properties of the fabrics are presented in the Table 1.

Table 1. Basic properties of fabrics investigated.

	Ingredients	Warp	Weft	Weft density
1	Cotton	50 tex	50 tex	110/dm
2	Cotton/PES	50 tex	50 tex	110/dm
3	Cotton	50 tex	30 tex	110/dm
4	Cotton/Rayon	50 tex	30 tex	110/dm

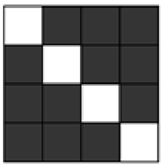

Figure 1. Weave applied in the woven fabric variants manufactured.

Moisture transport through the fabrics was tested using the Moisture Management Tester (MMT) M290 from SDL Atlas [10]. This instrument is used to evaluate textiles in the transport of moisture in the form of liquid through these materials. The sample is placed horizontally in the instrument between the upper and lower sensors. A sweat-like solution is dropped to the centre of the upper surface (skin side) of the test sample. As the solution passes through the sample, changes in electrical resistance are measured and recorded.

The test solution (synthetic sweat) is carried through the material in three directions [10]:

- spreading on the upper surface of the fabric,
- moisture transfer through the fabric from the top to the bottom surface,
- spreading on the lower surface of the fabric.

The MMT provides the values of the following parameters were determined:

- WT T – wetting time of top surface, in s,
- WT B – wetting time of bottom surface, in s,
- TAR – absorption rate of top surface, %/s,
- BAR – absorption rate of bottom surface, %/s,
- MWRtop – maximum wetted radius for top surface, mm,
- MWRbottom – maximum wetted radius for bottom surface, mm,
- TSS – spreading speed on top surface, mm/s,
- BSS – spreading speed on bottom surface, mm/s,

- R – accumulative one-way transport index, %,
- OMMC – Overall Moisture Management Capacity.

The MMT can identify 7 types of fabrics:

- Waterproof fabric
- Water repellent fabric
- Slow absorbing and slow drying fabric
- Fast absorbing and slow drying fabric
- Fast absorbing and quick drying fabric
- Water penetration fabric
- Moisture management fabric.

RESULTS AND DISCUSSION

Results from the MMT are shown in Table 2.

Table 2. Results from the Moisture Management Tester.

	WTT (s)	WTB (s)	ART (%/s)	ARB (%/s)	MRT (mm)	MRB (mm)	SST (mm/s)	SSB (mm/s)	R (%)	OMMC -
1	3.229	3.257	63.443	57.038	22.500	21.000	4.683	4.459	-76.056	0.382
2	2.836	2.911	57.747	54.480	24.000	24.500	4.985	4.880	-88.058	0.374
3	2.846	3.005	65.616	58.828	25.000	26.500	5.834	5.833	-86.831	0.386
4	2.668	2.827	66.903	61.171	30.000	30.000	7.214	6.993	-76.848	0.392

The OMMC indicator (Overall Moisture Management Capacity) is calculated by the software using 3 parameters:

- absorption rate of bottom surface,
- moisture spreading speed for the bottom surface of the sample,
- accumulated one – transport index.

Classification of fabrics according to the values of the Overall Moisture Management Capability is following [9]:

0 - 0.2 – very poor,
0.2 - 0.4 – poor,
0.4 - 0.6 – good,
0.6 - 0.8 – very good,
0.8 - 1.0 – excellent.

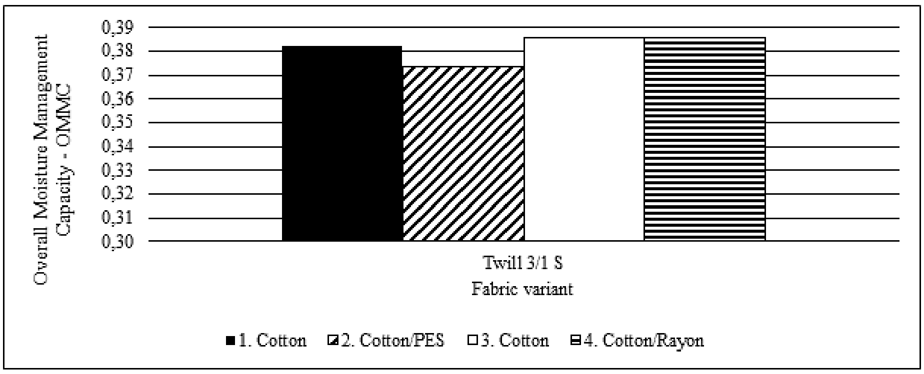

Figure 1. Overall Moisture Management Capacity of the investigated fabrics.

According to the manufacturer of the device, all investigated fabrics are classified as fast absorbing and quick drying fabric. Overall Moisture Management Capacity for all fabrics was assessed like poor.

Analysing the results for pairs of:

- Cotton (1) - Cotton / PES (2) and
- Cotton (3) - Cotton / Rayon (4) fabrics,

it can be concluded that samples containing only the cotton fibres have a smaller wetting radius compared to samples containing a mixture of fibres. It concerns both sides f the fabrics. In the case of the wetting time, it is longer for the cotton fabrics than that for the fabrics from blended yarns. Generally, more favourable results were achieved by samples containing only cotton in comparison to fabrics containing a mixture of fibres. Comparing the cotton fabrics it was stated that the linear density of the weft yarn influences the parameters characterizing the liquid moisture transport in the cotton fabrics. However, the values of the OMMC parameter for both cotton twill fabrics with 50 tex and 30 tex weft yarns are at the same level.

CONCLUSION

The structure of woven fabrics and raw material composition has a significant impact on ability of fabrics to transport a moisture in the form of a liquid. Overall Moisture Management Capacity for all investigated fabrics was rated like poor. This may be due to the fact that cotton is hydrophilic and can keep moisture for a long time inside the fibres. However, samples with a fibre blends did not achieve any better results. In the case of the Cotton-Cotton / PES sample pair, the samples containing only the cotton fibres achieved better results. Even though PES is a synthetic fibre, it did not improve the properties of the sample significantly.

For the second pair of Cotton-Cotton / Rayon samples, the results were similar. Rayon, like cotton, is also a cellulose hydrophilic fibre. Due to this in the aspect of liquid moisture transport ability an addition of cellulose fibres to cotton fibres did not improve the performance of the fabric.

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