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Çift Plaka Örme Yatak Kumaşlarının Nem Taşıma Özellikleri

Moisture Transport Properties of Double Jersey Mattress Ticking Fabrics

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Araştırma Makalesi / Research Article

MOISTURE TRANSPORT PROPERTIES OF DOUBLE JERSEY MATTRESS TICKING FABRICS

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ABSTRACT: Moisture transfer properties of fabrics are very important for thermal comfort of human body. To provide thermal balance, perspiration secreted from body should be transmitted to the atmosphere. The objective of this study is to analyze moisture transport behaviors of double jersey mattress ticking fabrics. In the experimental section drying time, vertical wicking and transfer wicking properties of cotton - cotton, polyester - polyester and viscose – viscose, cotton/polyester - polyester double jersey fabrics mattress ticking fabrics are analyzed. According to test results the role of material and fabric structure variation on moisture transport behavior is evaluated.

Key words: Thermal comfort, wetting, wicking, drying rate, mattress ticking

ÇİFT PLAKA ÖRME YATAK KUMAŞLARININ NEM TAŞIMA ÖZELLİKLERİ

ÖZET: Kumaşların nem taşıma özellikleri insan vücudunun termal konforu için çok önemlidir. Termal dengenin sağlanması için vücuttan salgılanan terin atmosfere aktarılması gerekir. Bu çalışmanın amacı çift plaka örme yatak kumaşlarının nem taşıma davranışlarının incelenmesidir. Pamuk-pamuk, polyester-polyester, viskoz-viskoz, pamuk/polyester-polyester çift plaka örme kumaşların kuruma zamanı, dikey ıslanma ve transfer ıslanma özellikleri incelenmiştir. Test sonuçlarına göre malzeme ve kumaş yapısındaki değişimlerin nem taşıma davranışı üzerindeki etkisi değerlendirilmiştir.

Anahtar kelimeler: Termal konfor, ıslanma, nem iletimi, kuruma hızı, yatak kumaşı

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1. INTRODUCTION

Thermal comfort shows the state of mind which denotes pleasure from thermal ambience. Moisture and heat transferred between clothing layers effect the comfort perception [1]. In cold ambient temperatures reduction of the average body temperature and in hot ambient temperatures sweating cause discomfort perception [2]. Moisture transfer through textile layer in liquid or vapour form has a significant role on thermophysiological comfort of human body. To provide thermal balance of the body, perspiration should be transmitted to the atmosphere. Fabric moisture rate, material type, body transpiration rate, and weather properties like humidity, temperature and wind speed have effects on moisture transfer properties [3].

Double jersey mattress ticking fabrics are double faced knitted fabrics with inlay yarn. At the beginning they were developed to be used as preforms for textile reinforced composites. Later on these fabrics were begun to be used as pique bed covers and mattress ticking. During fabric production in double bed circular knitting machines, thick Bulk Continuous Filament synthetic yarns are fed as filling yarns in middle layer. In fabric cross-section BCF yarns look like plush connected to both front surface and back surface [4].

Moisture produced in liquid and vapor form has significant effect on thermophysiological comfort of human body. For sweat vapour; diffusion, absorption-desorption and convection, and for liquid sweat; wetting and wicking are important mechanisms to provide thermophysiological comfort. Under normal atmospheric conditions and activity level, heat is transferred to ambient air by conduction, convection and radiation while perspiration is transmitted in vapour form. As activity level or air temperature increase, much more heat is produced triggering liquid sweat generation in sweat glands. Sweat in vapour form is called insensible perspiration and sweat in liquid state is called sensible perspiration. Human body is cooled by evaporation of liquid sweat from the skin surface decreasing body temperature. [3]. There are different mechanisms employed in liquid and vapour moisture transfer in textiles. Liquid moisture passage through a textile fabric depends on molecular attraction between fiber and water. This type of interaction is due to the surface tension and capillary pore distribution [3]. Wetting is the first step during liquid movement through a textile material and it is defined as change of fiber-air interface with fiber-water interface. [3]. Wicking, another important mechanism of liquid moisture transfer, is defined in Masoodi's study as the spontaneous imbibition of liquid into a porous medium where the driving force that pulls the liquid into the medium is the capillary suction force [8].

Wetting results in capillary forces and these forces cause wicking in a capillary medium. When a liquid can not wet fibers it also can not wick into the fabric. For a solid surface to be wetted by a liquid, the free surface energy of solid should cope with the free surface energy of the liquid. Free surface energy is called “surface tension”. Immersion, capillary sorption, adhesion and spreading are processes of wetting mechanism in textile materials [9].

Sempath et al. investigated the moisture management properties of microdenier polyester knitted fabrics. Comfort properties such as wetting, wicking, water absorbency, moisture vapour transmission, and air permeability of moisture management finish treated microfiber polyester fabrics were tested [10]. Hong and Kim improved a model using saturated flow mechanism to determine the comfort properties of cotton polyester blend fabrics. Main parameters of the model were permeability, capillary pressure and fabric thickness [7]. Fanguiero et al. studied the wicking and drying rate properties of functional knitted fabrics produced by using functional fibers in the backside and polyester or polypropylene in the fabric face. Polyester trilobal flat, polypropylene, polyamide, elastane, polyester Coolmax®, PBT, Dry-release® and viscose Outlast® are the functional fibers used in fabric samples. The researchers observed that Outlast back yarn fabric showing the best horizontal and vertical wicking ability following by Coolmax back yarn fabric. On the other hand fabric with the PES trilobal flat face yarn have better wicking property than that of fabric with the PP face yarn. For drying capability Coolmax have the best results in back yarn as well as PP in face yarn [5].

2. MATERIAL AND METHOD

2.1 Transfer Wicking

Characteristics of fabrics analyzed in this study are given in Table 1.

Table 1. Properties of sample fabrics

Sample No	Front face fiber	Back face fiber	Fiber Composition	Sample weight
CC	Cotton	Cotton	100 % Cotton	248 g/m^2
VV	Viscose	Viscose	100 % Viscose	262 g/m^2
PP	Polyester	Polyester	100 % Polyester	280 gr/m^2
CP	Cotton polyester	Cotton polyester	65 % Polyester 35 % Cotton	340 gr/m^2

Fabric samples are tested in order to determine their moisture transfer properties. To do this vertical wicking, transfer wicking and drying rate of fabric samples are measured. Test samples of 200 mm x 25 mm were prepared for vertical wicking test. 30 mm from the bottom end of the test fabric is marked and fabric is immersed into distilled water by 30 mm line. In order to protect the bottom level of the fabric bottom end of the specimen is clamped with clip. During the total test time of 15 minutes, water height wicking into the fabric is measured every minute.

For transfer wicking test 6 pairs of circular test samples with the diameter of 74.5 mm were prepared. The weight of each single sample is measured before the test. One of each sample pair is immersed into distilled water for 2 minutes while the other sample of the pair remaining dry. Afterwards sample is taken from the water and hung for a minute. In the second step fabric is laid over for 2 minutes for each face, total 4 minutes duration. Sample weight is measured again. Then fabric is put on a rubber disc. Other sample of that pair is put on the first one. 3 sample pairs are prepared as face to face (face side of each sample touching each other) and remaining 3 pairs are prepared face to back (face side of wet fabric touching back side of dry sample). After sample pair preparation upper disc is closed on the pair forming a sandwich like structure. Weight of the fabric samples are measured every 5 minutes of total 30 minutes test time.

Table 2. Specimen weights prior to wetting

Cotton		Viscose		Polyester		Cotton Polyester	
Sample	Weight (gr)	Sample	Weight (gr)	Sample	Weight (gr)	Sample	Weight (gr)
CC.1	1.032	VV.1	1.211	PP.1	1.155	CP.1	1.721
CC.2	1.033	VV.2	1.153	PP.2	1.144	CP.2	1.778
CC.3	1.026	VV.3	1.179	PP.3	1.130	CP.3	1.774
CC.4	1.025	VV.4	1.146	PP.4	1.109	CP.4	1.856
CC.5	1.039	VV.5	1.193	PP.5	1.139	CP.5	1.870
CC.6	1.007	VV.6	1.171	PP.6	1.124	CP.6	1.721
CC.7	0.99	VV.7	1.167	PP.7	1.170	CP.7	1.814
CC.8	1.014	VV. 8	1.172	PP.8	1.187	CP.8	1.731
CC.9	1.006	VV.9	1.175	PP.9	1.244	CP.9	1.846
CC.10	1.012	VV.10	1.169	PP.10	1.220	CP.10	1.858
CC.11	1.023	VV.11	1.137	PP.11	1.135	CP.11	1.735
CC.12	1.01	VV.12	1.185	PP.12	1.191	CP.12	1.808

Table 3. Specimen weights after wetting

Cotton		Viscose		Polyester		Cotton Polyester	
Sample	Weight (gr)	Sample	Weight (gr)	Sample	Weight (gr)	Sample	Weight (gr)
CC.1	3.087	VV.1	4.571	PP.1	3.076	CP.1	5.239
CC.3	3.064	VV.3	3.326	PP.3	2.968	CP.3	4.490
CC.5	3.420	VV.5	4.127	PP.5	2.942	CP.5	5.692
CC.7	2.975	VV.7	3.947	PP.7	3.038	CP.7	5.174
CC.9	3.052	VV.9	4.157	PP.9	3.323	CP.9	5.343
CC.11	3.214	VV.11	3.502	PP.11	3.069	CP.11	4.848

Weight changes of each sample pairs are given in figures below:

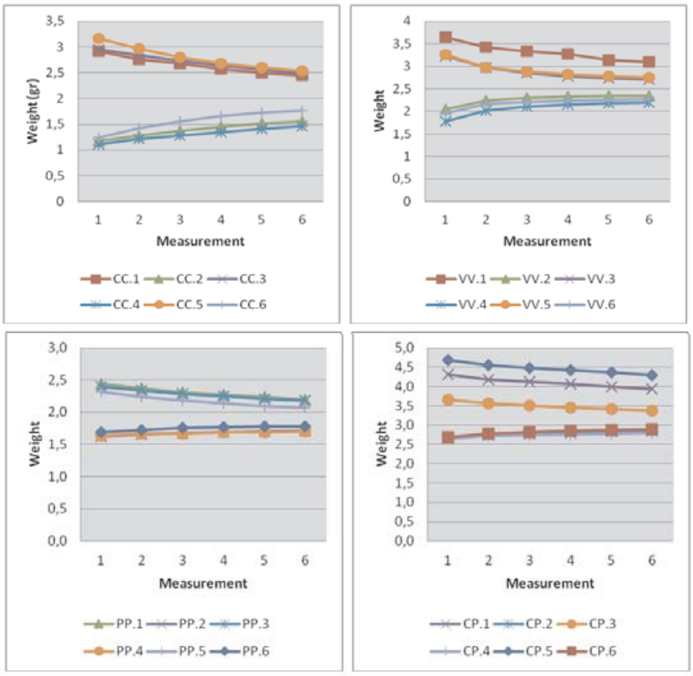

Figure 1. Weight change of face to face sample pairs

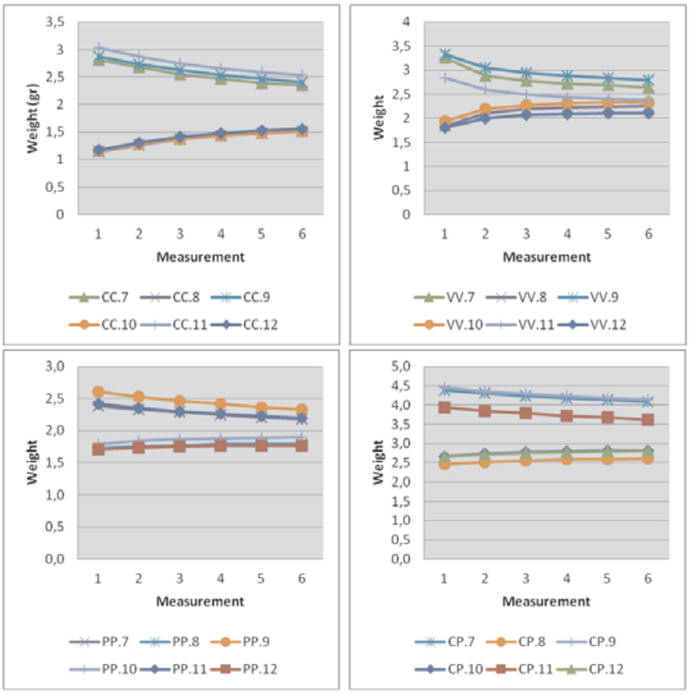

Figure 2. Weight change of face to back sample pairs

2.2 Drying Rate:

In order to evaluate the drying rate of fabric water evaporation rate should be calculated. 80 mm x 80 mm square specimens are prepared to measure drying rate of fabrics. Dry weight of each sample is measured and noted as w_f. Water, up to 30 % of w_0 is added to the samples and samples are weighed again and results are noted as w_0.

Fabric samples are weighed every 5 minutes of total 120 minutes test duration. Each measurement result is recorded as w_i. Water Evaporation Rate is calculated by the below equation:

$$WER(\%) = \left(\frac{w_0 - w_i}{w_0 - w_f}\right) x 100\ \% \qquad (1)$$

Measurements are done under standards conditions, 20±2 °C and 65±5 % relative humidity).

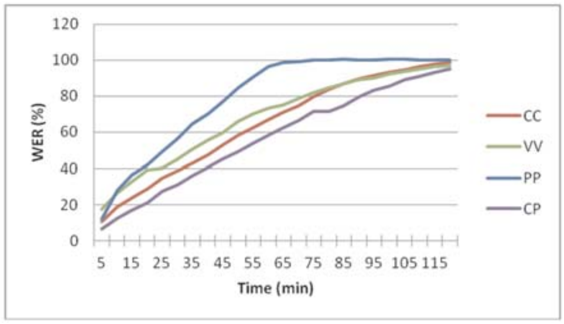

Figure 3. Water Evaporation Rate of sample fabrics

2.3 Vertical Wicking:

Specimens with the size of 200 mm x 25 mm are cut for measuring vertical wicking properties of fabrics. 30 mm from the bottom end of the fabric is marked and immersed into the distilled water. To protect the bottom end level of fabric a small clamp is attached to fabric. Water height is measured every minute of 15 minutes test duration. Measurement results of each fabric type are shown in the figure.

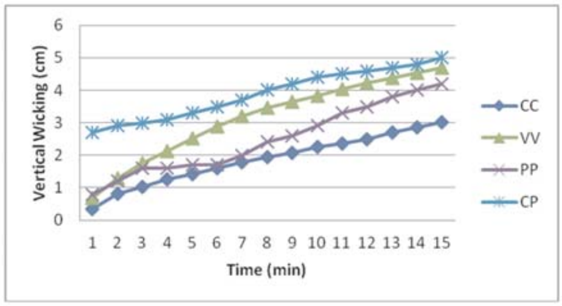

Figure 4. Vertical wicking of sample fabrics

3. RESULTS AND DISCUSSION

3.1 Transfer Wicking:

Figure 1 and 2 shows the transfer wicking ability of cotton-cotton, viscose-viscose, polyester-polyester and cotton polyester-polyester double jersey mattress ticking fabrics. As shown in figures transfer wicking ability of cotton-cotton and viscose-viscose double jersey fabrics are highest. This is because of the hydrophilic character of both cotton and viscose. In both fibers there is no significant difference between face to face and face to back transfer. Cotton polyester-polyester and polyester-polyester double jersey fabrics have lower transfer wicking property and it is because of the hydrophobic character of polyester. In cotton polyester-polyester double jersey hydrophilic cotton content leads to an increase in transfer wicking ability.

3.2 Water Evaporation Rate:

WER results of each fabric at the end of 120 minutes test duration is given in the Table 4.

Table 4. WER results of fabrics

Fabric	WER (%)
CC	98.55
VV	96.95
PP	100.19
CP	95.16

Polyester-polyester fabric shows the highest WER while cotton polyester-polyester showing the lowest WER. Drying ability is effected by the fiber regain and vertical wicking ability [5]. Polyester is a synthetic fiber and its moisture regain is lowest. As a result it shows the best drying ability. On the other hand water evaporation rate of cotton polyester-polyester fabric is lower than both cotton-cotton and polyester-polyester fabrics. Fabric thickness and weight also affect the drying time of fabric. Cotton polyester-polyester fabric is the heaviest of the four fabrics with the weight of 340 gr/m^2 while weight of cotton-cotton and polyester-polyester fabrics are 248 gr/m^2 and 280 gr/m^2. When WER results of cotton-cotton and viscose-viscose fabrics are compared, it can be seen that cotton-cotton have better WER result. This is again because of fiber regain. Viscose have higher fiber regain than cotton fiber making viscose have worse drying ability.

3.3 Vertical Wicking:

The vertical wicking results are sequenced as CP>VV>PP>CC. Cotton-cotton fabric shows poor wicking result because of low capillarity caused by high moisture regain. Cotton fiber tends to retain moisture and its surface wetness is not good. Polyester-polyester fabric is expected to have high wicking results, but in the experiments fabric showed one of the lowest results. It is thought to be the effect of the fabric construction because of pauses observed in liquid spreading. Although its hydrophilic character viscose-viscose fabric has better results in vertical wicking test than cotton-cotton fabric. Cotton polyester-polyester fabric has the best vertical wicking. It is the result of polyester proportion. Polyester decreased the effect of cotton to retain moisture by its high capillarity.

4. CONCLUSION

Transfer wicking, vertical wicking and drying rate properties of different double jersey mattress ticking fabrics are analyzed. As test fabrics cotton (face side)-cotton (back side), viscose (face)-viscose (back), polyester (face)-polyester (back), and cotton polyester (face)-polyester (back) are used. Cotton and viscose fabrics have the best transfer wicking results because of hydrophilic character of these fibers. In drying rate testing polyester-polyester fabric has the highest values as a result of hydrophobic property of synthetic fiber. Cotton polyester-polyester fabric shows the highest vertical wicking values in vertical wicking testing. In order to provide sleep comfort mattress ticking fabric should have good fabric comfort properties. In this study fabric comfort is analyzed by testing transfer wicking, vertical wicking and drying rate properties of mattress ticking fabrics with different fiber content.

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